

An action research case study of active learning
through dialogue, action and structure
in self-study distance education packages

by

Henrietta Wilson

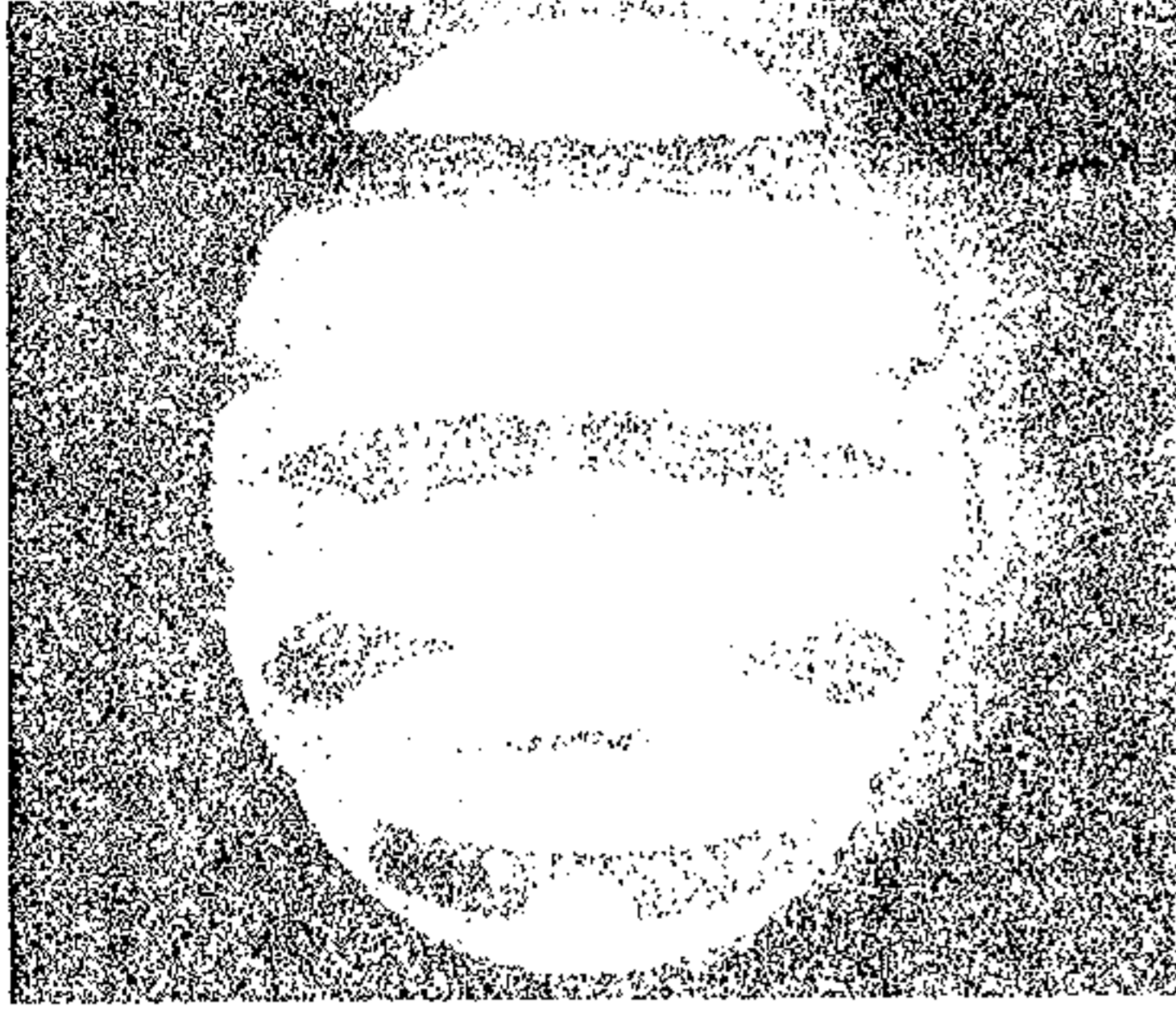
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SUMMARY

An action research case study of active learning through dialogue, action and structure in self-study distance education packages

By HENRIETTA WILSON

Supervisor: Prof W J Fraser

Degree: Master of Education

Department: Didactics

This study investigates the terms, dialogue, structure and active learning in Open Distance Learning texts in a constructivist and problem-solving approach. In-text activities are imbedded in self-study texts. Their construct is validated against appropriate instructional design and learning theories for active learning.

A course team developed, implemented and piloted a Unisa course for mathematics teachers in South Africa. The results describe their professional development through action learning. The Tornado-approach affects teams in organisations.

A team used participatory action research and action learning with rich descriptions to document the longitudinal case study of four action research cycles over eight years. Qualitative research involved a literature survey, notes, portfolios, mindmaps, letters, interviews, document analyses, and assessment results.

Our action research demonstrates ways to implement a post-modern learning design in an industrialized institution. The researcher applies action learning in professional development, in team management, and suggests models for successful/unsuccessful teams (tornado-effect).

Key terms of subject of title:

Distance education

Course design and development

Instructional design

Activities in Learning design

Participatory action research

Qualitative research

Case study

Mathematics education

Constructivist

Course teams

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Acronyms

AL	Action learning
ALP	Action Learning Programmes
AR	Action research
ARP	Action research project
CDD	Course Design and Development
DE	Distance education
DETC	Department of Education Training Council
DoE	Department of Education
HE	Higher education
ID	Instructional design
MMAT	Unisa Mathematics Subject Didactics course (MMAT00-8)
NCHE	National Commission on Higher Education
OBE	Outcomes-based education
ODE	Open Distance Education
ODL	Open distance learning
RSA	Republic of South Africa
Unisa	University of South Africa

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Since the University of South Africa is the copyright holder of the *Mathematics Subject Didactics* course materials only enrolled Unisa students access the course. Unisa holds the copyright. The basis of the study was the course design and development and staff development actions between the Department of Further Teacher Education (Mathematics Subject Didactics Specialisation area) and the Bureau for Learning Development. I am indebted to Unisa that provides me as a staff member with opportunities.

Declaration

Student number: 622-499-7

I declare that

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is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.



MRS H WILSON

15 June 2002

DATE

I: Chapter 1

Action Learning through dialogue, actions and structures in self-study texts

1.1 The need for purposeful, collaborative Inquiry into study material design

As distance educators, we need to question our views, the events that take place in the Distance Education (DE) course design environment, and the quality of the learning product. In distance learning circles there is a great concern that "research is not a high priority between professionals and specialists in distance education". It is vital that we keep in mind "the enormous potential, and value, and the practicality of carefully designed research activities" and that we "participate meaningfully in research, consider why it is done, what effects it has and how it can be applied" (Wedemeyer, as reported by Moore, 1987b:2).

This research describes the theory and practice that underpin the design of self-study texts for South African learners. The researcher argues that the development and use of instructional devices, like in-text activities, may create a learning environment that provides options that facilitate self-study. An active learning strategy focuses on the development of interaction and a discourse with the learner, as well as a guiding structure. This type of research addresses the need for establishing important issues in the creation of effective DE courses, "especially of an experimental kind, [as this] is urgently needed concerning ... techniques of facilitating interaction" (Moore & Kearsley, 1996:71, 60). Much remains to be discovered about how effective distance education really is.

In this study, the researcher purposefully questions, structures, explores, and tests aspects she has identified as affecting change in the field of distance learning strategies and pedagogy. In the distance education institution change often occurs during the course design and development process and in the learning situation. The forces that influence change in a DE institution are the structural elements of the distance education context imbedded in the social relationships and roles, the actions of the participants, and the discourse that takes place between the role players.

The existing literature provides little guidance concerning research-based course design project teams. A course design project based within a research methodology is required for ODL (Open

Distance Learning) practitioners. The constitution of such teams has been described. Nevertheless, little information is available on how a course team functions, how effective it is, and how it influences a DE institution like Unisa. A Unisa course team used action research (AR) as a vehicle to develop a Mathematics Didactics Education course. This development served as a case study to verify the theoretical arguments around active learning and to question distance learning practice.

The action research methodology used, is described here. It provided a model for development to allow the researcher to focus on and describe "events" or "moments" that take place in course design and development in DE. This research methodology is suitable when a group of people with a similar focus use planning, inquiry, description, and a seeking of meaning during events in the various stages of a course design project. Action research means to deliberately plan for strategic action while rigorously observing the effects or "happenings" during the various spirals in the process (Lewin, 1946, in Kemmis & McTaggart, 1988:34). This focus on events during the cycles allowed the researcher and participants in the process to reflect on their experiences.

The result of the reflection was that the course team, as participants, started to view reality from the same "window", mainly because of their constant collaboration in the processes. (Chapter 4 Figure 4.1 describes the spiral in a process of strategic action.) In the past action research programmes (ARP) such as course design and the use of media (like video conferencing for student support) spearheaded change at Unisa (Heese, 1995:1 and Wilson, 1998:1). There are many examples of subject-based case descriptions from Unisa (for example Oguda, 1997:95; Erasmus, 1998:95 and Wilson, Schenck & Grobler, 2000:1). A comprehensive description of a course development at Unisa is, however, not yet available.

In a quest for answers, the researcher followed a course design and development (CDD) process in use in the institution at the time. This course design project was initiated in 1994 (Heese, 1994:1). The process turned out to be an acceptable CDD process model at the University. The preplanning, design, development, production and delivery (PDDPD) process model proposed by Macintosh for Unisa (1998d:6), however, lacks the necessary elements to direct research into a particular development of study materials. The description of the processes and outcomes require practical on-the-run solutions that this research study wishes to demonstrate.

Instructional design principles, such as using activities to better self-study texts, attempt to address the many problems the distance learner experiences. Some typical problems are isolation, lack of direction in learning, a lack of skills required at tertiary education level, and the tendency to learn without insight (as described in sections 2.4.2-2.4.4).

The researcher argued that specific instructional design aspects might bring about improvement in the dialogue, actions, and structure of self-study learning texts. This research attempts to describe the outcomes. This reflection will help lecturers, course designers, instructional designers and subject specialists better to understand the complexities of events during the practice-based, theory-infused exercise of resource development (refer to section 4.10-4.12). The researcher proposed that it may be possible to design quality DE interactive study materials if guided by the principles of instructional design (ID). Such well-designed learning resources, which give students the option to ask for or refuse support, may help certain types of learners.

However, the researcher's reading covered many suggestions from instructional design experts on how to design courses overall. All these stress the importance of involvement through activities and identifying some related aspects. Very little is said about the specific purposeful structuring of activities or criteria for the involvement of learners in the learning process. This is essential when catering for a diverse population. One of the most important aspects in this involvement is the development, management and evaluation of activities in text, especially in distance education self-study learning packages, where printed self-study texts are still prevalent and are expected to remain so in the near future.

The course design proposed may enable academic staff to shift their emphasis away from marking assignments as the major teaching strategy for contextualised curriculum and course design, comprehensive tutor relationships and training, integrated authentic assessment strategies, quality learning strategies, and professional development for promotion. If implemented successfully, this approach could enable accomplished academic staff to direct learning for larger and more heterogeneous groups of students (as challenged by the NCHE, 1996:119-120). Based on this premise, major institutional-wide staff development workshops promoted the activities in self-study texts approach from 1993 to 1997, (Wilson, 1993; Wilson, 1994c; Wilson, 1995; Wilson & Goodwin-Davey, 1996; Heese, 1996) with the first new course developments (the Mathematics Didactics Course included) being piloted in 1996 (MMAT00-8 tutorial letter 101 1996).

We, as distance educators, in addressing change need to prepare ourselves and our learners to cope with the pressures of an unknown future. It would also be useful if we could establish how people in a large organisation could share their knowledge about course design and development in a "learning system in which the person himself will take a larger responsibility for initiating, expressing, and even in some ways assisting the opportunity to learn in order to solve indigenous problems" (Moore, in his interview with the "father of American distance education", Charles Wedemeyer, 1987a: 4).

Reflexivity can be of great value for educationists in guiding their understanding of the complexities inherent in distance learning, curriculum theory, and educational practice. This understanding will impact on the practice of study materials development. Educationists need to be able to manage the integration of learning theory in educational practice by focussing on educational dialogue and structure that support active learning through opportunities in the texts. (An example of such an opportunity is the instructional "tool" called in-text activities.) ODL staff are not always skilled in this area. Staff development enables the academic and administrative staff to function optimally and is imbedded in course projects, as is reported here. Multi-skilled ODL professionals are required in the post-industrial era (Macintosh, 1998c: 59). There is a need for a strategy to manage course teams according to project management and research principles. This may enable ODL professionals to better manage internal stresses. Course design and instructional design publications and workshop handouts assisted the University staff to focus on the need to follow the best practice examples (including Heese & Heese, 1996; Wilson, 1995; Heese, Mackintosh, Steyn & Van Zyl, 1996; Wilson, 1993).

During the developments described here, many changes took place in South Africa with the end of apartheid as well as the country's acceptance into the international community. Innovative projects resulted from external pressures to improve the quality of Unisa's study material, as Unisa's pedagogy was seen to be below international standards (refer to the Wedemeyer report, 1974; the SAIDE report, 1994; the Swift recommendations for first year courses, 1993; the Van Enckevort & Woodley report, 1995; the visit of Lockwood, 1996). Internally the dissent with an ineffective system (Macintosh, 1998d:3) and pedagogy strongly influenced staff as they gained knowledge through reports and examples of good practice. These new insights prompted the researcher to ask questions about improving the quality of Unisa course materials, especially the course guides. This context required the course team to take note of and integrate new thinking in order to improve the course in line with national and international quality standards for distance education.

This case study is a course development process that takes place within a highly successful distance education institution (Wedemeyer, 1974; Macintosh, 1997:3; DETC, 2002: report). Unisa was, and is, structured in specific departments based on functions which influenced the course design process and the resulting study material. The Unisa structure and system of producing courses have evolved over a period stretching from the inception of the University as an examining body in 1876 to the start of formal teaching in 1946, following a number of government acts (Boucher, 1973:16). This industrialist system has to accommodate post-industrial course design practices (Macintosh, 1998a:16).

In contrast to industrialism, post-industrialism requires a holistic approach with collaboration and co-operation between a network of people on a global scale. These special relationships result in shared decision-making. This approach is identified by autonomy in decision-making, together with accountability. It demonstrates a focus on initiative, innovation, and an adaptable learning material shelf life. The approach promotes diversity, customisation that adapts production factors, holistic approaches to quality, process-oriented instead of product-focussed delivery, total quality focus. It also has a client-focus. The Unisa system required a new practice such as the team approach within decentralized management and administrative working groups to design DE course materials. This was seen to be the answer to infuse change into the system and design a new innovative product with a short shelf-life, customised for the student and produced to enhance learning (Macintosh, 1998a:17-18).

This inquiry also opens up a discussion on the difficulties and stresses lecturers experience within organisational structures when they develop study guides and plan learning situations in a short time (Moore, 1987a:3, in his interview with Charles Wedemeyer). There is wide concern for the effective management of team members at Unisa in the quest for quality materials - more cases need exploration against proposals such as the ODL matrix of Macintosh (1998a: 85-110).

These are the reasons why research into a course design process that fosters a learning dialogue within text-based study materials is necessary. The aim of the research was to describe the reflective processes and the outcome thereof in the course reported here. The focus was on improving the instructional design of the course through the integration of both the theory and the practice of distance learning. The rationale for taking this path was to better understand the methods that mathematics teachers employ and to explore the complexities of making the "*personal act*" (Wedemeyer, in Moore, 1987b:3) of learning possible for mathematics teachers in the South African context where such dialogue and learning opportunities often do not exist.

Further challenges required that research establish how course teams function successfully in a distance education institution such as Unisa. Information on how to design courses according to good learning design principles, and whether specific learning strategies could foster learning in a particular course, is also of vital importance.

1.2 The challenges imbedded in Distance Education

Educational environments are affected by change. The forces that affect change include political, economical, social, and technological ones (refer Figure 2.3). Change takes place on a global, national and organisational level, influencing nations, groups and individuals. Clearly, such change affects both the students and the staff of an education provider.

1.2.1 Global changes in DE provision

Unisa as DE institution has answered the need for affordable, accessible, accredited, quality education since 1873 (Boucher, 1973:189; Unisa, 2001: Research Report; DETC report, 2002). All countries providing DE regard this method as an answer to the geographical distances separating their citizens and as a way of providing equitable access to education. Jegede & Shive (2001:210) discusses developments in Northeast Asia, Southeast Asia, South Asia and the Pacific Rim, as well as the USA. They identify Canada and Australia as being among the first to adopt DE, ignoring the pioneering role of Unisa that answered the need for distance education in South Africa as early as 1946 (Macintosh, 1998c:1).

As we move into the post-industrial era, changes are required. Improvements include a rapidly changing multicultural South African society, national education policy shifts, transformation in subject matter, changes in the student body, increased learner support requirements, less financial resources, and lecturing staff that have to adapt to DE and new pedagogy requirements. Unisa also strives to focus on the effects of globalization (Macintosh, 1999: 14; Pityane, 2002: speech).

1.2.2 Structural change in DE institutions

An industrialist workplace is characterised and influenced by principles of standardisation, division of labour, mass production, mechanisation and automation (Mansell & When, 1998:49). Unisa as an institution increasingly demonstrated a typical industrialist system. This was characterized by a standardised system, division of labour that caused the functions in the process to overrule learning requirements, mass production of materials that followed strict administrative rules that were separated from learning decisions, as well as mechanised and automated processes that exclude course design processes (Macintosh, 1998a:16). These linear processes driving an institution serving a diverse learner population result in standardised materials (for example in its layout and orange/brown cover design), and strict bureaucratic systems with no space for deviation. These characteristics of the industrialist system, dating from the latter part of the nineteenth century, drove distance education institutions that were formed during the height of the mechanised manufacturing period. The university of the future should *"no longer be based on the processes of ODL design and development but rather on the basis of dynamic design-driven projects"* (Macintosh, 1999:14). When pedagogy changes in order to address societal issues, different institutional practices that deal with a collaborative and participative working environment are required.

1.2.3 Increased student support

The new South Africa has seen a great increase in distance education learners who require support. The challenge is to address this increased need with organisational design and quality

learner-centred materials containing in-text activities that will foster dialogue, prompt active learning and provide sufficient structure (Macintosh, 1999:13).

1.2.4 Focus on professional development

The pressure on Unisa to "change with the times" and use relevant pedagogy spearheaded three main periods for change towards better practice in distance education. These occurred around the time this course development took place in 1990, 1994 and 1997. The researcher's experiences informed her opinion that these pressures existed in the majority of the courses at Unisa. Macintosh (1999:14) noted that one of the requirements for the university to adapt should be a strategy *"promoting and supporting a culture of transdisciplinary knowledge, as opposed to distinctive boundaries of specialisation."*

1.2.5 Pressing technological forces

Technology is changing rapidly and because communication is so central to DE, technology includes "machines, tools and the presence of a specialised knowledge base in the design, development and delivery of learning opportunities" (Macintosh, 1999:1). "Print is undoubtedly the most common medium ...used ... in some form by almost all distance education courses ... to provide an organisation and a structure for the course and to integrate... instruction" (Moore & Kearsley, 1996:78-79). These changes have to be addressed in the main medium of communication in DE, the learning texts, and in student support. The institution needs to use advanced information technology to facilitate cost-effective mass customisation of ODL learning materials. This will mean a shift from mass production of uniform parts for a uniform product to the assembly of uniform parts into a unique, individual product (Chattel, 1995:57 in Macintosh, 1999:13) and should "focus" on "leapfrog" previous eras of technology alternatives.

1.2.6 Diminishing financial resources

It is interesting to note that the economic level of a country correlates well with the educational technology and availability of ODE (according to Jegede & Shive, 2001:210). DE institutions are effective partly because of the economics of scale (Macintosh, 1999:9), so that the impact of new pedagogy on society reaches a great many people. The university is challenged to address learner support to facilitate an active learning approach while coping with diminishing financial resources.

1.2.7 Little appropriate research in DE course design

More validated teaching research concerning the course design and development process in distance education is urgently needed. The question of designing specific actions, structures and communicative discourse together with the learner has arisen. The question follows whether DE learning designers and developers can create a learning environment that will result in appropriate acquisition of knowledge and skills. Change in a learning environment requires a new approach to

the design of learning experiences. Learning theory should be validated in a DE environment (Moore & Kearsley, 1996:3). There are examples of the practice of learning through DE course materials and ID (Instructional Design) theory. There is a body of knowledge about learning in mathematics and other subjects, but no description of teaching practice at Unisa.

1.2.8 Multi-disciplinary team approach

The 1990s saw an increase in instructional design requirements for course design and a multi-disciplinary approach became necessary to address specialist areas. The challenge is to address problems in a planned and structured way, not as an individual lecturer with isolated contact opportunities with students, but as a participant in a team analysing the processes and designs of a course. This process of dialogue starts in the planning phase within the course development team and extends into a dialogue with the student. Moore (1996:127) states that even in the "simplest" of distance education situations there is always collaboration with somebody. This may be with administrative staff, technical staff, coordinators or tutors at the institution where the course originates or is presented. This factor distinguishes distance education from contact teaching and it is often overlooked by educators when designing self-paced distance education study material. A team approach and changes in pedagogy have profound influences on the DE institutional system and processes, which this research wishes to address.

1.2.9 Active learning pedagogy

Self-study text in print is still the most prevalent medium (Moore & Kearsley, 1996:78) and will remain so for the immediate future. Text is also imbedded in electronic and online media so that arguments about text-for-dialogue could apply to any medium. Since the early 1980s there was concern for the improvement of teaching and learning in higher education (HE). Although the focus of the reports varied greatly, all endorsed one important consideration, namely the use of active learning strategies. One example is Cross (1987:4) who noted that *"when students are actively involved in the learning task, they learn more than when they are passive recipients of instruction"*. Chickering and Gamson (1987:6) indicated that students *"must talk about it, relate it to past experiences, apply it to their daily lives. They must make what they learn part of themselves"*. The inclusion of activities makes learning an active process requiring effort on the student's part because of the physical and psychological distances which form part of the DE environment. Engagement with text is difficult for most adult learners.

Change in the self-study materials necessitates research and investigation. Change is fostered through dialogue, specific actions and defined structure within a particular context. Wilson (2002:3-4), extending Dlamini's argument (2001:26-28) to DE and course teams, proposes a change model to support and focus the management of change that new course material development

necessitates (refer to Chapter 9). This research investigates textual design components that influence the structuring of the learning environment, discourse building and the management of actions to learn specific skills and knowledge.

Many factors inhibit active learning. Getting students involved in the self-study material is commonly regarded as essential for learning effectively, but it is a complex, difficult area that can affect the learners' ability to learn. The most common factors that inhibit the fostering of an active learning philosophy (supported by Fowler, 1993: 210-211) are:

(a) Factors inhibiting systems

The massive increase in the number of school pupils has led to increased financial demands on pre-university systems and resources. This has resulted in a slow reduction in state funding for higher education.

Universities are unable to provide a flexible education system environment to learners, where access and exit points are possible at various stages. Other problems are low mobility or articulation between institutions of education, and inflexible assessment and study choices.

(b) Factors inhibiting learners

Primary and secondary schools tend to emphasise rote learning of facts rather than higher order thinking skills and learning strategies - thus insufficiently preparing students for their role in higher education.

Another factor that influences learning is students' inhibiting attitude towards teaching and learning. This is just as influential as the educators' attitude to and knowledge of the learning process. Some attitudes create a climate within which dialogue is limited and learning opportunities are not negotiated with care. Students are often seen as receivers and "regurgitators" of information. In contrast, where dialogue is encouraged and learning opportunities are an integral part of the study process, active learning is promoted. Distance education course developers should strive towards dialogue and active learning with the aim to building learner confidence and independence to study in this difficult environment. Developing such a text-based dialogue is a complex strategy (explained in chapter 3). The processes involved in developing an environment for the design of such course materials in a large distance education institute are complex and team strategies are crucial (see Section 2.7).

Some students find alternative learning experiences such as dialogue, active learning, and independence strange because they are used to rote learning (also refer to Moore, 1996:126). Such learning climates are evident even in written distance education texts where interaction and feedback are absent. Interaction (or lack thereof) influences the guidance the learners receive and

ultimately the accuracy and diligence with which they complete tasks and actively participate in learning. It can therefore be expected that, within an active and comfortable learning climate, learning activities should be carefully planned to lead learners through the learning texts, enabling them to learn more effectively (Wheless, 1975:132-133; Moore & Kearsley, 1996:126-7).

The theories of teaching (Johnston, 1995:2) indicate that the styles of student learning can be correlated. Irrespective of the typology of learning style, such as the holistic and serial approaches to learning by Pask (1976), contextual rationalization and task directed learning by Baird & White (1982) and the metacognition by Flavell (1976). The learning style imbedded in self-study guides may be different to the learner's style or inappropriate to the learner's paradigm - their abilities to reflect and their attempts at attaching meaning. Learning styles describe a student's preferred approach to learning. Various in-text activities allow the use of a variety of learning style approaches. This provides unique benefits for students with a specific preferred learning style (according to Osterman, 1984; 1985). Some learners favour innovative and feeling learning styles as they enjoy private discussion sessions which focus on meaningful applications of the material. The students with analytical and thinking learning styles will enjoy formal lectures more. Learners with common sense and sensing learning styles will enjoy the demonstration and "how to" material found in the study guide, as well as problem-solving activities. Learners with dynamic and intuitive learning styles favour the pre- and post-test sections in the guide and self-discovery material.

Boredom, anxiety, stress and lack of motivation or perseverance are problems that students in distance education courses are confronted with; these problems are often caused by the nature of the texts and their situations (Moore & Kearsley, 1996:126). Orr (1995:60-78) suggests a variety of learner actions such as writing strategies and techniques for distance education including examples, guidelines, and criteria for creative and effective teaching of assignment writing. She warns that the variety must not increase the marking load for the distance lecturer. This solution addresses writing skills for assignments in courses where there are large numbers (hundreds or thousands) of students. This solution can address motivation, different learning experiences and learning styles, different pre-knowledge, and other problems.

The study guides or lecturers may be unable to identify or address the needs of the learners. Such guidance should take into account their characteristics, part-time study requirements, linguistic and cultural/societal needs, as well as other distance education demands.

(c) Factors inhibiting teachers

An increased student-lecturer ratio, especially in distance education in South Africa, has become a reality. This causes educators to accept rote learning as this enables them to cope with the labour-intensive nature of the perceived problem. Additional guidance or good instructional design and

assessment strategies are required, especially in the case of weaker learners.

South African teachers have few resources and an inability to use existing resources and facilities fully. Resources include available time, available people with particular knowledge and skills, publishing opportunities, printing requirements, design requirements, and technological facilities.

Faculties are often unable to speedily adjust to change in a new, modern, integrated distance education environment and to adapt to new expectations by the government, labour market, and student body. In the same way, faculties may be unable to address students within a learner-centred approach.

(d) Factors inhibiting pedagogy

The curriculum fails to address needed changes and to reflect new trends in teaching philosophies. A re-evaluation of what the beginning professional should know and be able to do, should result in a change in focus and the use of content.

Moore (1989b:90) focuses on the issue of the high drop-out rate. The dropout rate in DE is exceptionally high when compared to contact teaching. He argues that dropout rates can be reduced through recruitment techniques and counselling strategies. At Unisa recruitment has never been a focus as the University is often the only option or the preferred form of education for many learners. Counselling is optional and difficult to provide to thousands of self-study learners - so some forms of counselling were explored.

Kember et al. (1990: 55) proposed a model to support student progress by changing the conceptions of both the student and the lecturer in relation to their respective roles and identified four key constructs: social integration, academic integration, external and academic incompatibility. Kember includes background characteristics. Although the model is robust, it accounted for 80% of variance in adult student persistence. This seems still to be a difficult area to research.

It is difficult to construct learning actions for guides. Distance educators need to understand the potential and limitations of the "business" of the DE system in order to explore effective strategies for learning in this technology-dependent environment (Moore, 1996:126). Understanding how to write self-study texts is one side of the coin; the other side is to find out what makes learning over a distance effective. Establishing whether learning took place, or how effective the construct of meaning and eventual knowledge acquisition was, is always difficult. What is required is knowledge of a variety of strategies to address various factors in the learning environment. Through research, distance practitioners should analyse cases where such methods were applied. Bell-Gredler (1986:325) proposes that analyses of specific cases and of theories may provide some answers. He argues as follows:

In today's complex society, both learning and education take place on several levels, for different purposes, and in a variety of settings. Education includes informal study groups, preschool experiences, industrial training, and advanced graduate study and research. Each of these educational contexts may foster the learning of a range of different skills, attitudes, and abilities, for which a number of variables that influence learning may be identified.

Theories ... provide a rich and detailed source of information for the analysis of learning and instruction in each of these contexts.

It is possible to identify variables that influence self-study. Learning theories often support the analyses of learning that take place in very different contexts. Activities for learning offer a solution because they can improve learning, but there are a large number of factors that influence the success of activities, and some activities can also hinder learning (De Wet, et al., 1981:241; Nussbaum, 1983:672; Seiler, et al., 1984:19). Pretorius (1996:50) indicated that self-study has to facilitate student activity, effort, involvement, etc., thus encouraging the student directly to deliberate on his/her own learning, to manage it and thereby gradually develop meta-cognitive skills. As Pretorius indicates, this is not enough. An example is the University of the Orange Free State (now the University of the Free State) where students did not complete self-evaluation activities or self-tests at the end of a module. The further they progressed through the course, the less motivated and more careless they became. Changing the pre-test, self-evaluation and post-test designs in a module to include experiential learning and combining it with tutor-guided group sessions solved the problem of participation greatly in this contact situation (Pretorius, 1996:49-50).

A subject specialist can help students by addressing the problem of passivity in learning through activities (Johnston, 1995:3) that:

- reflect on implications of existing knowledge without an outside stimulus. For example, when a place name like "Kaap punt" meaning Cape's point suddenly has meaning;
- can trigger incidental learning, such as when a person with an open and observant mind notices on an outing that dark fallen leaves are warmer to sit on than bleached dead grass, and relating it to the principle that dark surfaces absorb heat better than light surfaces, thus understanding the principle better;
- show relevance to the present and future life of the learner by the subject developer who guides students to probe their understanding of instances and events, which relate to understanding concepts, in an interestingly varied, but fun way.

This construction of meaning may include concept mapping, prediction-observation-explanation and conversation about instances or events (using drawings, actual objects and events). (Refer also to Piaget, 1927 in Bell-Gradler, 1986: 176.) This also includes conversation about concepts (exploring

knowledge about facts, beliefs, opinions, strings, images, episodes, intellectual and motor skills using association maps or matrixes), drawings, fortune lines, relational diagrams, word association, chaining, mnemonics, and question production.

Activities can trigger learning attentiveness and responses, but the type of response will be varying between individuals. Johnston (1995:3). For the first two points above, implications of current knowledge and incidental learning, it is especially relevant, but in the last case, using instructional methods to discover relevance, the outcomes were in the past considered to be relatively controlled, but this is not always the case; the differences in understanding need to be carefully addressed in the feedback as understanding is multi-dimensional, not linear.

Apart from the type of response activities can elicit, their effectiveness is also dependent on the matching between the lecturer teaching style and the students' individual learning styles. Different activities can, by their very nature, restrict students to a particular learning style such as asking them to list or discuss which are both linear formats. An activity can provide them with a variety of options to choose from. An example would be: draw a mindmap or list or show in a table the relationships between concepts A and B. Even the layout of the activity can imply some format such as dotted lines to write on which can inadvertently determine the amount to be written, the importance of it and time to be spent on it, as well as a linear listing format. The challenge is to simulate this experience in self-study text activities in order to sustain motivated active learning (see Chapter 3).

1.3 The relevance of this study

Teaching and learning theories abound, but the search for open distance education teaching learning theories is regarded as a priority. (Peters, 1994: 3; Rumble, 1995:2; Holmberg, 1986; Moore, 1983.) In order to formulate a theory, one has to base such theories on hypotheses about distance education learning and teaching, as well as the DE organisation and its administrations, only then can researchers test prevailing hypotheses. This study takes place in a DE institution and applies various DE theories. The study seeks appropriate course design principles based on an appropriate epistemology (grounding assumptions) in DE praxis. The results of the study provide a number of models which may improve DE course design.

The study documents the planned developments and results that took place in a specific case over eight (8) years using a qualitative research methodology, action research. This longitudinal description is unique as it describes actual self-study material development for adult learners.

The questions that emerged during this case were many and we found it difficult to narrow them

down for the research. As we focussed on one question, it had a ripple effect - a change such as adding activities into the text influenced not only the learning design, but aspects such as the assessment structure, the learning environment, the production processes of the course, the development of a team's members. Action research provides an answer to direct and document change in the instructional design of DE course materials.

Following the need for quality materials, staff development workshops were presented in 1994 on course development (for example sessions by Wilson, 1993; Wilson, 1994; Wilson, 1995; Wilson & Goodwin-Davey, 1997; and Heese, 1994), and courses based on a new pedagogy that contained activities in the texts were released in 1996. This course was an outcome of these staff development impetuses. Today it is practice to structure learning environments using activities as a tool; it is unthinkable not to.

Lecturing staff is under tremendous pressures. Total student enrolment at universities and technikons increased by an annual average of 10% between 1988 to 1993 (NCHE, 1996:11), at the time this research and development was initiated. In the wake of the increased student numbers and the requirement for increased output, lecturing staff accompaniment is often reduced or kept static for some time in the current economic and social environment (following the global trend predicted by Barr & Tagg, 1995:13). The student numbers and profile at Unisa changed over the last 5 years. A statistical analysis by Unisa predicted that, if all influences stay the same, student enrolments should increase in the future. Since 1999 this scenario changed: for a period in South African Higher Education student enrollments dropped and the distribution of student enrolments changed. With the new national higher education plans to consolidate institutions the enrolment profiles will change dramatically again. (Refer to Chapter 2 for details on the South African context.)

At Unisa there are three major threats to quality teaching provision namely shrinking budgets, large student numbers, and shrinking staff contingencies needed time to do it all. DE professionals are required to conduct research, to design and manage their courses, and to support community work (Unisa Research Report, 1996:1). This puts pressure on upholding the quality of the learning experiences if lecturers insist on staying within the existing learning paradigm while using resources as in the past. The pressure on universities is greater since the post-Apartheid era to teach with more efficiency within an arena of internationally competitive education providers. Global and national change forces such as political, financial, social and technological require constant change to the subject field knowledge which requires the study material to be constantly adapted. Global practices drive course development to better heights in quality and relevance, both in Africa and globally (as shown in the recent institutional collaboration in provision of English Access Courses as

described by Wilson, Spencer & Batley, 2002). Unisa has to develop and effectively use cost-effective and efficient learning methods and strategies provide a sustained and stimulating learning environment for their students (Wilson, 1998:1 in discussing the University's strategic management strategies when implementing video conferencing as a learner-support enabling medium). People will find themselves in a global village – our students of today will have to cope with a tomorrow where the move is away from an industrialized world to a knowledge society (McBeath, 1992b:166). However, these developments did affect institutional policy, organisational structures and systems, a staff training focus, finance, and learning materials (Macintosh, 1998) and this study describes the context and the impact of a new pedagogy on an large DE institution.

This study follows the increased focus on instructional design at Unisa, considering a particular case as it unfolded over six years, informed by theory. It reflects on the processes that took place, the experiences of the participants, the interventions made by the course team and the outcomes. In this process, the course team wanted to reach consensus about the instructional strategies used in the course. The researcher wanted to follow the developments and explore further questions. We also examine factors affecting learning from various learning theorists including face-to-face, correspondence and open learning environments. The field of instructional design is highly complex, a minefield fraught with difficulties, where skilful balancing of knowledge of the subject, the right instructional techniques and the knowledge of students are essential to attempt the multifaceted task. We attempt it with trepidation, because, often, as soon as you get the answers right, the questions change. As the new millennium dawns it appears that experienced distance educators are becoming more aware of their use of traditional approaches to teaching and are constantly seeking alternative ways to manage their situation and to address learning difficulties which students have. In analysing the development of learning theories, one realises why these theories have such an impact on teaching practice. There are times when certain approaches are followed and only later the limitations of the approaches are realised. It is thus understandable why there are moves away from a specific approach such as the logical empiricist lecturer-centred (traditional) approach to the more interactive, reflective learner-centred approach. The traditional approach is directed to the methods the teacher alone uses and often is characterised by one-way communication where learning material is presented, also called the transmissive approach. In contrast, the problem-centred approach relies on interactive communication where there is interaction between learner and materials, learner and teacher, as well as between learners themselves (Moore, et al., 1996:127-134; Bell-Gredler, 1986). An approach which consolidates knowledge, skills and values from various learning theories, based on a learning philosophical approach, and appropriate research methods, may result in a learner-centred approach. This approach integrates learning opportunities which are structured and planned so that learners are able to experience them as patterns of dialogue that are inter-connected, plausible, and complete

entities. These learning opportunities should facilitate knowledge construction, skills, value development and meta-cognitive abilities. It should involve innovation, monitoring and control of teaching-learning opportunities in the learners' own situations.

Text is the tool mostly used in DE to formulate educators' attempts in guiding students to become active participants in determining the implications of new knowledge on their lives. We will show in this study that we agree with the approaches of Jonassen (1988) and Newton (1990) that there are specific techniques that can be used to improve the structure of text in distance education, the dialogue between learner and lecturer, as well as the perception of learning progression. This creates a perceived reduction in the distance or separateness between the parties in the DE environment.

Magadla (1996:83-88) discusses the problem of fostering learning in context by citing the views of different theorists. He cites Von Glaserfeld (1989; 1988a; 1988b;1988c) who wrote that "we do not have the tools for knowing the world as it really is. We can only know the world as we experience it, and we experience it as we have constructed it" (Magadla, 1996:83) and that "... *mathematical learning should be viewed as both a process of active individual construction and a process of enculturation into the mathematical practices of wider society*" (Cobb, 1994:13 in Magadla, 1996: 86). Magadla (1996:85-87) concludes that learning is the result of self-organisation and that verbal explanation *alone* cannot lead to understanding. He goes on to show the relationship between the theories of constructivism and socio-culturalism (discussing the theories of Piaget, 1977, and Vygotsky, 1978), showing how these perspectives differ concerning the accepted setting for learning. The Piagetian perspective places emphasis on the experiential world of the individual, while the Vygotskian perspective places learning firmly in the social domain that the individual finds himself or herself in. In the marriage of these two perspectives, learning is seen as a dialogue process that "involves human beings in communication with another. Learning is an induction of the novice into the culture of a specific community where a more experienced member can lend support to a less experienced member by organizing tasks that facilitate this induction process" (Magadla, 1996:85-87). Magadla argues that this support by an experienced person should be given by paying attention to how the learner thinks, and by inferring various possible responses in order to determine what the learner's conceptual schemata are. "Only on the basis of some such hypothesis can teachers devise ways and means to orient, direct or modify students' mental operating" (Von Glasersfeld, 1988b:14).

For this reason interaction is never isolated; it has to be planned and integrated within a social context in order for learners to construct their own meaning, to understand and to begin on the path of constructing or gaining knowledge. Educators are advised to investigate the various

problems learners have in the light of their own teaching methods that are a focus in this study. People should share their knowledge, but tacit knowledge is difficult to interpret, formalize, represent for sharing, learn from, or critically scrutinize. Tacit knowledge is also not easy to codify or digitally represent in a knowledge management model. Knowledge of the organisation's systems, processes, and structure is often personal, not public, with very little information documented.

Internationally, distance education changes constantly in an effort to address societal changes and philosophical movements. Unisa practitioners should consider the rapidly changing multicultural society, the historical development of South African education, national education policy shifts, changes in subject matter, changes in the institution's student body, as well as lecturing staff who have to adapt to distance education learning environments. These factors affect institutional policy, organisation, staff training and development, finance, and most importantly, learning materials. Therefore, it is important to focus on fostering dialogue between parties in the learning environment. The application in tertiary education is made by Quinn (1988:48) who posits that

"andragogical theory requires that the methods of instruction take note of the need for self-direction by the learners. An open approach [requires] a learning environment in which the learner and teacher form a partnership for the facilitation of effective learning".

The challenge is to look at all these problems in a planned and structured way - not as an individual lecturer with isolated contact opportunities with students, but as a participant in a collaborative process to develop good learning materials. This process of dialogue starts in the planning phase within the course development team and extends to course management in the form of the dialogue with the student. The development of a dialogue fosters understanding of the subject matter. Moore (1996:127) reminds us that even in the simplest of distance education situations there is always some form of collaboration. This factor distinguishes distance education from contact teaching; educators often overlook this factor. Eison, Janzow, and Bonwell (1990:82) state several reasons why faculty members say they do not use active learning strategies:

- Some people claim that they cannot cover enough material in the time available;
- Some people say such activities take too much time to prepare;
- Some state that large groups restrict the types of active learning strategies that can be used;
- People tend to stick to the easiest, most accepted or safest thing to do and like to keep the *status quo*;
- People are unwilling to take risks.

These are commonly stated objections or feelings - all very valid. The course designer or team facilitator must address these feelings and opinions in order to support faculty in addressing the

new learning needs. In light of the above-mentioned problems this study investigates the successes and problems of the course as it manifests in practice. This enabled a collaborative team to change mathematics education teaching materials in the face of the lack of preparedness of mathematics teachers as well as large student numbers.

Contemplating these issues, and seeing how difficult it is for both learners and lecturers to participate in the process of dialogue, the researcher felt that there was a challenge not to be ignored: to assist distance educators to focus on planned and sustained dialogue in a team, but also to design such an environment for dialogue as learning opportunities. In the words of the researcher, on the role of the instructional designer in the team (1998:journal note)...

It was my dream to foster a textual environment which simulated a learning space with a climate where learners could start asking questions and get motivation, recognition and constant feedback which would just prompt them to open up a vista of more questions even in checking their replies.

I had little idea how to go about it. I tried out the ideas on my students and asked them what worked for them and learnt a lot. I worked endlessly to research how other educationists worked on this idea, how they felt it crystallized in practice. I know I was right, but I had no idea how to go about it in the Unisa environment. No one dreamed of "talking" to students in text, few people could sustain a discussion with students while fostering a constant flow of questions. Few people tried to provide learners with much needed support and motivation. Even fewer tried to indicate to learners when they were on the right track.

As a junior person in a department responsible for staff training and development in designing course material, this idea seemed promising and I was asked to elaborate on the topic during workshops scheduled during 1990 through to 1996 on "Activities-in-text". One day in 1994 a lecturer followed me out of the venue, drove with me back to the campus and while walking back to the office with me, we had a talk. He (Dr Dirk Wessels) was one of the first to ask me to work with him on his vision to build a course, the subject being didactics of mathematics, based on constructivist principles where the learner is expected to think things through and work through real-life problems. We talked excitedly about starting a team to develop the course materials for his learners who would enrol at the end of that year!

But who would lead? Who would be further enrolled to become messengers? The idea of activities was integrated in a much larger scheme of instructional design

principles by my other colleagues, and the principle of "activities-in-text" started to become a discussion topic in many university departments. Some research projects flowed from it and the idea began to grow and morph as it was applied in many faculties and subjects. There were many divided opinions, but it seemed that my vision was shared by some, while most of the other people were carried forward by the wave of expectation. There were some that still refused to include an activity in their texts insisting that key questions at the end of a unit were sufficient.

In the quest for an answer, a number of key areas of concern emerged.

1.4 Key areas of concern

The key areas of concern included concepts such as Open Distance Learning (ODL), Course Design and Development (CDD), Instructional Design (ID) teams, Action Research (AR) strategy, and Change Management (CM). In this study, the researchers posed questions about fostering change in a DE environment through a critique on dialogue, actions and structure brought about in a mathematics didactic course, where activities are imbedded in the text.

1.4.1 Focus question

The focus of this study is to address the challenges in ODL course design through critique and action research by analysing the role learning opportunities in texts can play in improving educational dialogue, structure and actions. In this study, the student's learning actions within open distance learning will be investigated.

1.4.2 The aim and thematic questions

The specific aim was to develop quality ODL course materials including an action learning methodology. The new pedagogy included the employment of an instructional design strategy using activities in self-study texts. The assumption was to change the actions, dialogue and the structures imbedded in the product and those informing the process of the development team in order to affect the learning and practices of mathematics teachers.

This researcher documented the outcomes of the processes and products during this typical Unisa course design and development project as done by a course team, using action research methodology.

Thematic questions and sub-questions formulated at the outset as aims were:

- Question 1:** Will the development of learning materials with activities-in-text as an instructional design strategy produce a significant improvement in the competencies of the learners in terms of their abilities to become active learners through:
- 1.1 critically reflecting on improving the dialogue in the DE course as evidenced in the literature, study material, letters and interviews?
 - 1.2 critically reflecting on applying the structure of the DE course as evidenced in the literature, letters, interviews, and course material analysis?
 - 1.3 applying meta-cognitive strategies as seen in letters, mindmaps and portfolios?
 - 1.4 applying study strategies as indicated in assignments, portfolios and letters?
 - 1.5 applying the problem-solving strategies in practice as described in letters and selected interviews?
 - 1.6 critically reflecting on learning experiences as evidenced in their letters?
 - 1.7 evaluating the outcomes of their learning as evidenced in their letters and the examination results?
 - 1.8 motivating themselves to successfully complete their studies as indicated by the fall-out rate, assignment results, examination results and letters?
 - 1.9 creating a positive effective response on the part of the learners in terms of self-confidence and attitudes to learning as indicated by the subjective evaluation of their letters and the interviews?

Question 2: Will the process of reflective praxis assist the members of the team to:

- 2.1 appreciate the complexities of events during distance education course design as indicated by their authentic "voices"?
- 2.2 critically reflect on changes that take place in their context regarding actions, dialogue and structure as indicated by their "authentic voices" and historical events?
- 2.3 understand the success or failures of their praxis in the design of activities-in-text based on the evidence in the course materials demonstrating their compliance to the criteria for activities-in-text strategies, "authentic voices" as notes and the interview?
- 2.4 formulate criteria for good practice when including activities-in-text to improve action, dialogue and structure in self-study packages?
- 2.5 add to the knowledge in the field through critical reflection about the processes during a typical distance education course design (preplanning, design, development, management and evaluation).

These factors point to a need for change in the course development process and product, aspects of which are explored in the following chapter.

1.5 Rationale for changing course development at Unisa

This research into a changed course design is necessary because of the factors influencing learning at a distance. This process is more complex than in a face-to-face situation; there is much less direct contact with the learners. Adjustments within a DE situation are cumbersome: changing an aspect in the course materials takes at least a semester to implement permanently. This study tracks a difficult course development case.

A description of a recursive longitudinal study over a period of 8 years is never easy however Peters (1998:111) supports our experience that most courses "... *have a working life of around eight years.*". In our case, with the academic requirements and the development-teaching-evaluation time, it is often not possible to design a course, try it out, establishing it for a period and evaluate it in Unisa in a shorter period, especially with the current increase in numbers of courses and workload because of the often personal attention to support and assessment of large student numbers all required from a lecturer eight years is not easy. A diagram (see the time line in Figure 1.1) illustrates the separation of the different phases in the materials' design namely the professional development phase as a precursor to changed practice, the development phase of an interactive learning environment with activities in the self-study texts, the testing phase to pilot the course in practice to correct mistakes, and the maintenance phase where the course is presented for a number of years before redevelopment starts a new process.

As this project's investigation took place by means of participatory action research (discussed in Chapter 4), the researcher was not only doing research, she was also working in the capacity of a teaching advisor (with a staff development and instructional designer function) at the Bureau for University Teaching at the Unisa. In the role of instructional designer and as a team member for the course, the researcher worked in collaboration with the subject specialists (lecturers) and other team members (each with his or her own supporting role) to complete the design of the new study package to improve mathematics teaching.

Contact teaching includes interactive communication cues, such as pauses, intonation and gestures. These cues are clearly absent in print media. Instructional activities built into the instructional repertoire provide this missing interaction between the student and the teacher. Therefore the use of instructional activities to effect teaching positively is not optional, but mandatory. Successful writers of distance education self-instructional material and tutors need to master the design and application of this useful teaching and communication tool.

The researcher decided to make a thorough analysis of the learning opportunities and learning

strategies in the course designed for the subject mathematics didactics. The researcher compared the results of the actual experiences gained in the case study with the experiences from the lecturer, the instructional designer and the students. The researcher reports on whether there is agreement between theoretical research in the literature and the analytical results. We then elaborate on the implications of the research in the concluding chapter. Suggestions and criteria are provided on how learning opportunities and in-text activities may be included into distance education texts to promote specific learning experiences.

The interactivity between the learner and instructor often takes the form of the learner being asked questions, or given assignments, or a set of procedures to perform. The learner then is provided with appropriate responses and helped to work through alternative responses (Schieman, 1990). In addition, Schieman (1990:74) is of the opinion that interactive instruction is a superior philosophy of teaching at a distance, compared to teacher-centred pedagogues, in that it "can release [students] from a situation of dependence to one of individual initiative".

Appropriate use of instructional activities in learning situations encourages learning by doing - as opposed to the memorization of facts. Galbraith (1991:1) is of the view that adults not only interact with instruction but also with other resources in the learning environment such as: other learners, new ideas, values and knowledge sources. He considers adult learning an "active, challenging, collaborative, critically reflective, a transforming educational encounter and a transactional process". These ideas could be extended to distance education practice, particularly when an interactive instructional approach is used to write self-study materials.

Schieman (1990) lists the advantages of interactive instruction as its ability to encourage learners to be more self-directed, and problem-centred. Then there is also its ability to address the social needs of students. Instructional activities also provide immediate feedback on the students' learning progress and they keep the students interested in the learning process through their ability to elicit active participation from students. In addition, activities allow students to share their experience with their tutors in the learning process. Therefore, the learning process becomes a co-operative endeavour that is also student-centred.

We chose the Didactics course as a case because the lecturer requested support, seeking improvement in the pedagogy with a focus on active learning in a problem-solving scenario. The lecturer was knowledgeable about mathematics and the preparation of teachers of mathematics. This was one of the very first full team-based course developments at Unisa that started mid-1995 for delivery to the 1996 students. The lecturer and the instructional designer had a trusting relationship with the core team easy to construct. The core team shared a vision of a changed teaching and learning environment and their focus throughout the project was on observing and

reflecting on the events that took place through research.

1.6 Research methodology

The research methodology was participatory research. Participatory research is an approach that has been used to address institutional change (Du Toit, 1996: 96) and includes staff development (Walker, 1994:51) and course design (Engelbrecht, et al, 2001:105-113; Mashile, 2001: 132-139) The research addresses social change as well as such as the change required in a large educational institution to affect structures and roles, change towards an acceptable pedagogy, change in the power relationship between the lecturer and learner, and change in the role the learners play in the study process . The approach challenges the way knowledge is produced with conventional social science methods and disseminated by dominant social sciences educationists (supported by Mashile, 2001:138) . Through alternative methods, it puts the production of knowledge back into the hands of the people where it can influence their struggles for social equality, and eliminate dependency on the system and its symptoms such as low dialogue, absence, isolation, alienation, low motivation etc.

This researcher planned to document the outcomes of the processes and products during this typical Unisa course design and development project by a course team using action research. To achieve this, the researcher combined the following elements:

- 1 *An analysis of relevant literature. This provided an overview of the characteristics of DE and the DE learner. The issues of the day were a discourse on active learning and the use of activities in text. Out of this flowed the concepts of dialogue, active learning and structure to bring about change in the distance learning environment. It involved investigations into the philosophies underpinning the expected learning, change theory, theories of curriculum and course design, learning theories, staff development theories, instructional design theories, distance education theories, and theories in dialogue for active learning within structured study texts. The literature review enabled the researcher to establish the factors involved, to simplify and classify these factors within a particular course and educational environment and to establish possible relations for the research. This enabled her to:*
 - 1.2 establish the factors influencing changes in learning, namely actions, language and structure of self-study texts;
 - 1.3 establish possible relations between these factors;
 - 1.4 describe criteria for the development and inclusion of activities in interactive distance education texts in a particular Unisa course;
 - 1.5 examine the role and effect of the course development on the DE educators.

- 2 A case study which included the application of a variety of data collection methods such as:
 - 2.1 personal experiences from a reflective journal;
 - 2.2 informal conversational interviews and correspondence with local and overseas experts (during trips, or by mail);
 - 2.3 videotaped interviews with the lecturer;
 - 2.4 student-related documents including reflections in letters from students, portfolio results, assignment and examination results.

The course team agreed to follow the researcher's suggested research methodology using participatory action learning and action research. The team engaged in critical analysis of the DE institution as well as the process of course design and pedagogy. This process has the advantage of empowering them to alter their pedagogy, their relationships with one another, and the nature of the distance learning institution in order to challenge oppressive forces they may encounter.

In action research studies of all previous conceptualizations of problems are treated as questionable, knowing that solutions are often difficult and problems are difficult to identify. In this study a number of questions were asked in the typical style of action research methodology. The core team members posited educated guesses that they thought to be true, but for which they lacked evidence. These theories were posited in the format of "if such-and-such occurs, then this results" referring to the outcomes of problems within the course team and course development process. (Refer to De Vos 1998:42.)

The data collected included noted observations of the difficulties encountered, the processes and perceived solutions to problems. The data also included the results of interventions, the semi-structured question interviews, the informal discussions, and the analysis of student letters and course documents. The questions for the learner reflections and the interviews were open questions. The data included the researcher's analyses of the learning design and development of the course materials as well as the actual experiences gained during the project, plotted against the results of the literature survey (see Chapter 3) and the events during the course design and development process(see Chapters 5 to 8). This was compared with results from the literature survey on action research projects and team management (see 2.7 and Chapter 4). The results were not tested in any situations or environments other than Unisa (see Chapter 2).

From this data, the researcher developed a conceptual model for the success of teams (see section 5.4). Another model demonstrates how key aspects in educational institutions can be changed through course design projects. The action research model (see Figure 2.3) was accepted. The researcher reports whether there is agreement between theoretical research in the literature and the analytical results. The implications of the research is elaborated upon. Suggestions and criteria

are provided on how learning opportunities and in-text activities may be included into distance education texts to promote specific learning experiences. The researcher suggests conclusions on whether there is agreement between the predicted and experienced results and the implications of the research are elaborated on. Suggestions include how the model can be refined to include more variables and how a new conceptual model can be constructed and tested.

1.7 Interpretation of terms

The distance learning study package has to ensure quality, relevant education for people at a good price - whilst meeting the needs of society. The outcome of this study was to guide adult learners towards coping with the demands of being citizens in tomorrow's society, and, specifically, ensuring that mathematics graduates have the knowledge and skills needed to support the learning of subject mathematics. A secondary outcome was to provide distance educators with an example of what constitutes best practice so that they can foster active learning and dialogue by including activities within appropriately structured self-study packages.

Researchers need to understand the complexities of terms in varying contexts. In this section we discuss concepts such as education, learning, open distance education, course teams, and action research. Defining terms assists us in providing a common point of departure for further research.

1.7.1 *Distance education (DE) and open distance learning (ODL)*

We will use the term open distance learning (ODL) as it embodies the relationship between how learning and learning behaviour in distance education has developed and the political, social, economic and pedagogic factors inherent in open learning (Peters, 1998:98-104).

Education is defined as activities focussing on a systematic development of knowledge, moral values and understanding required for people in all walks of life - in contrast to knowledge and skills, which relate to a limited field. Training is part of an education process (refer to Fowler, 1993:14). A person's growth in terms of attitudes, values, interactive people skills, and job ethics implies change which is inevitably part of the process of education. The focus in education falls on providing a professional growth environment, with theoretical and practical knowledge, in a process which allows for change. Education provides liberation through empowerment of the individual, and the community. Liberation also implies a collective responsibility in a growth environment to engage in a struggle towards liberation (Freire 1973 in Heaney, 2002: online). This liberation strives to control the creation and use of culture, as well as a critical consciousness (section 3.2.11), through a collective struggle in praxis. Only through learning and action in DE texts can a critical consciousness be attained. Praxis is a complex activity by which individuals create culture and society (section 3.2.12), and become critically conscious human beings (3.2.11).

Praxis comprises a cycle of action-reflection-action central to liberatory education. Characteristics of praxis include self-determination (as opposed to coercion), intentionality (as opposed to reaction), creativity (as opposed to homogeneity), and rationality (as opposed to chance) (Freire, 1973 as indicated by Heaney, 2002: online).

Liberatory education is a component of, and subordinate to, a liberatory praxis, which seeks to transform the social order. Transforming actions imply a revolutionary stance. This stance implies, in turn, an equal, participatory, and democratic social group and it denounces hierarchical, authoritarian, and alienating systems. The content of liberatory education is both critical consciousness and the development of appropriate skills and competencies related to liberatory praxis. The process of liberatory education is dialogical, affirming the mutual and coequal roles of lecturers and students. The empowerment of liberatory education reflects the social order and anticipates a vision for a new social structure. The key aim of liberatory education is to regain dominion over the creation and use of culture (Freire 1973 in Heaney, 2002: online).

There are several sources of information about learning: folklore, philosophy, empirical research and learning theory. Teaching, seen as an art, disregards the possibility that systematic conceptions or planned research has a role to play in successful learning (Bell-Gradler, 1986:2). Philosophy is systematic conceptions about the origins of knowledge, the nature of reality, and conceptions of learning - but it does not explore the processes of teaching. Empirical research views the source of knowledge in experiments on objects or events. However, such knowing does not contribute enough to the understanding of processes of learning or teaching (Bell-Gredler, 1986:3). Also, a view of learning and the construction of a learning theory is dependent on a person's views (epistemology) and on that person's view of reality (ontology). The relationship between a particular ontology resulting in a corresponding epistemology is an illustration of a specific paradigm. A paradigm is "the particular conceptual framework through which the community of researchers operates" (Carr & Kemmis, 1991:72). Such paradigms, according to Carr & Kemmis (1991:74) "are informed by a whole complex of beliefs, values and assumptions, which are never made explicit in the theories produced by research, but ... nevertheless structure the perceptions of researchers and shape their subsequent theorizing".

(a) ODL Theory

In 1986 distance education theorists debated whether DE is a discipline because of the presence of, or search for, suitable DE theory as a source of knowledge. Many urged distance education scholars to strive to develop theory; this study is itself an attempt to add to that body of knowledge. Distance education "research and teaching areas include many different approaches both to scholarly studies and to practice ... new approaches to problems emerging in different societies and under different circumstances are bound to be developed. Both distance education theory and

practice is increasingly concerned with ... issues [such as individualisation and student autonomy, respect of students' integrity versus student support, media and methods, a rationale and search for comprehensive theories]" (Holmberg, 1986b: 29-36). In order for DE theory to be well-grounded (Keegan, 1990:3; Moore & Kearsley, 1996:211; Bell-Gradler, 1986:4; Reason, 2001:4) it should:

- be embraced in a phrase, a sentence, or a paragraph.
- help to describe and explain a phenomenon (such as student behaviour) and be subsumed under existing cognitive structures.
- prescribe essential pervasive characteristics of course materials implying clear recommendations for course development work, or specify requirements for mediated communication.
- include generalisations about events in several situations, even though realities differ. (Comparisons are not always possible in teaching or learning situations which are, more often than not, unique.)
- be conscious of the philosophical assumptions, thoughts, paradigms, world views and values from which we argue, and justify our position.

When we examine the influential work of Kuhn on "scientific revolutions" (1970; first published in 1962) one comes to realise that he argues that a paradigm need not be questioned at the height of its influence: "... to the extent that normal research work can be conducted by using the paradigm as a model, [therefore] rules and assumptions need not be made explicit" (Kuhn, 1970:88). Rather, new paradigms emerge because of a crisis caused by unacceptably troublesome scientific anomalies, which eventually become a "scientific revolution", to use Kuhn's term. When this happens, Kuhn observes, a fundamental philosophical analysis accompanies the development of the new paradigm.

Learning theories "help to describe and explain a phenomenon" (Moore & Kearsley, 1996: 211; Bell-Gredler, 1986:70) in contrast to prescriptive instructional theories. These theorists proposed that many theories help describe how learning takes place: Skinner (behaviourism), Thorndike, Tolman, Roger (facilitation of learning), Ausubel (cognitivism), Vygotsky (Zone of Proximal Development), Bruner (discovery learning), and Freire (power relationships) (Collins et al., 1973:76; Rowntree, 1981:153; Page et al., 1977: 202-203). In his analysis Bååth (1979) discussed a number of the above learning theories in relation to DE (see Chapter 3). These theories underpin learning but in order to contextualise it a number of theoretical approaches in DE aimed to identify essential characteristics of distance learning, including:

- Charles Wedemeyer's liberal, individualising learner autonomy (Wedemeyer, 1979, 1981) ;
- Manfred Delling's process model (Delling, 1985; Graff, 1970:44 in Holmber, 1986: 35, 30);
- Otto Peters's (1983) view of distance education as an industrialised form of teaching and

- learning, with technologically mediated communication;
- Michael Moore's theory of independent study classifying the dialogue and structure in educational programs on the two dimensions of self-direction/autonomy and apartness/distance (Moore, 1987a; Moore, 1987b);
- Moore's theory of transactional distance (1986);
- David Sewart's support model, called "continuity of concern" (Sewart, 1981);
- Kevin Smith's student-centred small scale approach (1983 in Moore, 1973:663);
- Kurt Graff's decision model of the structure and process of distance education;
- Holmberg's theory of distance education as a guided didactic conversation (1985, 1986b);
- Keegan's reintegration of the teaching acts through distance systems like interpersonal communication through learning materials and additional technology-mediated discourse (Keegan, 1992:83);
- Henri and Kaye's functional reorganisation/recreation of an educational environment in the student's life situation with regard to culture and needs (1985 in Keegan, 1992:83).

Correspondence teaching and learning, mainly in adult education, was the origin of today's distance education. Learning by means of correspondence was referred to for the first time in the 1720s, with the first direct reference of the term in the 1830s (Bratt, 1977:161; Holmberg, 1986:6-7). Holmberg (1989, 1990) has expressed the view that the basic practice of distance education, as it moved from correspondence education, has not changed appreciably. Its conception and practice remains industrialised and a private form of learning based upon self-instructional texts and print-based communication - notwithstanding technological innovations in distance education. Our experiences at Unisa support this idea.

(b) Explaining DE and ODL

There are a wide variety of terms for the term "distance education", some focussing more on the distance element and some on the system itself.

- ***Distance and instructional strategies***

Bjorge Holmberg's approach focusses on the absence of presence and instructional variables.

Distance education is "the various forms of study at all levels which are not under the continuous, immediate supervision of tutors present with their students in lecture rooms or on the same premises, but which, nevertheless, benefit from the planning, guidance and tuition of a tutorial organisation" (1977:9).

- ***Distance and technologically enabled communication***

When looking at distance education, Michael Moore concentrates on the distance between the lecturer and the learner actions and notes the use of media to overcome communication barriers: "Distance teaching may be defined as the family of instructional methods in which the teaching behaviours are executed apart from the learning behaviours, including those that in a contiguous

situation would be performed in the learner's presence, so that communication between the teacher and the learner must be facilitated by print, electronic, mechanical or other devices" (1973:664; 1977a:8). Moore & Kearsley (1996:211) identify a relationship by defining distance education as a teaching-learning relationship. The authors defines this relationship in terms of course variables, learner variables, and instructional variables.

- **Distance and organisational structure**

The work of Otto Peters, which was based on an analysis of distance education teaching institutions throughout the world in 1973, concludes (1989:6-7) that distance education is structurally different from traditional face-to-face instruction when it comes to the teaching organisation and its ability to deliver cost-effective education. Peters avers: "Distance teaching/education (*Fernunterricht*) is a method of imparting knowledge, skills and attitudes which is rationalised by the application of division of labour and organisational principles as well as by the extensive use of technical media, especially for the purpose of reproducing high quality teaching material which makes it possible to instruct great numbers of students at the same time wherever they live. It is an industrialised form of teaching and learning" (Peters, 1983: 206, in Keegan, 1991:37). We agree with Macintosh (1997:15) that this structural aspect of distance education is a major characteristic of the Unisa situation.

(c) Characteristics of distance education

There are a number of factors that make the distance education system unique. These are characterised as follows (by Wedemeyer, in Keegan, 1990:58; Keegan, 1991, as adapted by the researcher from the Unisa experience):

- The learner and teacher are often separated in time and space;
- The learners have the freedom to start and stop as they see fit and to pace themselves;
- The normal process of teaching and learning as a two-way dialogue is conducted in writing or through some other medium;
- Learning may be individualised by the lecturer, especially when provided as two-way communication (as occasional and specially organised meetings, seminars, group discussions, video- or tele-conferencing, or visits);
- Learning is done by individuals or groups;
- Learning takes place through the learner's activities;
- Learning is more convenient, but also more difficult, because learners study in their own environments and they must take responsibility to balance study, work and home roles;
- Learners take responsibility for their own progress;
- The institution has a watered down influence on learning within the private study environment;
- Media (print, video or electronic) play a bigger role in the educational context;
- The organisation of the DE institution makes use of more industrialised forms of course

production and teaching strategies.

Peter Raggatt (1993:21 in Peters, 1998:111) identifies the industrial nature of DE education, which gave rise to a debate concerning "Fordism", a concept which refers to the industrial production process developed by Henry Ford. This is evident in distance education and identifies it as the most "industrialised" form of learning and teaching, unlike other forms of teaching (Peters, 1967; Peters, 1989; Champion, 1990; Farnes, 1993; Raggatt, 1993; Peters, 1994; Rumble, 1995). The notion of Ford-like industrialisation gave rise to a focus, firstly, on economies of scale and a reduction in unit costs of production, and, secondly, on the limited scope of consumer choice (Edwards, 1991:37).

Standardisation and industrialised processes - Fordism - confronted distance education (Peters, 1998:8 Raggatt, 1993:23). This is evident in the Unisa system. The character of DE and its industrialised processes include:

- bureaucratic pyramidal organisational structures and systems which include preplanning, preparing and organising the process of study.
- the division of labour for processes with centralised planning of study material generation and production. At Unisa there is a division of labour where different people are responsible for different aspects of the teaching process, such as the authoring of the text, the design of the learning experiences, the design of student assessment, the marking of such assignments, the printing of the texts, and the contact sessions with students.
- authoritarian relations with clients with a product-centred manufacturing philosophy.
- the growing use of technology and systems (for example postal systems and printing systems) in the detailed process. At Unisa technology includes high levels of mechanisation and the use of large machines in the production of the printed matter or videos, or the postage of material.
- the formal evaluations that are necessary and part of the process.
- teaching and learning phases that are strongly alienated - separate from one another.
- the teaching process takes place long before the learning process, it is often objectified, with the communication and dialogue being indirect, via the media: the interaction can be seen as being "unreal".

One hopes that the subtle move at Unisa into its new organisational structure during 2002 will not entrench the institution in the Fordist paradigm. Such a move back to Fordism (Edwards, 1991:37; Champion, 1990:64) could arguably negatively influence Unisa's course design and development processes and any innovations achieved - such as in this study (supported by Macintosh, 2001: 3).

In contrast to this opinion, Peter Jarvis (1999:48) indicates that although certain forms of DE tend to use an industrialised way of producing and disseminating information, industrialisation does not

have to be a defining feature of DE. For an institution addressing the needs of a post-industrialised knowledge society industrialisation might be problematic. However, in order for distance education to survive it must address these changes, both in theory and practice. In order to consider practicalities inherent in mass distance education and in order to strive towards maximum open learning with self-directedness in students, self-study and related activities become an important focus. The education environment, the lecturer's management of that environment, the student's abilities to manage the environment, and the educational technology behind self-study activities become important factors when planning, executing, and evaluating meaningful learning. The focus in education should be for the learner to investigate the complexities of a discipline - sometimes according to prompts - with a definite move away from purely rote-learning of a body of knowledge. Globally, societies are showing a distinct move away from Fordism to neo-Fordism and post-Fordism - or mass production, flexible production, and flexible specialisation or lean production (refer to Rumble, 1995:12-13 although he warns against the use of "Fordism" as a term because of its vagueness; Edwards 1991:37; Campion, 1990:64; Peters, 1998:114). In distance education post-Fordism manifests as:

- *A high degree of product innovation*, enabled by new pedagogy in learning and teaching in ODL, enhancing autonomy and independent contracted learning with support, where needed. There is use of "personal contact" via audio-visual or text-based technology (such as videoconferencing, Internet chat rooms and email). Product Innovation is supported by new technology, short production runs (which negates large print runs with huge storage requirements), and a quick reaction to market demands through strategies such as the design of new products supported by database-driven knowledge granules;
- *A high process variability* where the processes in the institution is enabled by horizontal networks of people, use of technology, the social needs, and an empowered pedagogy; and
- *A particularly high labour responsibility*, where specialised workers work in small focussed project groups in creative environments (often providing greater job satisfaction) which indicates high labour responsibility in a worker-orientated paradigm (the birth of course teams) in contrast to a strict division of labour.

One development in recent years is the notion of openness in distance education. An open system is (Letseka, 1995, in Higgs, 1995:289-291) one:

- Which can maintain itself by exchanging matter and energy with its surroundings (compared to no exchange in a closed system) and become something new as it is in a continual state of change with respect to its internal structure and environment.
- Which has a product that is exported into the environment.
- Where the pattern of energy exchange is cyclical and the exported product is the source of

energy for the repetition of the cycle of activities (compared to a system that cannot import energy).

- Which aims to maximise its ratio of imported to expended energy.
- Where the system tends to increase complexity through specialisation in a bid to differentiate (compared to a dominant element or subsystem that dictates the operation as a whole). In decentralised structures control is distributed among the elements and prediction requires knowledge of all the parts of the structure. There is an independence and tolerance of the other because of its securing role in the system. Outcomes are negotiated and not imposed by the powerful. There is a recognition of rights, freedom, and public accountability.

We believe that an open educational system at Unisa will contain elements of the above in, for example, organisational structures that promote flat management structures, in role definitions and working systems such as project teams, in its responsiveness to evaluation of study materials by peer and student review, in course products that can be scrutinised, in energy exchange in frequent staff development, and in critical reviews by learners and peers to renew and recycle energy.

Although Keegan (in Ortner et al 1992:83) reject the equation of DE with OL (in Peters, 1998:98) there is a special correlation between DE and ODL which provides a criterion for openness defined as a learner-centred approach and makes arrangements to enable people to learn at the time, place and pace which satisfies their circumstances and requirements (Daniel, 1998:127 in Peters, 1998:99). The emphasis is on opening up opportunities by overcoming barriers that result from geographical isolation, personal or work commitments, or conventional course structures which have often prevented people from gaining access to the training they need. Open learning is paradigmatically different in how learning and teaching behaviour take place, as well as in factors of a political, social, economic, and pedagogic nature. Open learning focusses on a number of principles, which, according to Peters (1998:98), relate it to distance learning:

- *Equality of opportunity* where everybody is able to acquire knowledge, skills and attitudes without economic barriers such as low income, gender-specific practices, socio-cultural inhibitions, limitations on minority groups.
- *Lifelong and ubiquitous learning* with no defined life-cycle, locations or times.
- *Open curricula* where teaching programmes are left undetermined and undeveloped in the rigid sense, but are able to accommodate unforeseen developments in the development of individual growth towards action.
- *Learner-relatedness*, the direction in which learning should be moving, is opened up to allow learners to start from, be shaped by, and determine the outcome/end of their

learning according to individual value perspectives, interests, and experiences.

- *Autonomous learning* which allows learners to organise their own learning within the institution.
- *Learning through communication and interaction* as learning is steered by discussions and active management of the structure of the presentation, interaction and discourse processes - in contrast to rigid presentation that controls all learning aspects.
- *Relatedness to everyday life* as the learning takes place in a flexible, not bureaucratic, institution that addresses the needs of learners and the society of tomorrow.

Criteria for ODL include (Daniel, 1998 in Ortner et al 1998:127) extended accessibility, independence of the learning location, methodological flexibility, and openness to new ideas. Learning opportunities include a choice of place, time, design, an attention to individual needs, financial aid provisions, a flexible admission policy and courses, a flexible timetable, flexible content in courses and evaluation methods, and flexible modes of learning access. Open learning has a philosophy of learning that is more student-centred - although always within the resource constraints of any educational environment (Paine, as reported by Fraser, 1993:34; Lewis, 1986:5).

Be this as it may, in our experience of course development at Unisa over the last fifteen years, an industrialised method of planning, production and sometimes teaching was strongly imbedded in each step of the process. Moore warns that DE is "much more than simply using technology in teaching. It also represents changes in the ways we organise the resources of people and capital that are dedicated to the enterprise of education" (Moore & Kearsley, 1996:233-4). In this study, Unisa's move towards post-industrialisation was attempted, typically, by a course team focussing on change of access, dialogues through media, opportunities for contact and guided conversation, power relationships, and change from dependence to liberation (Peters, 1998). However, there were many institutional obstacles, which this study indicates.

(d) Modes of DE

We disapprove (as did Rumble, 1995:18) of the stages in conventional and DE development (referred to by Farnes, 1993:11) as first generation single media DE, second generation multi-media DE and third generation computer-based ODL. Macintosh (1999:3-4) describe suitable distance education models relevant to South Africa including the

- **Distributed model** where the learning environment is distributed to many places (sites) often through information communication technologies. Learning takes place when student-student and student-lecturers communication is place and time bound (synchronous delivery). It is similar to the Remote Classroom teaching (Daniel 1995:13) where he cautions against a teacher-centred approach.
- **Dual and parallel mode model** where the learning environment includes systems where

students study either through contact or distance at the same institution, or through both contact and distance. This mode is similar to Flexible Learning (Daniel 1995:13).

- **Independent study (with or without tutoring) model** where DE is the separation between participants and the interactions between them are important: *"Independent study encompasses several teaching-learning arrangements in which teachers and learners carry out essential tasks and responsibilities apart from one another, communicating in a variety of ways"* (Wedemeyer, 1978:214). This model is a correspondence course that have a higher level of interaction between the lecturer and the learners. The independent learning courses include student assignments and other tests that are exchanged (Moore & Kearsley, 1996:38). The assignments usually include some feedback, mostly in the form of a general tutorial letter which addresses pertinent problems and issues that the lecturer feels are of importance to the group of learners, and/or written comments on each assignment. High student numbers make it difficult for lecturers with a 1500:1 ratio to use personalised feedback, so the search for "automated" feedback strategies becomes more important, otherwise lecturers revert to not setting assignments or not giving feedback.

The access requirements for degrees require students to adhere to specific entrance requirements. Independent study courses are also more likely to include other media, supporting study guides, letters and textbooks. Such support media include audio- or video tapes, television broadcasts, video conferencing, online learning, or computer programmes. Independent Online study is based exclusively on the use of telecommunication networks with or without tutoring or "moderation". Also called Online Learning it includes e-mail, bulletin boards to post messages from one person to many students simultaneously, discussion forums to allow discussions between individuals independent of time, or real-time conferencing in chat rooms or during webcasts (which can be text, video and/or audio).

Technology-enhanced group study includes tele-courses (as Moore & Kearsley, 1996:39 call these) or tele-study - courses where the primary communication technology is pre-recorded video, television, real-time video or radio. This is a form of study that requires the main teaching to be delivered to groups of students, prescribed according to a predetermined schedule set up by the lecturer. The interaction may be limited to one-way or two-way communication, either via the same medium or different media such as one-way television broadcast with two-way tele-audio supported by data-responses using digital keypads.

Self-study is a form of independent learning in which the learner works completely alone (refer to Jeffries, Lewis, Meed & Merrit, 1990:106; also called autonomous learning (Moore, 1996:5). Guided self-study is undertaken with guidance from a lecturer (Greyling, 1992:20; Jorissen, 1988:32). At distance education institutions such as Unisa this self-study guidance

can manifest as different strategies such as self-study packages with a special discourse to guide students when they need it, and no contact between students and lecturers. Another strategy is to have limited contact between students-student(s) and student-lecturer(s) using direct discussions, print, or electronic media for example online learning. This contact can take place simultaneously (called synchronous communication, such as a lecture, telephone conversation, video-conferencing, or face-to-face discussion) or at different times (asynchronous communication, such as when a letter is written and read later, email is sent to be received and read later).

My own experience as an instructional designer has shown that "unlocking" the course material requires learner and teacher to work together, and that this learning structure and dialogue determine the success of students. Success means students learn with motivation, they manage their learning, and complete their studies to the extent they desire. The teacher is a facilitator of the learning, not only a provider of information, while learners indicate their preferences and direction for study in a mutually agreed learning process. In contrast, a badly prepared teaching package requires constant corrections by the lecturer - which is a waste of time and unnecessary activity for students. Such problems can be prevented by good study design, planning, and role delineation. Self-directed learning is a learning-centred approach (also referred to as self-managed learning), and is designed to put the learners in a position to manage and take responsibility for their learning. The MMAT students studied independently in a post-Fordist institutional milieu.

Getting students involved in the self-study material is commonly regarded as essential for learning effectively, but it is a difficult area, fraught with complications which can affect learners' ability to learn. Activity opportunities in the text offer a solution because they can improve learning, but a number of factors influence the success of activities, and some activities can also hinder learning (De Wet et al., 1981:241; Nussbaum, 1983:672; Seiler et al., 1984:19). Pretorius (1996:50) shows that self-study has to facilitate student activity, effort, involvement, etc., thus encouraging the student directly to deliberate on his/her own learning, to manage it, and by that gradually develop meta-cognitive skills. We also ask what they require from a teaching team to design such materials? The learning unit is part of an overall package and has to function as a whole. The unit can be an integral part of the learning package, enabling the learner to make the knowledge his/her own according to the set goals or objectives. A learning unit can also be an optional module to provide additional information, or it may be purposeful enrichment to the text.

To consider practicalities inherent in mass distance education, and to strive towards maximum "open" learning with self-directedness in students, self-study with any related activities that evolve, becomes an important focus. The education environment, the lecturer's management of

this, the student's abilities to manage it, and the educational technology in it (media, strategies, systems, or techniques) become important factors when planning, getting into and evaluating meaningful learning. The focus in education should be for the learner to investigate (sometimes according to prompts) the complexities of a discipline, with a definite move away from purely rote-learning a body of knowledge. Self-study is the ideal strategy that can foster an enquiring approach that can provide a problem-solving environment for the non-traditional learners of today and tomorrow.

1.7.2 Pedagogy of distance learning and teaching

We will use the term learning to mean the adaptive and relatively permanent change in behaviour through the acquisition of knowledge, attitudes, or skill as a result of experience (rather than, say, through maturation), either produced incidentally or through institutional learning. Learning need not be correct, deliberate, or overt. Learning includes conditioning, training, learning of motor skills, and cognitive learning and enables people to adapt partially or permanently to their environments. Teachers and instructional designers use cognitive science and instructional design theory to establish how people come to know and how instruction can be better designed to aid learning. In DE students learn better by being actively involved in doing something in the text, either doing something practical, or doing some mental processing (psychomotor or cognitive involvement). The self-study text has to compel the adult learner to enter into a "didactical conversation" (according to Holmberg, 1982:7 and Rowntree, 1974:119) and "engage and involve them in deciding what they are to learn, and how they are to learn it" (Henderson, 1989:2). However, as distance practitioners we know that students tend to spend more time focussing on surface level thinking and the transmission of factual knowledge (also known by lecturers as "rote" learning) than on fostering deep and critical thinking.

Distance educators need to be aware of how their learners think, learn, see things, and know where they experience difficulty. This awareness requires by the educator an embodied form of knowing and of understanding, a "pedagogical tact" that enables acting and judging. At DE institutions such judgement comes mainly through extensive experience because of the distance from the student. This case study is the text-mediated study of the structure of pedagogical tact and how pedagogical tact functions.

This research is also a human science study of how practitioners change and deepen themselves by the process of reflecting and writing about pedagogical themes as subjects and as co-researchers.

Education takes place in a social system and its purpose is to change and enrich the human psychical system: *"Education is defined as intentionally modifying the environment of a learning system for the purpose of initiating and encouraging learning processes ... education does not*

mean intentionally changing an individual (!), but systematically changing the environment of one (or several) individuals with the intention of initiating learning processes" (Treml, 1995:277-8).

The psychological or cognitive system of a student or his consciousness is the environment of the social system in which he communicates. Effective teachers display a wide range of skills and abilities that lead to creating a learning environment where all students feel comfortable and are sure that they can succeed both academically and personally. They integrate this complex combination of skills and abilities in professional distance teaching standards that also include essential knowledge, dispositions, and commitments required of lecturers.

The understanding of teaching is based on four basic informal theories underpinning a teacher's approach (Fox, 1983; these theories are remarkably similar to Clark's (1998:4) four different instructional or operational principles to control or personalise knowledge). The first two are "simple" theories while the last two theories describe the release of power and control by the lecturer. The last two instructional principles include learning with conceptual understanding, critical analysis, and various life skills, which they can all apply in various real-life situations.

- **Recursive:** The transfer theory (according to Fox, 1983 in Johnston 1995: 1-2) is where they view the subject matter as a commodity that they can transfer into an empty vessel, the student's mind, which is waiting to receive it. If the vessel does not receive it (i.e. the student does not learn) then the vessel was "leaky" - it was then the student's fault that she or he did not learn. Teachers consider that they have done enough if they prepare, organise and impart the material.
- **Directive:** This is about training rather than about the educative type of teaching where the student needs to be "shaped" into some predetermined form. These teachers used verbs such as "develop" and "produce" to indicate the learning outcomes of the teaching. Often a layout design would be perceived as an indication of directive teaching, or training, as the underlying approach.
- **Guided discovery:** Teachers with a "developed" theory view the student and teacher as on a journey of discovery together where there is a "shared adventure" (Baird, 1992). During this journey the knowledgeable and experienced teacher acts as a guide and fellow explorer within the subject area. In this view, there is no "correct" body of knowledge and the exploration is the focus for both the learner and the educator. In their knowing that there is no correct body of knowledge, Svensson and Hogfors (1988 in Johnston, 1995:68) indicate that their encouragement of engineering students to consider various alternative conceptions was an important element and that they may have brought about lasting conceptual change in the learners. We believe the socio-constructivist view is more appropriate to embody the extended growing from intertwined with a particular context.
- **Exploratory:** An "extended growing" theory is where a student develops and makes a

significant contribution to develop his or her own understanding according to his or her own explorations. Learners grow from their existing or past experiences, learning, and knowledge at their own pace, in their own direction, toward their own outcomes, and following their own processes. It is an "open environment" with an undetermined outcome of the learning: learners determine its direction, extent, and level. The educator has to be very responsive to the context in which the learner developed.

Didactic, from Greek *didacticos*, means being apt at teaching or means the "art" of teaching as a science. Instructions are provided for guidance, nurturing, uplifting, and enlightening. The "didactics" of a subject such as mathematics would denote the doctrines, precepts, principles, moral issues, or rules behind teaching that subject: *"Didactics is that part-discipline of education that studies the communicative facets of teaching ... Teaching as a didactic event concerning the teacher, the pupils, the aims and objectives of teaching mathematics, the media for mathematics teaching, evaluation and remedial work in mathematics"* (Wessels, 1997:2). In this study the term is not associated with the negative connotations sometimes ascribed to "didactics" as merely imparting facts rather than with inspiring ideas. Nor does it fail to give learners an opportunity for discovery or for making meaning of their subject (Collins, et al., 1973:60; Rowntree, 1981:76).

1.7.3 Action and active learning: action, dialogue and structure

In distance education the instruction is designed to overcome the distance between the learner and the lecturer. This study argues that activity or action, language or dialogue, and roles or structure are interrelated components of an effective learning system.

- (a) *Activities and action*: The term "action" must not be confused with physical movement (Miller et al, in Lazarus, et al., 1989: 156). Action is understood to be past, present and future happenings such as activities, concrete experiences, practical explorations, and applications. These actions affect our current insight, understanding, and learning when we create and extend our knowledge through reflection, enquiry and critical evaluation. They compel us, also, to plan our future actions.

Action learning is the process of *"learning from action or concrete experience, and taking action because of this learning"* (Zuber-Skerritt, 2001b: 5). In the distance education context, action learning takes place in a setting that empowers people to learn through reflection from their collective actions, and act on transforming themselves and their surrounding social system through participatory reflection-in-action (Passfield, 1996: 50). Action learning is highly concrete, it is topical and specific, and requires people to share their knowledge gains through reports or publications.

As critical DE practitioners, we often do action learning. Active learning is viewed as a multifaceted ability that involves reading skills, study skills, critical reflection skills, writing skills, meta-cognition ability, contextualising ability, and relationship-building skills. Active learning is a process and form of engagement, intellectual "play", challenge, encouragement, discovery, structure, monitoring, assessment, or evaluation that gives learners another "voice" and guidance through their study material.

An activity, the minimal unit of analysis, is defined as the engagement in a subject, being motivated toward certain problems, goals, purposes, or objectives (Engeström, 1988; Websters [s.a.]:20). The engagement has a certain quality or state of being active, an action, a motion, the use of energy, or the normal power of mind or body and its energetic action, nimbleness, agility, and animation".

Activities are human interactions with the objective world. Rather than learning before acting, activity is seen as a precursor to learning as the human mind emerges and exists as a special component of interactions with the environment. It is in doing that the learner, as the driver of his/her actions, can know or have knowledge of something. There is a regulated relationship, with feedback between knowledge and activity, which means that as we act, we increase our knowing, which affects our actions, which influences our knowledge, and so on. This conscious process transforms our understanding of learning. A conscious learner unifies attention, intention, reasoning and speech (Vygotsky, 1978:7); there is no separate set of discrete, disembodied acts such as decision making, classifying, remembering, executive control mechanisms regulate that (Nardi, 1996 in Jonassen & Ruhrer-Murphy, 1999:64). Activity is dependent on intention to act, where this intention develops from contradictions learners perceive in what they know and the knowledge needed to reach a particular goal. An activity is object-oriented. Activities are socially and contextually bound and are developed within a particular culture and within a particular historical situation. Other people inform the learning - such as a course team at Unisa. Activities also always involve some artifact (procedures, methods, organisation, machines, instruments, or signs) such as instructional design tools or study materials which influence knowledge and actions. The performance on the part of the learner may take place in different circumstances and on different levels; the mental mastering of cognitive objectives (by means of self-study, by executing a physical skill, or engaging in some form of interaction while certain attitudinal development takes place)(Jonassen & Ruhrer-Murphy, 1999:65-66). Self-activity refers to the learner's active participation in his or her own independent study process; this is not merely being passive or receptive, but means *originating* action (see the identified DE types in section 1.7.3).

We define in-text activities in independent learning texts as that learning device or tool that define and foster interaction. Any action changes the way a situation or task is experienced by the person who produces that action (Miller in Lazarus, et al., 1989:156) therefore it is clear that we cannot control the way a situation or task will be experienced by the learner. (Refer to section 3.2 for a discussion on how action supports autonomy, communication, the whole learning experience, motivation, social and historical issues, structure, growth, empowerment, reflexivity, change, identifiable progress, outcomes, assessment, development of different kinds of knowledge, and assists in problem-solving.) (Also see 3.5.4.)

- (b) *Language, interaction and dialogue*: Engagement or involvement by students and between team members is part of a conscious and focussed social interaction. Moore refers to this interaction as dialogue or as an interplay of words, actions, and other interactions between the lecturer and the learner (Moore and Kearsley, 1995:201-202). Interaction may take place between the student and the subject matter, the learner and the instructor, and between students. There is also inter-learner, intra-learner and peer-group interaction (Moore & Kearsly, 1996:130). Dialogue is considered the process of conversation and communication. In DE it mainly describes the written forms of communication where representatives of an interest group (the lecturer or a learner) exchange ideas with another person. "*Dialogue is the term that describes the communications which take place between the lecturers and students ... [where they are] engaged actively in the making and exchange of meanings*" (Evans & Nation, 1989: 37). In DE the study text manifests the dialogue as attempts to enable students to become active participants in determining implications of new knowledge on their lives and share their views. We can argue that our learners are able to be in a dialogue by being actively involved in doing something as prompted in the text or entering in an exchange of meaning. The doing can be either practical or mental (psychomotor or cognitive involvement). The text has to compel adult learners to enter into a "*guided didactic conversation*" (Holmberg, 1982:7 & Rowntree, 1974:119) not only to "*engage and involve them in deciding what ... and how ...*" (Henderson, 1989:2), when, where, and why they learn. Dialogue is affected by the presence and size of the group, the language and the medium of communication (Moore & Kearsley, 1996: 202).
- (c) *Roles or structure*: Moore (1977a:18) defines structure as a set of variables that determine transactional distance where structural progression is the measure of individualisation or flexibility. The general principles of course design includes a good structure and planned participation with interaction (Moore & Kearsley, 1996:122; see section 3.4.3 in the discussion on textual design).

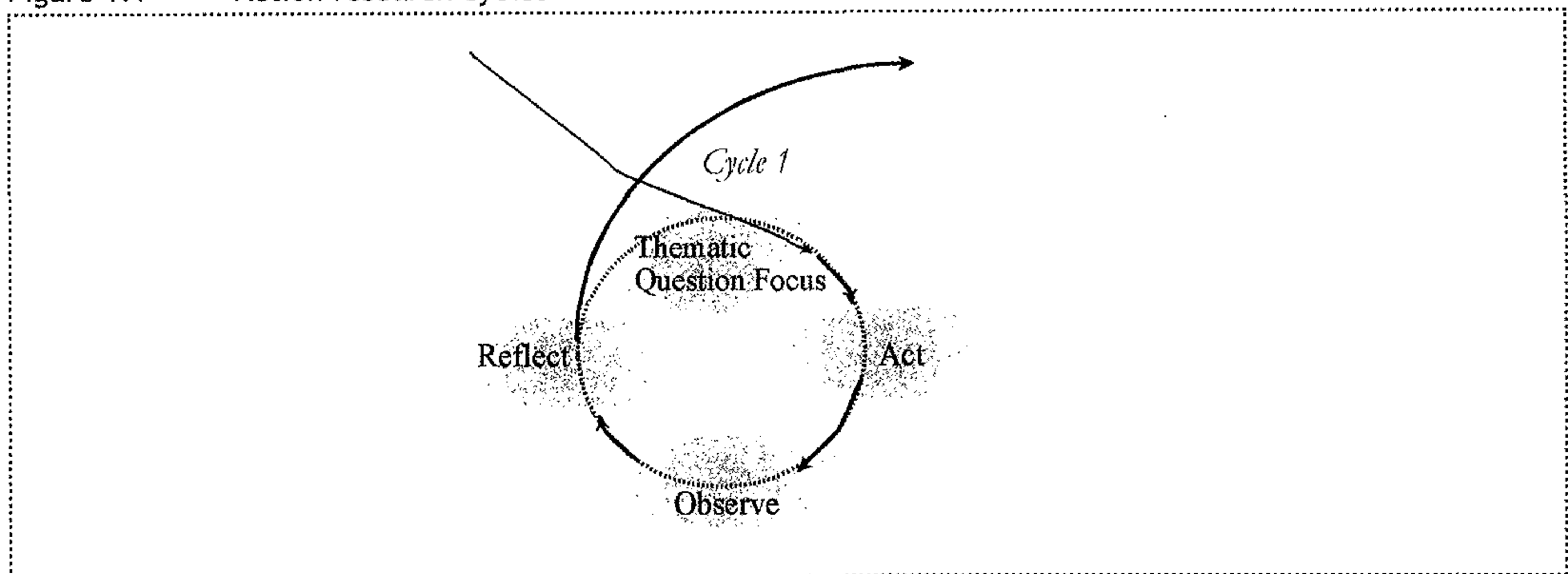
Guidance and support enable a sustained change over time, or play a role in changing situations or environments. Guidance and support in self-determinism and self-direction because of liberation and empowerment therefore can include learning skills such as concepts and processes in a subject field, but they can also cover life-skills. This includes counselling as individuals "come to know" things. "Coming to know" includes internal processes such as learning, perception, comprehension, thinking, memory, and attention.

The relationship between structure and interaction/involvement determines the transactional (or pedagogical) distance as a defining theory of distance education (Moore 1973: 665). The distance student has a right to independence; however, the greater the distance the less the dialogue and the more distant the environment becomes. In distance education the instruction is designed to overcome the distance between the learner and the lecturer, the instruction has a specific structure, and there are a particular dialogue and interaction between the learner and the lecturer. Moore (1982) describes these characteristics as integral to distance and open learning.

1.7.4 Action learning (AL) and research (AR)

Action research means to act following deliberate planning for strategic action while rigorously observing effects or consequences during the spiral of planning, acting, observing, and reflecting - and critically reflecting in a team on the phases, outcomes and the process of the research (refer to Carr and Kemmis, 1987:7).

Figure 1.1 Action research cycles

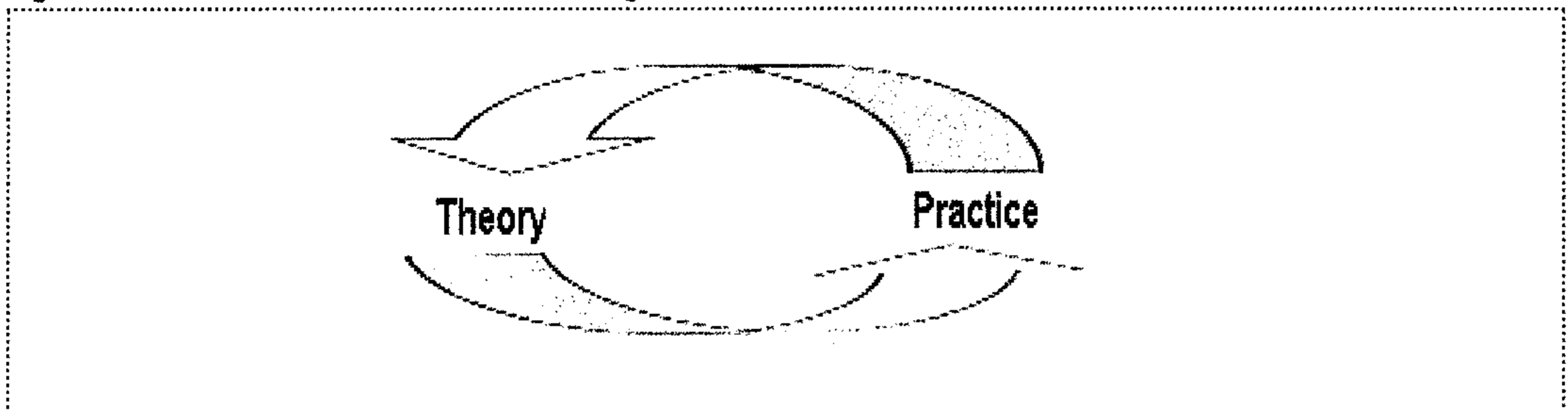


When theory is imbedded in practice and is interdependent upon practice, theory acts in an advocacy role; this role of theory is called praxis - theory-in-practice (see Figure 4.1). This dialectic relationship extends to research and development, as well as thought and action (Zuber-Skerritt, 2000: 42; Bailey 1992: 28; Cohen 1989: 47; Sarantakos 1998: 38-39; in Collins, Du Plooy, et al., 2000: 31). The dialectical relationship between "action" and "learning" or "research" is

is responsible for the concepts action learning and action research.

In contrast to action learning, action research is more systematic and rigorous in its methodology. It uses methods that can be scrutinised publicly and focusses on facts, goals or outcomes that, when interpreted, contribute to the knowledge in a particular field of enquiry. Action research results may or may not add to grounded theory (refer also to Grinnel, R. M. 1993. in De Vos, 1998: 19; Tuckman, 1994: 4). Action research is based on an epistemology of experience, presentation, proposition, and on practical ways of knowing. It is also based on a subjective-objective ontology with a methodology based on co-operative relationships. Action Research is therefore more than action learning as it may influence the individual and the broader society (as McTaggart, 1993: 10-11 indicates) while also being more about accountability, as the researchers are more reflective and have to make their experiences public through publication (Zuber-Skerrit, 1991: 81). Action research has much in common with action learning and experiential learning; these things shade into one another at the boundaries. Action learning also underpins action research where action research takes a step further because the reflective practitioners, as *accountable* educationalists, make their experiences public (Zuber-Skerrit, 1991:81). McGill and Beaty (1995:16) discuss how to share and solve problems through the use of action learning "sets".

Figure 1.2: The Praxis of Action Learning and Action Research



1.7.5 A course team

The importance of using a team approach to course design and development has been often referred to in distance education.

Kember & Mezger (1990: 67) define a course team very loosely to refer to "*any infrastructure which provides a mechanism for an instructional designer to work together with one or more writers to develop distance learning courses, hence providing and opportunity for staff development*". The large bureaucratic segregated system of a DE institution requires specialists from separate departments. Any project team should be founded on a relationship in which all are participants in the changed processes (according to the view of Hart and Bond, 1995). The aim of the team is to improve something and to involve all the members in the process. This process should grow and

involve reflective inquiry while it affects the quality of practice. Such a process where learning improves is often extremely educational for all involved because each time there is intervention, change takes place - some for the best, and some detrimental.

A number of types of teams have been identified by Heese and Van Zyl (1997:90-102; Moore & Kearsley 1996: 105): the author-editor core team, the pressure-cooker team, the wrap-around team, the transformer team, and the full-scale OU-UK type team. A full-scale project team will have different experts of the institution involved (from management through policy and institutional processes to integration with the DE processes by committed people). The author-editor team and the wrap-around team are common at Unisa, but do not include instructional design input. The transformer team is rarely used in designing print materials where the process is split into the production of first drafts by the subject experts and then altered by the instructional-media design team, although this seems more common in online course materials preparation.

At Unisa, course design where a learning developer is involved usually takes place using the pressure-cooker team. Input is limited but intensive and takes places over a few days only. At Unisa a full-scale course team involves one or more individuals from a specialist area (Macintosh, 1999:6; Unisa Tuition Policy, 1998:2; Moore & Kearsley, 1996:105 and Kember & Mezger, 1990:67). Although each team is unique, the team may include up to 20 specialists such as (1) an academic subject lecturer, (2) a learning developer, (3)an assessor (4) an editor, (5) a translator, (6) a graphic designer for the medium, (7) a production specialist, (8) a distribution dispatcher, (9) a scheduler, (10) a publisher, (11) an examining coordinator, (12) an assignment coordinator, (13) a computer systems specialist, (14) a project team facilitator (15) a course coordinator (16) a Faculty course development manager, often the head of department (17) a tutor coordinator (18) a student advisor (19) management policy specialist (20) media specialist. At Unisa an important specialist is the course development projects manager to coordinate teams in different phases of the course development of the 2500 modules.

The team prepares activities within the very specific constructs of the course design and the organisational structure, constantly negotiating the rules within the institution and their roles as a guide (adapted from Jonassen & Rhorer-Murphy, 1999:66).

Successful project team members have a number of qualities like acting collaboratively, having planning skills, understanding the complex structured policies and working procedures in an institution, being able to relinquish and share decision-making, respecting the skills and knowledge of others, being prepared to compromise, being able to communicate, and being co-operative (Moore & Kearsley, 1996:106). It is an advantage for the members and the institution if members are willing to learn, to be accommodating to different personalities, to be prepared to

compromise, to be able to facilitate and coordinate, and to be skilled in action research. The team facilitator/leader must understand and be able to manage conflict as conflict is both a source and result of change - change develops from dissatisfaction with the current towards a desire to improve and find alternatives (Robbins & Jones, 1974:166-168, in Kember & Mezger, 1990:60).

The learning designer role is complex and in most cases difficult. Learning designers are considered change agents, managers, staff developers, academics, and learning design specialists. However, Kember & Mezger (1990:60) warn that *"designers can only function as effectively as the system within which they operate will allow them to function"* (see section 2.6.3). Kember & Mezger suggest a verified contingency model for the management of the team and staff development: the model indicates seven stages of concern for staff who attempt teaching innovations (refer to section 2.6.2). Zuber-Skerritt (2001a: Section 8, p. 4) suggests a Figure Eight of Strategic Project Planning (see section 2.6 for a discussion of these models).

1.8 Underlying assumptions and implicit limitations of this study

As researchers we are required to expose the underlying or unquestioned assumptions and aspects that this study does not consider.

1.8.1 Unquestioned assumptions

The post-modern paradigm determined our assumptions about a fragmented and diverse reality while subjective and contextualised knowledge influenced our choice of a qualitative research methodology.

This research was influenced by the fact that it sought to assist the development and implementation of a Unisa tuition policy (a policy based on practice and not on pure knowledge production). Policy is used to institutionalise change into practice.

Another assumption for the case study was that course development does not occur in a neutral or value-free environment with human "actors". It occurs in a complex organisational setting with a culture and a history, both of which have a crucial influence on the course development and production process (Altrichter, et al., 1991:23).

This research also presented a typical Unisa case of study materials development. This case would not necessarily be one that would best yield understanding but we attempted to honour the multiple realities of the team participants. It allowed this researcher to report the various experiences of the team members. We attempted to formally generalize as far as it was possible in this specific case. This research was intended to facilitate a value debate as part of the professional development of the team instead of value conclusions (see Stake, 1995:48).

Is there value in promoting active learning opportunities? Admittedly, if interactivity is limited to a simplistic view of learning, the inclusion of a few arbitrary activities into old content-based texts will not be sufficient to promote the use of active learning opportunities by students, nor will it be socially enabling. Simplistic arbitrary activities may produce learners who are both intellectually and emotionally vulnerable to manipulation in a stimulus-response manner. The interactive texts that were developed for the purpose of this study (referred to as the Didactics course), however, attempts to address the issue of independent creative thought. It also attempts to embed skills within learning texts in order to support learners in exercising critical reasoning. This reasoning could be in the form of analysis, synthesis, judgement, and an increased ability to observe their environment or their own responses (Mouton & Marais, 1990:156-9). We accept that when linking reality (observation) with theoretical concepts, this focus on praxis may improve reasoning. We argue that the result is an increase in understanding or knowledge.

International, national and professional tendencies influence curriculum development. It is also generally accepted that all the components of the curriculum must be involved in any development as they are interrelated. This inter-dependence means that any change to a component leads to a fundamental change in the process and a change in the total curriculum. It is also accepted that any change in the curriculum should involve a purposeful decision based on knowledge and insight. These decisions should be taken by a curriculum committee based on an analysis of issues underlying the subject and implications that would affect the curriculum. These decisions, according to the lecturer, often follow a specific model and acceptable scientific research influences the decisions (UNISA, 1997c: 3).

Many things are affected when the prescribed book for a course like this one is changed. However, when the whole approach to the teaching of mathematics countrywide is changed by setting different goals and objectives, that is an entirely new picture. Currently we are moving away from the traditional approach towards a problem-solving and problem-centred approach. The "new" teaching of mathematics uses different strategies, different activities. It is logical, therefore, that the type of approach that is used to apply to evaluation will have to change drastically to accommodate the problem-solving and problem-centred approach.

We accept that mathematics education is a practice orientated field based on a theoretical and intellectual basis which has to comply with the realities and requirements of practice within a professional ethical framework. Mathematics is a complex, ever-changing and unpredictable educational field. Mathematics requirements are driven by societal needs, expectations and tendencies. This field of knowledge is characterised by the relationships between cognition, judgement and actions based on a problem-solving approach.

We similarly accept the view that distance education is based on a theoretical and intellectual

basis which comes to fruition as a practice orientated field which has to meet the specific realities and requirements of education practice in a South African professional ethical context. Distance education makes up part of a multi-faceted and dynamic education system in Southern Africa. Distance education requirements are formed by societal needs, expectations and international and national tendencies.

In order to answer this question, the basic assumption in the case study was that *"course development does not occur in a neutral, consensus vacuum, devoid of actors - on the contrary, it occurs in a complex organisational setting with a culture and a history, both of which have a crucial influence on the course development and production process"* (Altrichter et al., 1991: 23).

We accept the view that professional researchers, lecturers and learning designers should empower their research participants, students and professional development staff to understand and address their own situation and problems, become aware of their own potential and regain their own sense of dignity, so as to take collective action for their self-development. (De Vos et al, 1998, from Grinnell, 1993; Rahman, 1993: 34). Any intervention in an educational context should, ideally, involve some participatory action.

1.8.2 Parameters of this research

The research does not investigate the following areas because they lie outside of the limited scope that can be researched at any one time:

- Learners in South Africa have unique individual and collective identities formed through their schooling, so we do not investigate reasons for their learning behaviour.
- We accept that each case is unique.
- The relationship between different learning modes is important: learning systems, distance education and classroom-teaching will not be investigated as the context of this research was in independent study.
- It has been assumed that modular learning guides are effective for distance education study (refer to Moore & Kearsley, 1996:80).
- Students are all young adults, adults, or mature adults; each with an individual identity influencing their learning.
- Organisational change and its influences have been identified, but this study does not attempt to address solutions to the Unisa dichotomy of industrialist and post-industrialist factors in one DE institution.
- This study does not investigate the paradigm shifts within education or mathematics education in detail. We accept their nature as presented in the team context and describe events that flow from the learning environment fostered by holding such notions.

These issues are important for further study by other researchers.

1.8.3 Value of the study

The value of the study lies in the integrated approach that is introduced to the complex phenomenon of the process of learning. This approach examines the learning process and its outcomes in a specific case against the background of a literature study of learning theories and research methods in a learner-centred approach to practice. The experiences would be of interest to lecturers (or teachers) in education, whether face-to-face with additional material, online or distance teaching. This research can be of great value in understanding and guiding the complex learning process more effectively by using learning opportunities and activities.

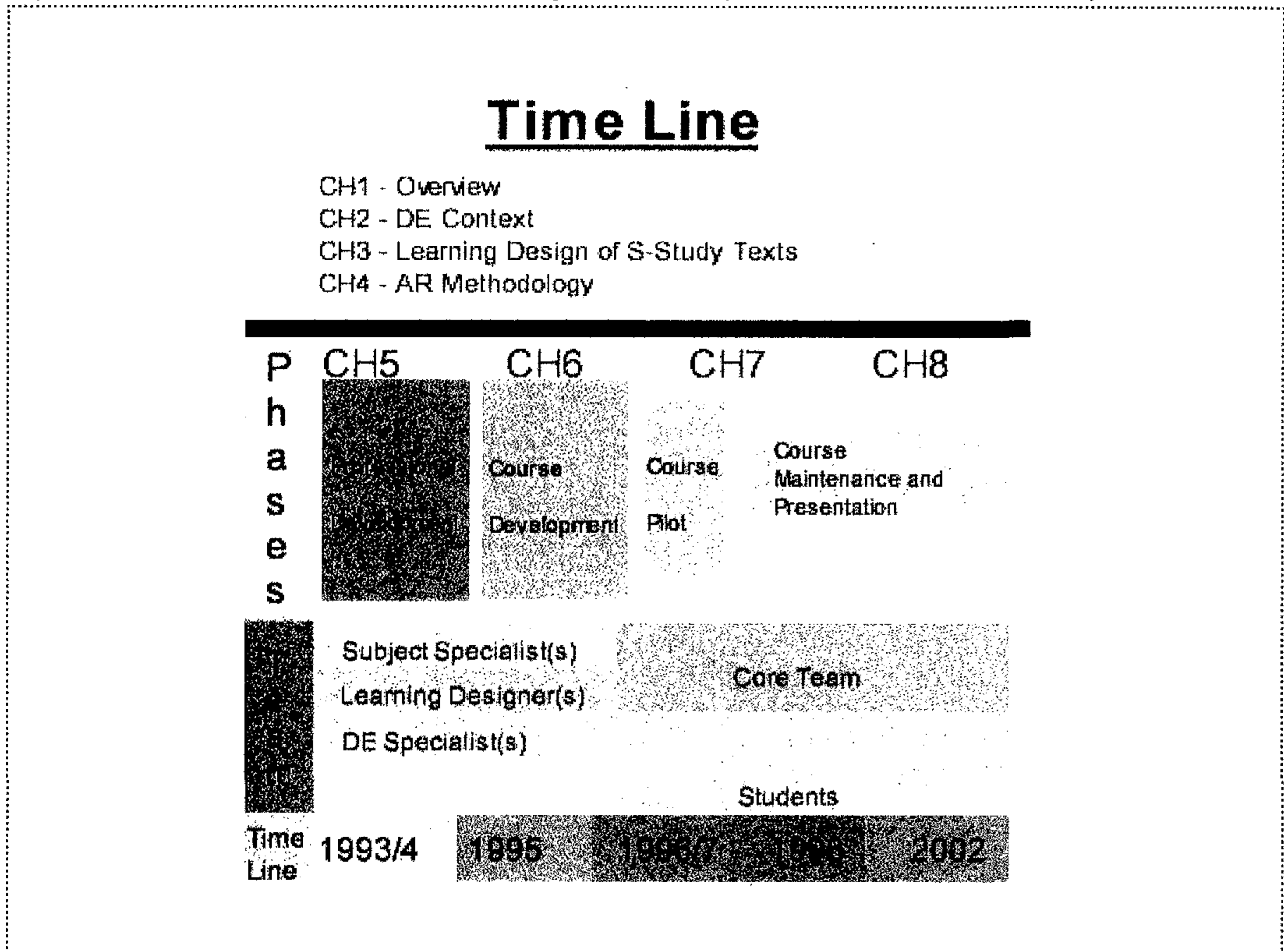
The use of activities-in-text can be beneficial in both print and online environments incorporating textual activities. The rich descriptions provide a sharing of events and experiences other researchers might find useful to follow. The action learning and action research methodology fostered change, the planning and monitoring of actions and events, and focussed on reflection - appropriate for the complex CDD situation.

1.9 Outline of this thesis

Course design and development is a complex process of teaching and learning events (Section 2.3.3; Macintosh, 1998a:38). The research focuses on effective course design and course development methods within the distance education environment of Unisa as well as essential teaching strategies as identified by Moore & Kearsley (1996:59-71). The events line in this research (see Figure 1.3) describes a typical full DE course development that developed through a number of AR 'cycles'. In this case four phases over ten (10) years are described. Firstly, this research describes a phase of two (2) years of personal development through Action Learning (AR), the second phase of one (1) year focuses on producing a course through an Action Research Project, the third phase of two (2) years describes how the course is established through a pilot programme, and fourthly, the course is maintained over a five (5) year period. These phases are usually repeated in practice with further revisions, substantial changes or refinements (as later supported by Macintosh, 1998a:41). (Refer to the Events-line in Figure 1.2). This process made collective conclusions possible through logic, deduction and evidence, and it was possible to support some of the researcher's experiences based on learning and DE theory.

The design and report on this research is unique because action research takes place in cycles of refinement. This study hopes to reflect those cycles in the chapter exposition. The script is divided into chapters with the literature study in the first part and the case study in the second part. In following this structure we are able to investigate the relationship and interdependence of theory

Figure 1.3: Time line of the course design and development of the MMAT00-8 study



Chapter 1 provides the details of the literature study which enabled this researcher to identify concepts involved in this research area in order to provide a review of the theoretical background to the concepts. These concepts include such ideas as distance education, open distance learning, learning theories, curriculum design, self study and active learning.

When considering different aspects during the curriculum development of a course at a distance education university, the components have to be considered as an integrated whole and as interdependent. These aspects are discussed in Part II, Chapter 3.

Chapter 4 explains why the research methodology, namely participatory action research, was chosen. Action learning cycles will be discussed in Chapter 4. Because action research takes place in cycles of refinement, this study will provide an overview of those cycles in the chapter. This chapter will be concerned with the development of the research, the research types used and the process followed, the data collection, the methodology of the case study description. The relevant

course materials are separately bound in an addendum. This explanation of the case study form the environment within which the research took place.

Part III describes the events and details during the phase of the research cycles in the action learning and action during 1993-2002 (Fig. 1.1). In the first cycle (Chapter 5) the action learning of the distance professionals is described as a necessary precursor to the team developing an active strategy to change learning. All aspects had to be addressed to improve the learning opportunities in self-study texts. These are described in Chapter 6. The results are discussed in each section. Chapter 7 describes the results of the pilot study.

The type of institution and the social environment sets the scene within which such developments may take place. These are discussed in Part II. Some of the aspects that are important are combinations and types of education such as contact or different distance education models, the differences in education between developed countries and developing countries, different organisational structures and roles of personnel.

In the conclusion, Part IV, Chapter 8, the significance of the findings and the actual experiences gained in the research are evaluated. The results should still be tested in other situations or an environment with similar factors. The researcher suggests conclusions to the case study and analyses these results. Implications for the teaching-learning situation (with specific reference to distance learners) are discussed critically. This part also exposes the shortcomings, value and limitations of the research. Finally, suggestions for further research are made. It is suggested how the use of learning opportunities may be refined to include more variables. The researcher suggest how teams can deal with change in an industrialist organisation.

1.10 Conclusion

This chapter provided the reasons for the study and an overview of the concepts involved. It delineated the study and opened up some assumptions that underpin the approaches in the study.

The following section, Part II, describes the results of the literature search. The organisation and the learners are identified as crucial in the design of study material. The process of curriculum design and the development of the team are examined. Course design and instructional design are described and analysed. Chapter 3 looks at learning theory underpinning this research, provides support for the practice during the design of the materials in the case. In a later chapter, Chapter 4, we describe the research methodology that made this research relevant and possible in order that the reader can appreciate the choice and difficulties inherent in a descriptive case study.

The reader would be well advised to consider the research methodology in reading this study as it is

substantially different from the most common descriptions of programs or arguments for teaching modes. This is a process described in a linear format, so the reader will become aware of recursive cycles. The specific action research process and the action learning is described in Part III.

DE theory has practical consequences and at the Unisa mega university this is no exception. As background to this study the next chapter will discuss the distance education environment at Unisa, curriculum and course design and development, the team approach, learning theories, distance education theories, activity theory, change theory, and the philosophical underpinning such as constructivism.

II: Chapter 2

DE institutions, learners & course development teams

2.1 Introduction

In the distance learning environment both lecturers and students are isolated as they work in different locations and at different times (see section 1.7). It is therefore vital to design and develop self-study resources that create a learning space and sustain academic debate. This chapter provides an overview of the context within which the instructional design took place, and shows for whom, and by whom they designed it.

This chapter describes recent international developments in mathematic pedagogy and changes in South African education culminating in the Outcomes-based Education (OBE) approach. These influences had a direct impact on the curriculum and assessment of mathematics teachers in distance education.

The adult learner who plans to teach mathematics has many challenges to face. When distance learners learn through self-study texts, many factors determine the outcome and quality of their learning. Although the focus in instructional design is to foster active learning, many factors influence the development of a talk and a relationship.

Here a course team designed the self-study texts. This chapter describes the approach and the roles and relationships that develop in a course team. The course team participants developed their knowledge, skills and new strategies to deal with constant change in their own environment. At the same time the team designed an enabling learning environment helping learners to develop problem-solving skills and openly approach novel teaching approaches.

A set of instructional guidelines infused the course design and development of the course (see Chapter 3). A course development team planned the interventions and afterwards reflected on their experiences according to the action research guidelines (see Chapter 4). We describe the results of the design process in later chapters (see Chapters 5-8).

2.2 Unisa in post-apartheid South Africa (1994-2002)

In a move to address the deficiencies in education and training in South Africa, National Training Task Teams started a process to improve education, training, human resource development, access and mobility in the educational system. This resulted in a number of reports identifying good practice in teaching, distance education and course materials (NEPI, 1992; SAIDE, 1994). We required Human Resources development to address the development of human capabilities, abilities, knowledge and skills to meet the needs for goods, services and improve standards of living. This resulted in a Government of National Unity White Paper on Education and Training, the White Paper on Education and Training through a National Qualification Framework (NQF) and the South African Qualifications Authority (SAQA) (SAIDE, 1996). SAQA has been established to facilitate *"the development and implementation of a National Qualifications Framework which contributes to the full development of each learner and to the social and economical development of the nation at large"* and for this purpose it was established (SAQA, 1995:1).

Mathematics teaching materials received substantial investigation and criticism regarding a teacher-centred behaviourist teaching philosophy (SAIDE, 1996:324-330). This course development was anticipated during 1993-4 when the researcher and the lecturer identified global practices and attempted to address the identified inadequacies in South African mathematics didactics. Individually they underwent a period of professional development (see the descriptions in Chapter 5). Unisa started with its transformation phase.

2.3 A change in Unisa self-study materials

A number of requirements from the national educational policies affected course development, learner support and institutional collaboration. An increased awareness of quality learning self-study packages (Monyooe, 1995:39) formed an important part of these changes. This includes the revisions of curricula following an OBE paradigm, quality control and authentic assessment (Macintosh, 1998d:2). Figure 2.1 demonstrates the number of Unisa learners affected by the national change in curricula.

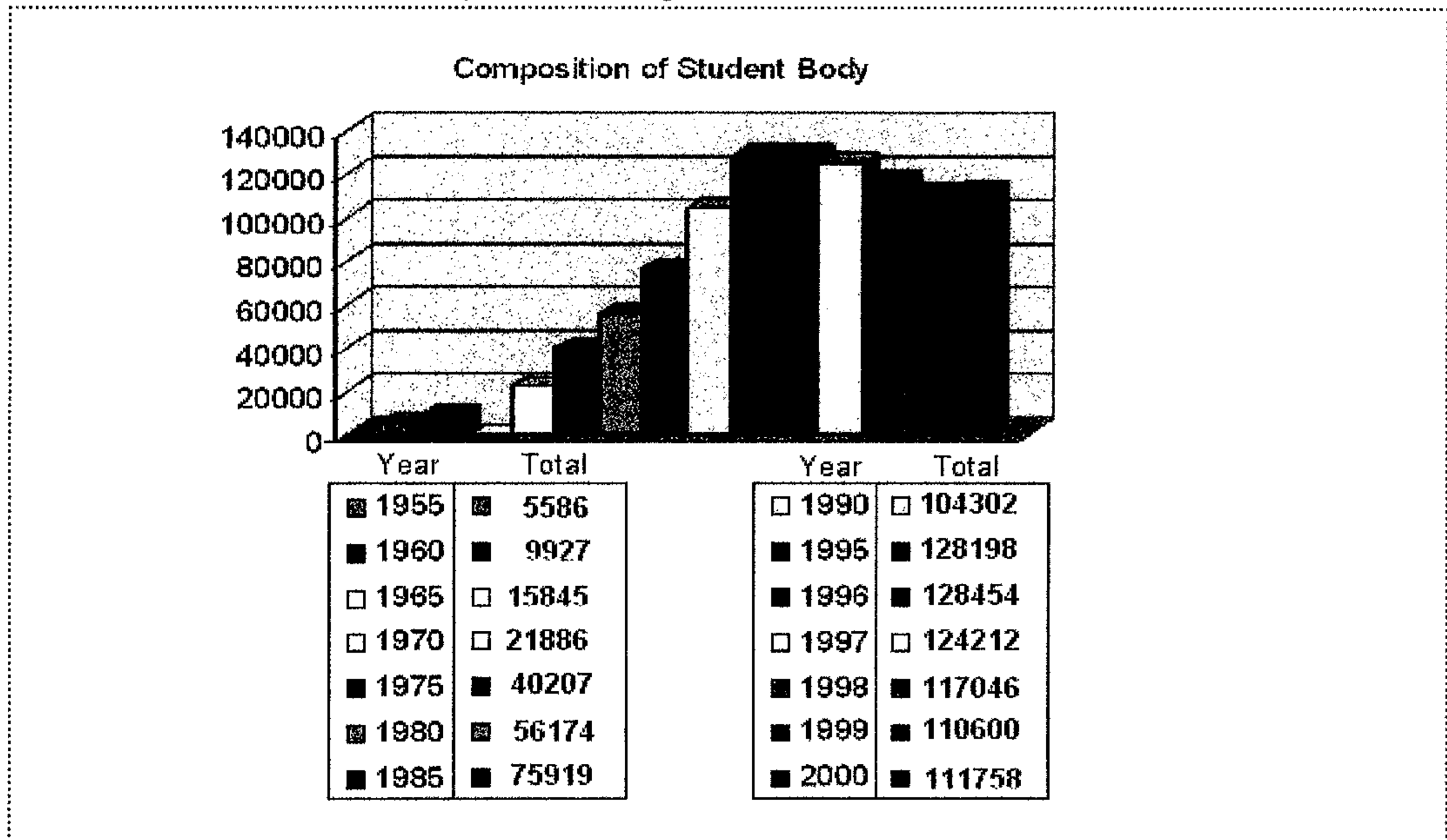
2.3.1 Revised National Curricula

In the post-apartheid educational system, mathematics curricula were scrutinized (SAIDE, 1996:45). The MMAT00-8 course development took place during this national movement. We noted developments within the context of the new structures for the development of national policy regarding curricula (DoE, 1996a:1). However, the implementation of the NQF and OBE systems were only initiated at Unisa in 1998 in the form of extensive staff training and development workshops. In order to stay abreast of developments, the course material was added in the form of tutorial

letters throughout the year and provided information about the American National Curriculum for Teaching Mathematics (NCTM, 1987, 1991, 1992, 1995, 1998, 1999) as well as newly developed South African curricula or examples.

SAQA (1995) requires all courses to be registered within one of the NQF learning fields and sub-

Figure 2.1: The student enrolment numbers at Unisa (1955-2000) to demonstrate the number of learners that are affected by national change



fields. The mathematics didactics course (MMAT00-8) is part of the Education, Training and Development Higher Education and Training field. According to the NQF levels of learning, this course would fit into levels 5-7 as a Diploma, Higher Diploma/First Degree or Higher Degree/Professional Qualification at a university. SAQA also specified that all courses should be designed to focus on outcomes. The types of outcomes include seven critical and five developmental outcomes (Table 2.1).

2.3.2 Outcomes-based education

Outcomes-based education forms the foundation of the curriculum in South Africa. It strives to enable all learners to achieve their maximum potential. It achieves this by setting the outcomes to be achieved at the end of the learning process. The outcomes encourage a learner-centred and activity-based approach to education. The Revised National Curriculum Statement builds its Learning Outcomes for the General Education and Training Band for Grades R-9 (for schools) on the critical and developmental outcomes that the Constitution inspired and developed in a democratic process.

Table 2.1: Critical and developmental outcomes according to SAQA

Critical outcomes	Developmental outcomes
1. Problem-solving skills	<ul style="list-style-type: none"> Identifying and solving problems in which responses display that responsible decisions using critical and creative thinking have been made. Reflecting on and exploring a variety of strategies to learn more effectively.
2. Teamwork & Citizenship	<ul style="list-style-type: none"> Working effectively with others as a member of a team, group, organization, and community. Participating as responsible citizens in the life of local, national and global communities.
3. Self-responsibility skills & Cultural awareness	<ul style="list-style-type: none"> Organizing and managing oneself and one's activities responsibly and effectively. Being culturally and aesthetically sensitive across a range of social contexts.
4. Research skills & Employment-seeking skills	<ul style="list-style-type: none"> Collecting, analyzing, organizing, and critically evaluating information. Exploring education and career opportunities.
5. Communication skills	<ul style="list-style-type: none"> Communicating effectively using visual, mathematical and/or language skills in the modes of oral and/or written persuasion.
6. Entrepreneurship	<ul style="list-style-type: none"> Developing entrepreneurial opportunities.
7. Technological and environmental literacy	<ul style="list-style-type: none"> Using science and technology effectively and critically, showing responsibility toward the environment and health of others.
8. Developing macro vision	<ul style="list-style-type: none"> Demonstrating an understanding of the world as a set of related systems by recognizing that problem-solving contexts do not exist in isolation.

The Revised National Curriculum also requires the curriculum to:

- Be culturally and aesthetically sensitive across a range of social contexts.
- Explore education and career opportunities.
- Develop entrepreneurial opportunities.

Issues such as poverty, inequality, race, gender, age, disability and challenges such as HIV/AIDS all influence the degree and way in which learners can participate in schooling. The Revised National Curriculum Statement Grades R-9 (schools) adopts an inclusive approach by specifying the minimum requirements for all learners. All the Learning Area Statements try to create an awareness of the relationship between social justice, human rights, a healthy environment, and inclusivity. Learners are also encouraged to develop knowledge and understanding of the rich diversity of this country, including the cultural, religious and ethnic components of this diversity.

The Revised National Curriculum Statement for Grades R-9 (schools) consists of an overview and eight learning area statements for: (1) Languages (2) Mathematics (3) Natural sciences (4) Social sciences (5) Arts and culture (6) Life orientation (7) Economic and management sciences and (8) Technology.

Each learning area statement identifies the main learning outcomes to be achieved by the end of Grade 9. Each learning area statement also specifies the assessment standards that will enable the learning outcomes to be achieved. Assessment standards are defined for each grade and describe the depth and breadth of what learners should know and can do. Learning areas' assessment standards show how conceptual and skill's development can take place over time. Assessment standards can be integrated within, and across, grades. The achievements of an optimal relationship between integration across learning areas (where necessary and educationally sound), and conceptual progression from grade to grade, are central to this curriculum.

The aim of the Revised National Curriculum Statement is to promote commitment and competence among teachers, who will be responsible for the development of their own learning programmes. To support this process, the Department of Education will provide policy guidelines based on each learning area statement. Provinces will develop further guidelines where necessary to accommodate diversity. The underlying principles and values of the Revised National Curriculum Statement Learning Area Statements underpin the learning programmes. Whereas the learning areas stipulate the concepts, skills and values to be achieved on a grade-by-grade basis, they specify the scope of learning and assessment activities for each phase. Learning programmes also contain work schedules that provide the pace and sequence of these activities each year, as well as exemplars of lesson plans to be started in any given period.

2.3.3 Quality mathematics course materials

Unisa became a full member of the select band of British and imperial universities in 1877. Queen Victoria bestowed the Royal Charter and promoted the advance of education between "*all classes and denominations*", with degrees fully recognized by the British world. They resented and never repeated an attempt to conduct quality inspections in colleges in the 1880s. Today quality assurance is again highlighted, but not mandatory, as with courses at the Dutch Open University. The attainment of quality is imbedded in good quality courses, its design and presentation combined with impartial assessment. Courses may be subjected to critical reader scrutiny and assessment feedback from learners, but regrettably these are both optional exercises. (Boucher, 1973:11; Macintosh, 1998a:1).

The unique features of learning and teaching mathematics include (NCHE, 1996:23):

- Working with numbers, data, space and shape: visualizing, measuring, ordering, calculating, estimating, interpreting, making informed choices, comparing and contrasting, classifying and representing with confidence and accuracy.
- Problem solving: making sense of the problem, analysing and synthesizing, determining and executing solution strategies, as well as validating and interpreting the solutions appropriate to the context.
- Investigating patterns and relationships: describing, conjecturing, inferring, deducing, reflecting, generalizing, predicting, refuting, explaining, specializing, defining, modelling, justifying and representing.

The Mathematics Learning Area develops (UNISA, 1996a:3):

- A critical awareness of how mathematical relationships can be used responsibly in addressing human rights issues such as social, political and economic relations as well environmental problems and risks;
- An appreciation for the diverse historical, cultural and social practices of mathematics;
- Pleasure in mathematical experiences;
- An ability to engage in the process of inquiry and investigation;
- An ability to use manipulative as well as electronic and other technology effectively; and
- Effective, independent working as a member of a team.

Mathematical knowledge, skills and values will enable the learner to (NCHE, 1996:22):

- Participate equitably and meaningfully (with an awareness of rights) in political, social, environmental and economic activities by being mathematically literate;
- Contribute responsibly to the reconstruction and development of society by using mathematical tools to expose inequality and assess environmental problems and risks;
- Display critical and insightful reasoning and interpretative and communicative skills when dealing with mathematical and contextual problems;
- Describe suitable situations using mathematical notation and language;
- Apply mathematics in a variety of contexts;
- Transfer mathematical knowledge and skills between learning areas and within mathematics;
- Display mental and technological confidence and accuracy in working with number, data, space and shape;
- Display mental and technological confidence and accuracy in investigating patterns and relationships;
- Display mental and technological confidence and accuracy in problem solving;
- Constructing new insights and meaning;
- Develop a critical awareness of how mathematical relationships are used in social, environmental, cultural and economic relations;
- Attain the necessary confidence and competence to deal with any mathematical situation without being hindered by a fear of mathematics;
- Develop an appreciation for the beauty and elegance of mathematics;

- Develop a spirit of curiosity and a love for mathematics.

In addition, the teaching and learning of mathematics can enable the learner to (NCHE, 1996:24):

- Develop an awareness of the diverse historical, cultural and social practices of mathematics;
- Recognize that mathematics is a creative part of human activity;
- Develop deep conceptual understanding to make sense of mathematics;
- Acquire the specific knowledge and skills necessary for the application of mathematics to physical, social and mathematical problems;
- Acquire the specific knowledge and skills necessary for the study of related subject matter (e.g. other learning areas);
- Acquire the specific knowledge and skills necessary for further study in mathematics.

2.3.4 Authentic assessment: portfolios, examinations, assignments and prior-learning

The University of the Cape of Good Hope (the precursor to the University of South Africa) was created by Act 16 of 1873, with the approval of the Queen of England. It functioned as an examining body with written examinations being regarded as an objective assessment method. In Britain, the University of London was founded in 1836 as an examining body to combat the exclusiveness of Oxford and Cambridge. They slowly viewed written examinations as a more impartial means to select the best person for a post in an increasingly competitive world. The Cape was more advanced than the British in extending the efficient written examinations as a recruitment method to the entire colonial civil service. The Board of Examiners managed the administration of these examinations for Government Service, established in 1850, with a representative government in 1854, that conducted examinations in many centres. They started teaching for these examinations when the first law classes for the Board's certificates were presented in 1859 (Boucher, 1973).

In the post-apartheid South Africa, the established South African Quality Assessment body, SAQA (DoE, 2002:3), requires that each Learning Area statement include a detailed section on assessment. A qualification shall:

Incorporate integrated assessment appropriately to ensure that the purpose of the qualification is achieved, and such assessments use a range of formative and summative assessment methods such as portfolios, simulations, workplace assessments, written and oral examinations (SAQA 1998:6).

An outcomes-based framework uses assessment methods that can accommodate divergent contextual factors. Assessment should provide indications of learner achievement in the most effective and efficient manner, ensuring that learners integrate and apply skills. Assessment should also help students to make judgements about their own performance, set goals for progress

and promote further learning. Fowler (1993:129, 117-128) states that a changeover to a modular system of education actually has wider curriculum development implications. Modularisation developed with another move towards criterion-referenced instruction in the late 1970s.

Assessment instruments should reward deep learning to encourage learners to use participation opportunities to learn to analyse, synthesize, validate and judge. When activities, assignments and examinations require factual or descriptive responses, students tend to adopt a surface approach to learning (White, 1992). Problem-solving and a problem-centred approach (as described in Chapter 1) may culminate in evidence of learning in a portfolio. This allows learners to become aware of change, actively participate and verbalize their experiences as described in Part III in the action research descriptions.

The recognition of prior learning is still a difficult issue that received due attention in the year 2000 with the support of government legislation, collaboration agreements, and better knowledge of the process. One of the most important benefits of the NQF and SAQA structure was the Recognition of Prior Learning (RPL) (SAQA, 1998:6) where they recognized that they could acquire learning in non-formal settings or courses. Some ways to identify and recognize prior learning includes tests, or a portfolio that allows the learner to demonstrate competence in relevant areas. The case study deliberately included a portfolio assignment, written assignments, examination, vignettes (a simulation in words of a situation) and self-assessment of workplace performance.

Learning outcomes are linked to assessment. A change towards a constructivist view of learning because of modularisation will involve assessment aspects such as moving, perhaps partially, away from highly reliable objective and easily automated assessment to attempts at more difficult, although authentic or integrated assessment via an "objectified" assessment strategy. This will allow "professional judgement" of knowledge and skills according to explicit criteria. This judgement may consider both analytical and holistic judgements; analytical assessment being the score tallies of criteria while holistic assessment judges the overall quality of a task, based on the argument that the quality of a piece of writing is more than the sum of its parts (Nightingale et al, 1996: 5-7).

2.4 The Unisa student in need

In distance education the adult learner is physically isolated from the lecturer (Keegan, 1986: 45-46; 1990:58, Knowles, 1984; Wedemeyer, 1978:214). All the learning material, management of learning, and lecturing guidance (teacher talk) has to be included in the distance education study package. Distance students are not resident at the university nor do they come to the university on a regular basis. Independent study takes place through mainly printed course materials and print is

used as a primary delivery medium for guides and letters. These documents provide guidance and information (Holmberg, 1995:51). The typical DE situation causes a variety of difficulties and problems. The process of course design is an industrialist format where the learning courses are packaged for mass consumption. Curriculum and course design in distance education study has to account for the system and its structures, focus on altering the strategies to increase dialogue through reducing both the physical and psychological distances, and foster habits that enhance or change actions within the learning environment.

South Africa is a melting pot of cultures and students traditionally come from many cultural backgrounds. We argue that the autonomy and self-directedness of Unisa learners can be expected to be different to other DE learners in the world because of South African learners' social and historical situatedness.

The promotion of values is important not only for the sake of personal development, but also to ensure that they build a national South African identity on values very differently from those that underpinned apartheid education. The kind of learner that they envisage is one whom these values will inspire, and who will act in the interests of a society based on respect for democracy, equality, human dignity, life and social justice. The curriculum seeks to create a lifelong learner who is confident and independent, literate, numerate, multi-skilled, compassionate, with a respect for the environment and the ability to participate in society as a critical and active citizen (DoE 2002:3). Life long learning fosters a new attitude to learning by an individual. It demands that each citizen feel responsible for learning throughout his or her life. It also demands that they create opportunities to respond to the demand. Lifelong learning cannot be defined narrowly as it includes all purposeful learning activity undertaken to improve knowledge, skills and competence. This learning includes formal (pre-school, school, higher education, adult education, vocational training) or informal (work and leisure) work. Lifelong learning plays a central role in promoting social inclusion, in enhancing competitiveness, and in combatting unemployment (Reding 2000:2; Moore & Kearsley 1996:239).

2.4.1 Advantages of focussing on potential learners

In the world of modern technology, it is increasingly difficult to predict in advance who is going to use a product, where and for what purpose. It is estimated, that by making sure that most people in varying environments and situations are able to use a consumer product or service, they gain a market share increase of about 20% (Lindström, 1997).

The role of the learner in course development has until recently been restricted to that of a consumer, who is forced to cope with and adapt to existing and new products and institutional services. In an industrialist institution such as most distance education universities, learning

packages have often been produced for an imaginary "standard" learner, who is often a reflection of the lecturer and course designer.

In addition, accommodating disabled or elderly users has often been on a very limited scale, consisting of grouping them according to different individual features. Variations concerning individual features like abilities, age, sex, education and other factors may be useful in course development when planning the marketing. These variations should also be considered when analysing the representatives of the various user groups selected as the focus for the design. Yet, this solution does not seem adequate for studying needs of potential learners and the evaluation of the usability of products and services.

2.4.2 Problems distance learners experience when learning

Much has been written about adults learning by means of self-instructional materials. The pace of today's "information society" makes constant demands on adults to learn and change; exponential increases in information require many adults to make learning a lifelong preoccupation. The expectation that many working adults will require re-training as they make several occupational shifts during their working life, coupled with the growing population of older workers and retired adults interested in enhancing their personal development and lifestyle, suggests a growing need for adult-level learning opportunities based in innovative types of instructional delivery (Decoy & Mills, 1989:39)

Some common problems South African adult learners experience at a distance education institute when using printed materials (Fowler, 1993:15; Van Aardt & van Wyk, 1996:16, 170-173) are:

- A lack of time because of other commitments and different life roles. The students in distance education are mostly adults who combine study with work that provides an income to their families or extended families. Such learners have a wide range of prior knowledge and have difficulty in coping with the different roles required of them in a balanced and appropriate manner. That also reduces motivation to focus and draw out the considerable energy needed to finish their studies (supported by Holmberg, 1995:50).
- Difficulty in understanding the university environment. Learners often have inappropriate expectations, especially for higher education requirements.
- Financial difficulties.
- Feelings of isolation because they tend to study alone (unless they form study groups) and do not receive sufficient or timely learner support.
- Lack of preparatory activities. Working through text is not enough to prepare them for long and complex assessment methods or even multiple choice assessment strategies. If shorter in-text activities are included, they are not always specifically motivated or structured to link with the

assignments or examinations or to address the skills and knowledge required from a beginner in the field of study.

- The turnaround time for assignments for marking and then for a student to redo or correct misunderstanding is unacceptable as accommodating feedback as a learning principle is too short.
- Difficulty in understanding tasks, unawareness of activities, a lack of interest or dislike of activities, assignment vocabulary and the structure of the assignment required by a faculty.
- Difficulty in coping with advanced argumentation needed as there is traditionally little guidance in the texts to develop higher-order learning skills.
- A lack of reading, writing, numerical and study skills, such as pacing, summarising, analysis and critical evaluation.
- Students are sometimes not explicitly motivated or guided to perceive the contents of courses as relevant to their everyday life or work situations.
- Teaching styles. The most common teaching approach used by lecturers tends to be to give information, written in an autocratic style, expecting only specific information to be memorised. This shows a teacher-centred approach - what Heese (1993:188) called the *"process that became the product"*.
- Lack of DE text development to address different target groups, individual differences, or preferred and alternative learning styles.
- Difficult personal circumstances (Beneke 1999:79) that cause great deviations in the group. These personal circumstances are non-academic in nature and include place of the home, power supply, temporary structures as homes, electrical or other power and light sources, water supply, an unreliable and infrequent postal service or instant electronic document transfer, short or long travelling times and modes of transport such as walking, taxi rides, trains, or private cars.

Considering this large number of serious problems, finding ways to address all these problems and differences in text-based self-study materials is clearly difficult.

2.4.3 Aspects that influence the quality of learning through self-study texts

Aspects influence the outcomes and quality of learning such as the following (Van Leeuwen, 1994:180; Kilfoil, 1996:205-206):

- The students' perceptions and expectations of the course.
- The knowledge of the discipline.
- The teaching philosophy and learning theory application.
- Appropriateness of and types of assessment instruments imbedded in the course.
- The cognitive and skill's development of the student, including language competence.
- The institutional framework's impact on the course presentation.
- The social and academic environment in which the learning takes place.
- Student experience of distance and tertiary education.

When problems arise with limited learning or assessment experiences, the developers of the course have to look at aspects such as those listed above. It is difficult to change or anticipate what the student brings to the process of learning. This includes prior experience, expectations, development and the social environment of the learner. However, factors within the teaching context that can be modified are content, method and structure.

Educators are key contributors to the transformation of education in South Africa. The Revised National Curriculum Statement Grades R-9 (Schools) envisions teachers who are qualified, competent, dedicated, caring and able to fulfil the various roles outlined in the Norms and Standards for Educators (DOE 2002:4). These qualities include being mediators of active learning, interpreters and designers of learning programmes and materials, leaders, administrators and managers, scholars, researchers and lifelong learners, community members, citizens and pastors, assessors and learning area or phase specialists.

2.4.4 Factors inhibiting active learning in a changing South Africa

A number of other factors that appear to inhibit lecturers from embracing an active learning approach in a rapidly changing educational environment in South Africa (refer also to Fowler 1993:210-211, De Joy & Mills, 1989:40). These factors include:

- The massive increase in school pupil numbers that lead to increased demands on the systems and resources at pre-university level. This resulted in a slow reduction in state funding for higher education.
- Primary and secondary schools' tendency to emphasize rote learning of facts rather than higher order thinking skills, insufficiently preparing students for their role in higher education.
- The increased student-lecturer ratio, especially in distance education (traditionally also considered "a last resort" for many students) which often results in educators accepting rote learning to cope with the labour-intensive nature of the problem.
- A lack of adequate resources (such as time, publishing, printing, design, technology, people with particular knowledge and skills) and an inability to use existing resources and facilities fully.
- An inability speedily to adjust to change in a new modern, integrated distance education environment and to adapt to new expectations by the government, labour market and student body.
- An inability to move from a teacher-centred towards a learner-centred approach.
- An inability to provide a flexible education systems environment to learners, where access and exit points are possible at various stages, and mobility or articulation between institutions of education.
- An inability to identify or address learners' needs, that is, their characteristics, part-time study requirements, multilingual and multi-cultural societal need and distance education demands.
- An inability to address needed changes in a subject's curriculum to reflect modern teaching philosophies and/or a re-evaluation of where the focus in content should lie.

2.4.5 The *Mathematics Subject Didactics* case

The Faculty of Education is one of six faculties at Unisa providing a conventional university structure. The university offers short courses, certificates, modules, diplomas, full degrees and postgraduate studies. They introduced a semesterized system during the 1996-1998 period. The mathematics didactics course (the MMATOO-8 course) covers *"that part-discipline of education which studies the component facets of teaching"* (UNISA, 1997b:2). They designed the course as a module stretching over two semesters. The nature of the course is based on knowledge development and assessment that requires time.

The aim of the HED course is: *"to provide the (future) secondary school teacher with the necessary academic and professional training so that meaningful task fulfilment may be experienced."*

Particular aims of the HED course are:

- *intellectual and scientific development for scientifically grounded teaching practice*
- *to enable the student to become a balanced, rational and responsible teacher*
- *to enable the student to serve the community in which she/he will be teaching"*.

The course was first presented as a year course in 1996 (UNISA, 1996a) as part of the B.Ed degree presented by the Faculty of Education in the Department of Secondary Teacher Education. University degree programmes are three- and four-year degrees, with the B.Ed degrees requiring a first Bachelor degree. The MMATOO-8 course is modular and is a year course within a semester system. The course is part of the B.Ed degree within level seven of the NQF levels of learning (Higher degree/Diploma/Professional Qualifications). The course focusses on problem-centred and problem-solving learning where real life poses problems of tasks that need solving. Learners are encouraged to decide to solve real life problems or simulated problems such as case studies or vignettes. Such real life situations are authentic situations, about the adult DE learner's life, society and career.

Problem-centeredness is still a largely experimental field. When following a problem-centred approach *"mathematics should be learnt by solving problems with little or no outside help, and the children should not be taught algorithms. The selection and compilation of materials is very important and must be planned well. The teacher involved must be highly skilled in this regard"* (UNISA, 1997c:xx).

Problem-solving is an appropriate challenging environment where *"the learner has to explore the problematic character (nature) of mathematics by solving problems and to learn this skill according to specific strategies, including certain algorithms or other strategies favoured by the teacher. [One] can also successfully select constructivism as its learning theory, but is not as dependent on it"* (UNISA, 1997c:xx).

In the case study, the MMATOO-8 students were made aware of the problem-solving and problem-centred approaches and they were encouraged to apply these teaching and learning approaches in their work situations as mathematicians and teachers (UNISA, 1997: viii). The textbook is based on a new and popular problem-solving approach. The learner has to explore the complexities of a subject area by solving problems. Stressing specific strategies, such as providing certain algorithms in mathematics, eases the skill of solving problems. Problem-solving does have elements of the mainly experimental problem-centred approach where the learner is expected to solve problems with little or no outside help, and no algorithms should be taught. It is vital to select and compile materials very well. The educator has to be experienced in this approach.

The study package of the MMATOO-8 course included a prescribed book (Cangelosi, 1998) with supporting study guides, tutorial letters and examination papers. The study guide provided overviews as meta-cognitive organisational strategies, learning strategies, philosophical views, simplified descriptions, and South African examples. It seemed important to list many factors playing a role in the learning process and to include a variety of learning theories in order to assist designers of distance education texts in the design, management and evaluation of self-paced learning courses for students. Establishing whether learning took place, or how effective the construct of meaning and eventual knowledge acquisition was, is always problematic as the student body is so diverse. What is required are a variety of methods to address various factors in the learning environment and to analyse cases where they apply such methods? Khan (1992:3) places the broader goal in perspective by stating that "maintenance of educational standards depends largely on learners, educators and the socio-educational norms of the society. Distance education has the potential of spreading education at a faster rate at no risk to standards. Since distance education uses the mass communication system and multimedia approach, a few good and honest teachers can teach innumerable learners, which is otherwise not feasible in a face-to-face situation. Therefore we can say that democratisation of education is possible without lowering its standards".

Educators or instructional designers can probably use this research to understand the processes in the learning environment better. They need to collaboratively, systematically and with a careful attention plan the guidance and exposition of learning matter to many students who find themselves at a distance. Nevertheless, who would these Unisa adult distance students be?

2.5 Characteristics of the Unisa students

Students at Unisa have particular characteristics, according to experienced student counsellors (Gous, 1997:5; Oosthuizen, 1997:72-82). Instructional design requires care in addressing the learners, so we will now discuss individual characteristics of Unisa learners.

Its diverse and heterogeneous nature characterizes the student body at Unisa (Unisa, 2000: Pocket Statistics Pamphlet). Their diversity makes writing a single course that would address each learner's needs very difficult. The independent study model is extremely difficult when course design and we plan learning. The mass provision and delivery of course materials to support the economies of scale that makes DE so successful, make life very difficult for learning developers and lecturers. The MMAT students are part of the Unisa student population. (A discussion of their characteristics is presented in 7.4 as part of the results during the piloting of the course.)

2.5.1 Racially diverse

Unisa lecturers deal with a multicultural group of learners in Africa, especially Southern Africa. The multiracial composition of Unisa learners affects the MMAT course development.

Table 2.2: Racial composition of Unisa student body

Years	White %	Black %	Coloured %	Asian %	TOTAL
1996	38	49	4	9	128,454
1997	38	49	4	9	124,212
1998	38	47	4	11	117,046
1999	40	44	4	12	110,600
2000	39	44	5	12	111,758

2.5.2 Geographically distributed

Unisa learners are geographically separated from the institution. They distribute students throughout the nine provinces of South Africa (Unisa 2000: statistic, Unisa 1996: Statistics) and internationally. The MMAT students were widely distributed throughout South Africa.

Table 2.3: Geographical distribution of Unisa learners in South Africa

RSA Province	1999	2000
Gauteng	44,394	45,815
Kwa-Zulu Natal	20,419	19,860
Western Cape	10,276	11,143
Other (Northern Cape, Eastern Cape, Mpumalanga, Northern Province, North West, Free State)	27898	36,184
TOTAL	102,984	103,002

Table 2.4: The global distribution of Unisa students

Area	Number in 1999 (%)	Number in 2000 (%)
South Africa	102,984 (93%)	103,002 (92%)
Rest of Africa	5,128 (5%)	6,266 (5%)
North America	317	373
South America	30	14
Asia	887	648
Europe	1,094	1,254
Australia	107	145
New Zealand	53	57
TOTAL	110,600	111,758

2.5.3 Different age groups

Students who study by means of distance education are traditionally older than contact teaching student groups. The Unisa adult student may fall into the late adolescent, early adult, adult and geriatric stages. Unisa learners traditionally have an average age of 30 years for 1992-1996 (in agreement with OU learners as reported by Keegan, 1986:46). This diversity affects the characteristics of the learner. The MMAT course students were between 30-55 years of age.

2.5.4 Different gender

Males and females are generally equally represented in most courses at Unisa with 34% males and 55% females. In the MMAT course this tendency is also true.

2.5.5 Differing experiences in life as professionals

A wide range of experienced working adults characterizes adult learners within a field, or preparing to venture into new fields (Gous 1991, 1992). Most of the MMAT learners were mathematics teachers, with some singular exceptions each year that were a microbiologist or not working (see section 7.4.1 and 7.5.1(d)(13)). Their experiences and prior-knowledge of mathematics also differed according to the lecturer (see 7.4.1). A common view is that adult learners focus on problems of a practical nature and are task-directed (Holmberg, 1995:49). This is not always the case with young adults at Unisa. They are warned not to start their studies without a particular career in mind (Van Leuwen, 1999:30) as they may be less professional experience than is required in the course.

2.5.6 Prior knowledge

They did not recognize prior learning at Unisa until 2001, unless in limited cases. The new South African education policy focussed on the recognition of adult knowledge and opened lateral movement in an educational system (Unisa: Assessment Policy, Unisa: prior learning policy). Being mathematics teachers crediting them for their knowledge and experience becomes relevant.

2.5.7 Varying autonomy as learners

We challenge Knowles's notion of autonomous learners and agree with Keegan (1986:45) that it would be harmful for students if they treated them as if they know how to go through the learning events. Learners expect constant feedback while inexperienced learners tend not to insist on feedback and often fall into a confused isolation. Learners may be shy or not realize that their study fees entitle them to study assistance from a lecturer (Van Leuwen, 1999:32). Lecturers at Unisa deal with lecturer-student ratios of up to 1:2500 (Wilson, Spencer & Batley, 2002:10) and therefore they find it difficult to provide the crucial feedback learners require. This often leads to a greater drop-out rate in DE. In the MMAT course one of the solutions explored was to include motivation and regular feedback in the text prompted by the activities as learning opportunities (see section 3.2). Some of these activities required collaboration which was difficult to manage

sometimes because of the practical difficulties of meeting with other learners (see section 6.5.2). Some learners require an individualistic approach and they expect to be allowed to study alone without being dependent on others. Adult students often have to unlearn old habits and incorrect concept definitions which is often difficult for the autonomous learner that still needs direction (Holmberg, 1995:50; Keegan, 1986:45).

2.5.8 Feelings of isolation and stress

In the distance education environment the lecturer and learner are separated, they work at different times and in different locations. Both feel isolated. It is therefore vital to create and sustain academic dialogue between the instructional material and the student, between the student and the lecturer, and between students and their environment (Keegan, 1986:45). Job stress is one of the main stresses on the learning environment (Bartels et al, 1988:45, Peters 1992:244).

2.5.9 Multiple responsibilities as adults

Adult learners find themselves in environments where they are accountable to a number of other "stakeholders" which place restrictions on their private lives (Oosthuizen, 1997: 80 for Unisa; Bartels, et al 1988: 45 in Peters, 1992:244). These people include the state as subsidizing body, lecturers, administrators, employers, parents, family, friends and children (Keegan, 1986:46).

2.5.10 Clashing needs with changing relationships

Parents, family or other stakeholders may have expectations or requirements that differ from the student's own needs. Different roles and personal responsibilities bring change and stress. These clashes and changes have to be resolved outside the study materials, however, they still affect the learner's success in study (Oosthuizen, 1997: 77; Shelley, 1996:120).

2.5.11 Low pass rates and long study periods

Around the 1860s the pass rate for the University as a whole was 20% with an aggregate of 33% in the examination as a whole - surprising low marks according to Boucher (1973:75). The pass rates in the MMAT course fluctuated dramatically depending on the time provided to study the module, the student population, their motivation and pre-knowledge.

2.5.12 Varying degrees of study discipline

We advise Unisa students to spend 8-10 hours per week per subject. This equates to 4 hours per week per module at first year level. The number of subjects or modules a learner can register for in DE should then be carefully considered. We provide learners guidelines on study skills, time for study and preparation for assessment (Oosthuizen, 1997: 72). The result is, often, high drop-out rates. The MMAT course expected a strong commitment with most of the knowledge and skills gained, observed or reflected on in the classroom.

2.5.13 Varying levels of motivation

Forces which are either intrinsic or extrinsic can motivate a group of learners. Extrinsic motivations may include competing with other learners, completing a course to get recognition, or being number one in the group (Oosthuizen, 1997: 75). This external motivation rarely calls for inner standards of excellence and perfection, or a goal creatively to build something new. Both of these motivations often exist in the motivation of learner (Keegan, 1986:46; Senge 1990:207). The view is also that they are intrinsically motivated to solve such problems by means of their studies. If one considers the variations in age, experience, culture, history, societal and other local influences, this might be an oversimplified statement in the South African context. Unisa provides access opportunities not otherwise available to South African students (Otto, 1994: 15) because of financial, political, geographical, age, experience, and/or work pressure constraints.

2.5.14 Multilingual with linguistic disparities

The official language in the 19th century was English. Dual language usage became more common and from 1921 until 1998 both Afrikaans and English were the official languages at the university. Now English is the language of preference in the multi-cultural and multilingual university. Courses may be presented in one language only. The MMATOO-8 course was presented in English only. In 1996 the home language of 48% of all students was an African language against only 31% English and 17% Afrikaans. In 1996 98% of African and Asian students studied through the medium of English. This is significant as students are often studying through a second or third language of communication (Beneke, 1999:114). Interestingly Miller (1998: 174) concluded after a study of students at a South African university that took part in an access course that second language, basic proficiency in language and mathematics or initial performance levels have limited predictive value regarding future ability or current learning ability. Clearly more research needs to be done in this field.

2.5.15 Varying degrees of skill

The reading, writing and study skills of the adult learner at Unisa vary extensively. Heese (1993:180, 203-204) found that the elements of reading instruction that were useful were text mapping (which includes identifying key words and ideas, the relationships between them and noting these insights in a visual form, such as in a mindmap) and vocabulary development. In her study, the other elements of reading construction that were found useful were study reading, critical reading, topic sentences, main ideas in longer paragraphs, skimming and scanning. Her study showed that knowledge of parts of a book, linked with scanning, should increase reading efficiency. Metacognitive monitoring strategies, such as the "*deployment of cognitive and metacognitive resources*" (Garner, 1987:191 in Heese, 1993:181) enable learners to respond to cognitive failure and success, and are linked to reading competence. Unisa learners are advised or

sometimes expected to purchase their own dictionary (Van Leeuwen, 1999:30; Kilfoil, 1996:207). At Unisa writing and study skills are often lacking and require academic support (Kilfoil, 1996: 205-206).

Practical deviations from the norm (as stated above) are to be expected with the diverse Unisa learner population and the course team in this study decided to explore all possibilities as far as possible. One main component of this study was to include as many reading, writing and study skills in the MMAT course as possible to support learning (see 3.2.3).

2.5.16 Different strategies to deal with workload

The one problem that most distance learners find it hard to deal with is workload (Chambers, 1994, in Lockwood, 1994:103). Workload is a difficult issue; on the one hand the course has to have a suitable standard and less content may lower the quality; on the other hand an excessive workload is definitely associated with a superficial approach to learning (as the research by Chambers, 1992, Entwistle & Tait, 1990 shows). What is the nature of this association of workload to a surface learning approach? This is unclear - it could be that the learner's perceptions could influence it, or it could be that the actual heavy load leads to a "quickly-learn-the-facts" attitude. If the design of the course focusses on fewer unnecessary facts and more reflection, a change of attitude, with information retrieval and learning management strategies, workload may be an issue that becomes less of a problem. If educators focus on analysing the type of work implied in the curriculum, they could probably expose the purpose and nature of the learning that they embed ("hidden") in the curriculum. This will enable them to change tasks that promote surface learning. More research in the Unisa open distance learning environment in this regard is imperative and needs to be encouraged at course development level. This research into the MMAT00-8 course exposed aspects of the workload that showed it to motivate, and to demotivate. This shows the complexity of this aspect of course design.

2.5.17 Different reactions to adapting to new ways

Adaptive learning takes place because of external factors and it is possible to change without a vision or belief. However, generative learning occurs when learners expand their ability to create (Senge, 206:1990). Therefore generative learning occurs only when people strive to accomplish something that really matters deeply to them and is something about which they can get excited. When this feeling is shared among people, this shared vision focusses their energies and creates a common identity among diverse people.

2.5.18 Different perceptions of their responsibility to learn

We design the learning-centred approach (also referred to self-managed learning) to put the learners in a position to manage and take responsibility for their own learning. The roles of the

learner and teacher change; the teacher is known as a "facilitator" for the learning, not only as a provider of information, while learners indicate their preferences and direction for study in a mutually agreed learning process (Section 7.5.1). Self-directed learning is the basis on which self-study operates, and it forms an integral part of the philosophy of open learning. Cognitive learning is the process of mentally retaining complex experiences by constructing structural patterns from concepts; in the MMAT course the learners understood this expectation.

All or some factors above might contribute to a distance student having difficulty with their studies with a result that the drop-out rates of courses are affected. The drop-out rate of a student is "*a student who ends studies prematurely and thus does not sit examinations.*" (Peters, 1992:235). Drop-outs at Unisa should be calculated in four different categories: *non-starters* are students that enrol, but do not take up their studies and do not take part in the course as they cancel; *draw-backs* are students that abandon their studies after some study without sending in any assignments; *drop-outs* study regularly, send in some assignments but who fail to get examination entrance because of too few assignments or failed attempts; *failures* fail the first and aggregate examination. (Fritsch 1988:5 in Peters, 1992:242). The statistics for the drop-out rates for this course over the eight-year period were not complete so making any conclusions was not possible. (Addendum F.)

2.6 The course team, professional development & change

The primary purpose of this section is to reflect on the functions and roles in course and project teams. The development stages of professional development of the members indicate the processes of change during the course design (including the preplanning, design, development, management and evaluation) of a successful distance education course team.

2.6.1 Institutions and change

Institutions become bureaucracies because of their desire to remain a stable system, also because of sustaining the division of labour and the resulting differentiation of roles. These roles are linked with the power to affect relationships where, to keep the system constant, they reward people for their self-interests with status, money and power. Course teams are post-modern structures within a bureaucracy that accept it with difficulty.

Educators through continuous critical analysis can only contest such power-based roles. Within an educational institution embracing changes is possible and one can develop an understanding of producing the new. If this embraces action and dialogue (especially a language focussing on action), it allows educators better to understand their roles and the dilemmas and issues in their situation.

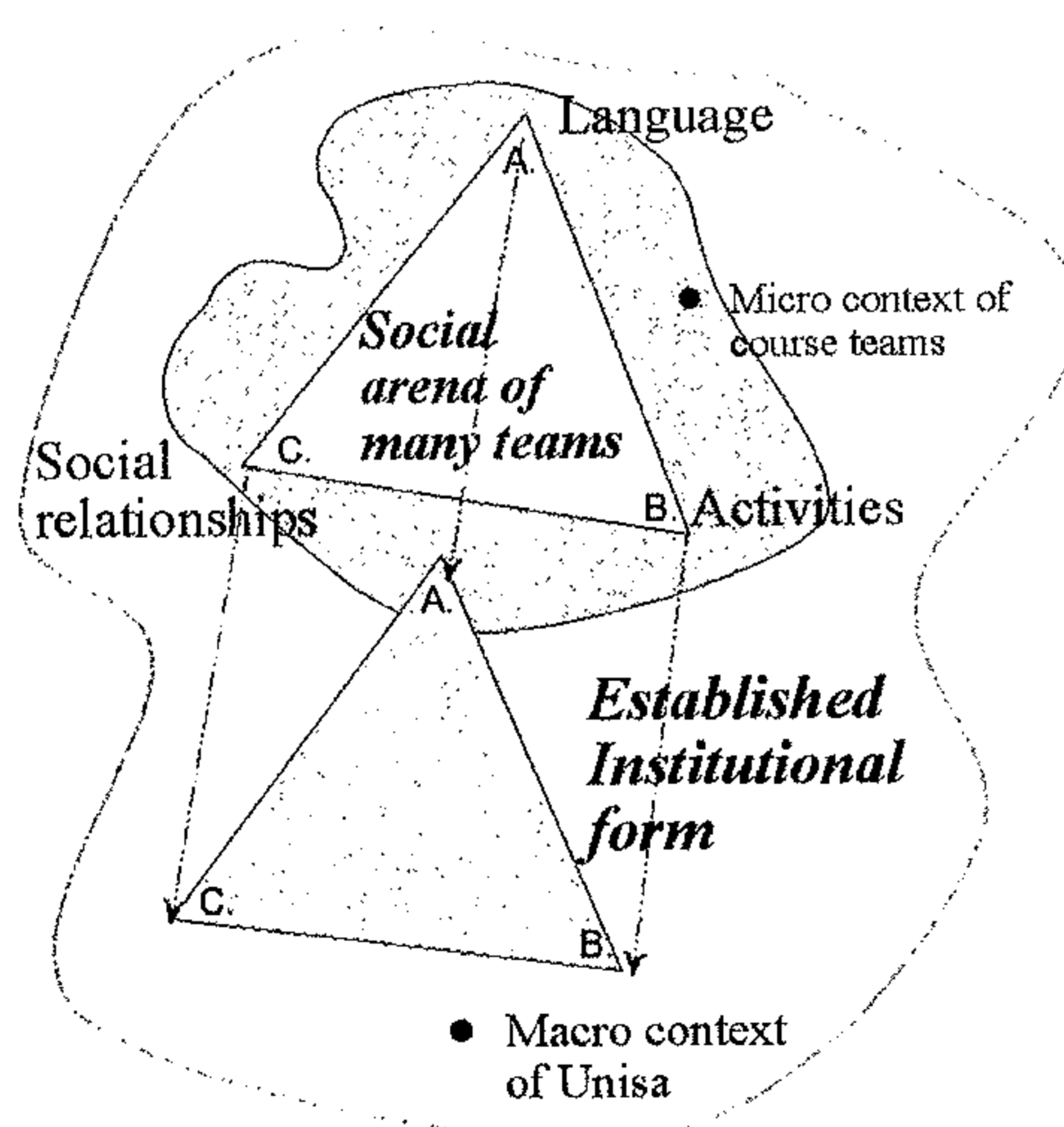
Through contesting the roles and social relationships, their activities and the language of the discourse, they can affect change.

When many groups embrace similar types of language, activities and roles in lasting relationships, the climate is set to "institutionalise" such new patterns and change the culture of an organisation such as Unisa (Daniel 1995:78).

Further institutionalisation and acceptance happen when stability, routine practices, and accepted patterns allow for newly established institutional discourses, practices and structures in the organisation (see Figure 2.2). This can cause viable collaborative operating units (see Figure 2.3). One of the more successful strategies to make an organisation change is to use action learning projects and, if possible, to formalize these as action research projects. A number of such efforts have the potential to move the organisation in a particular direction of change (see Figure 2.7).

The use of action learning or action research projects leads to increasingly focussed investigations and an understanding of practice and change. It has a further advantage that this strategy develops the managerial competencies and workgroup-specific competencies of the people involved in such projects. When these personal support capabilities develop, it is a sign of the development of a learning organisation (adapted from Mashile, 2001:133 and Kemmis, 1991: 58).

Figure 2.2: The institutionalization of change through newly established discourses, practices and structures.



Though members of a course team may have many years of experience, there is often an important critical stage where we empower and liberated the team members, not only the lecturer. This may

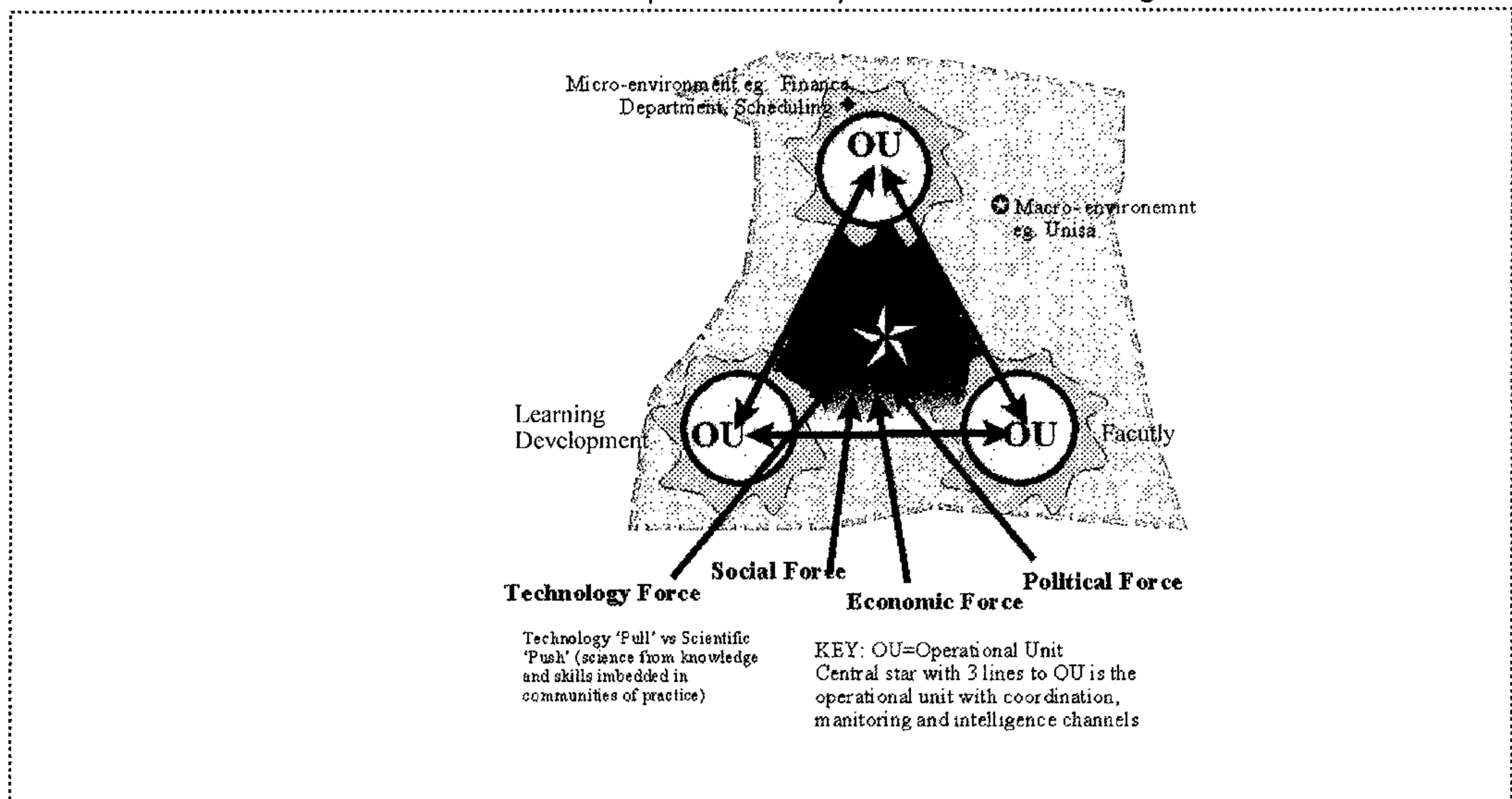
happen through a dynamic staff training and development period or during their collective struggles (supported by the critical transitivity stage of Freire, 1973) (see Chapter 1).

An organisation requires concepts and tools for dealing with the complexity of collaborative projects. Dlamini (2001: 25 in Wilson, 2002:10) defines the organisational prerequisites for the viability of systems and distinguishes a set of functions which ensure the viability of, in particular, organisational systems.

These functions and their interrelationships include:

- 1) A set of management functions with a specific set of the interrelationships, identified and formalized to
 - (a) regulate the capacity of the basic units in the organisation;
 - (b) decrease and amplify deviations from the focus and co-ordinate activities via information and communication;
 - (c) establish optimum functioning among basic units, for example via resource bargaining;
 - (d) investigation and validation of information of the above through monitoring activities; and
 - (e) deal with the long-term overall outside environment.
- 2) Balance the interactions of unit functions and monitoring to embody ideal guidelines and standards.
- 3) Any deficiencies in this system, such as missing functions, insufficient capacity of the units to function, or the faulty interaction between units, can impair or endanger the viability of the organisation.

Figure 2.3: Model for organizing viable collaborative operating units, described here as the course team members' roles and relationships with other professionals in the organisation.

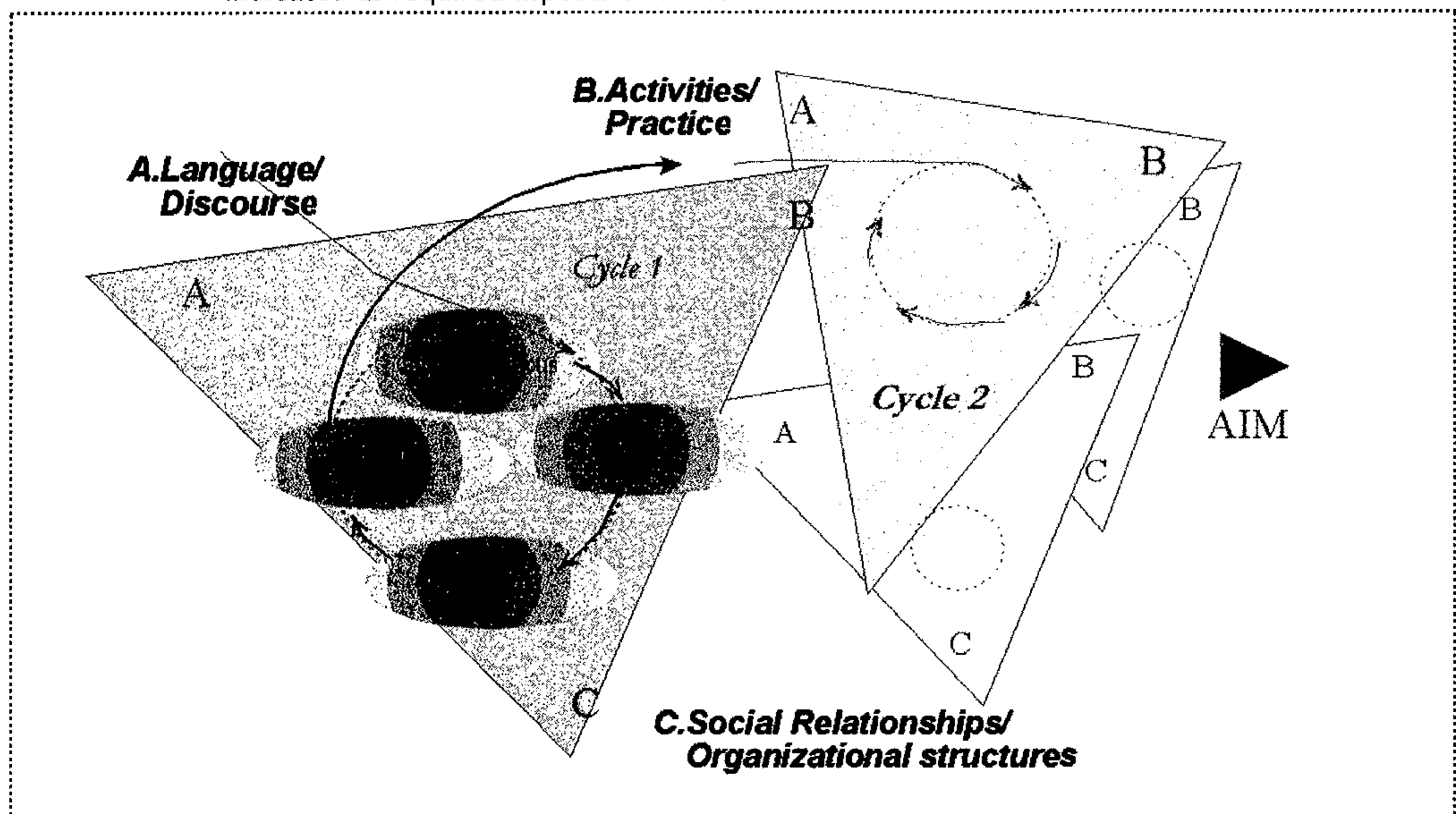


- 4) The viability, cohesion and self-organisation of an enterprise depend upon these functions being recursively present at all levels of the organisation. A recursive structure comprises autonomous units within an integrated institutional structure.

However, the team at this point has to consider their relationship to the learners and other departments (see Figure 2.3).

Moreover, a viable organisation is made up of viable units and it is itself embedded in more comprehensive viable units. Each unit, since it is producing the organisation's task, rather than servicing or supporting its own production, replicates the totality in which it is embedded. A unit can manage, from start to finish, the processes for the purpose for which it exists. When we apply the aspects that Dlamini (2001:26-30) describes, we see that in an organisation such as Unisa there should be good communication and management processes. Sets of people collaborate in cohesive units such as the different specialized departments, for example Production, Dispatch, or Editing. They have a common concern or focus, share information or knowledge, and share enthusiasm about it. At Unisa there is no doubt that the operational unit is part of a cooperative environment which shows the collaboration patterns of interaction or functions required to enable a distance education institution to provide a service to its students on the massive scale required. All operational units are required to be functional, providing feedback

Figure 2.4: A model to align various action research projects working in stages towards a common aim to affect change in an organisation. The roles of discourse, activities and relationships are indicated as required aspects of educational life that constitute reform.



to control, and monitor control. On a meta-level the strategic management of the organisation includes the control of the resources to ensure the functions at operational levels (Figure 2.3).

Performance is evaluated and strengthened at all the levels through training and development, research, and individual tasks. Intelligence as part of strategic management ensures an understanding of economic, regulatory, technological, demographic and social trends and opportunities (Dlamini, 2001:29). Strategy development in an organisation such as Unisa is central to its success. Policy which provides closure such as the framework of rules, embodied in the shared agreement and indicated in the general aims, provides clarity about the direction, values and purpose of the organisation.

Unisa's operational leadership becomes experienced in its divisions or operational units collaborating as one and changes as formalized through policies. All the operational units in the system may have to realign with the institute's strategies and improve coordinating to the benefit of the organisation.

The main focus for any bureaucratic organisation would be to control the functions within sections and operational units as it is in this control of shifts or change that the success of the organisation lies (Daniel, 1995:81). All the Open Universities may have similar structures, functions and roles, but these have to be aligned, shared and often new rules and functions have to be negotiated. This is where problems start and they test opportunities for change.

The implications for course teams are that these organisational structures, functions and roles are often invisible to the project team, yet affect it.

2.6.2 Development stages of professional development

Staff training and development programmes can effectively initiate change. Many institutional projects initiate change through collaboration, especially when the programme or project follows an action learning or action research process.

If one considers a range of staff development sessions as an action learning programme, it would include:

- A series of presentations to foster collaboration, trust, a shared vision and to expose theory to the participants in the project;
- A coordination who facilitates a discourse where the group strives to share tacit and explicit knowledge. This guards against the criticism of action research being uninformed as stated by Smith (1998: 251);
- The application of prior and new knowledge to a real project of value to the participants and

the organisation;

- A team that collaboratively helps in making sense of the experiences and outcomes grounded in theory;
- A small workgroup methodology to enable feedback and reflection. There are different stages in the action research process where the team members should discuss draft documents and where they have opportunities to suggest new lines of enquiry for the research and/or the teaching strategies as they influence others. They should also note changes that affect the team dialogue and the external dialogue.
- The effective management and the successful development of group dynamics and team culture;
- Experiences which present team members with new discoveries and alternative or creative strategies for new situations;
- Projects aligned towards a shared vision to foster a culture where people engage in and take note of the "moments" taking place in various action learning or research projects and programmes.

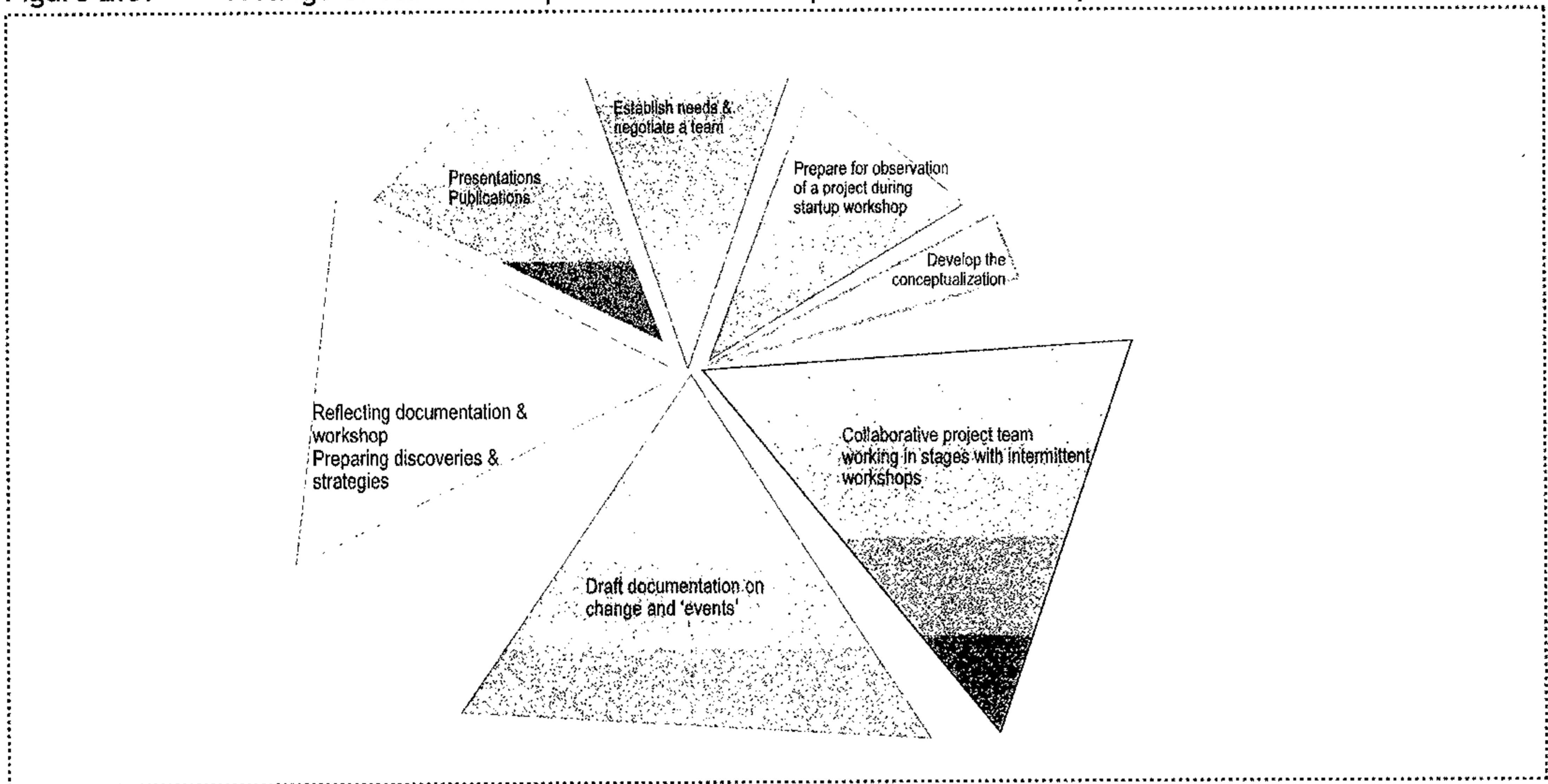
The team also purposefully used the process to develop professionally as the processes described for developing professional practice follow similar cycles as those of action research (refer to the argument of McGill Beaty, 1995). The researchers became aware of their practices as teachers, as distance education course developers, and they became more reflective practitioners. They focussed more on publication because of this personal and professional development. Elliott (1996: Ch.5) voiced a concern regarding the dilemmas and temptations of the reflective practitioner using action research as a form of professional development for teachers. She compares the craft of insider research and teaching with that of reflective practice. This becomes a characteristic of action research. However, Zuber-Skerrit (2001: Section 2, p.1) and Engelbrecht et al. (2001:105) make it clear that action research is appropriate for professional development.

In future action research and action learning will continue to play an important role in R&D (Research and Development) programmes in small and corporate business, communities and in the public sector.

This researcher proposed a professional development project cycle model (Figure 2.5: Model of Professional Development Cycle). The processes described for developing professional practice follow similar cycles as those of action research. Many practitioners say that they are already doing action research because action research and some forms of practice and consulting are similar in many ways. Both action research and practice are often directed towards the achievement of change, both are qualitative and often participative, and tend to be flexible and cyclic. In both instances there is a desire to base planned changes in the situation on understanding, and to derive that understanding from evidence. Because of these and other similarities, less formal approaches

to action research may be very similar to some forms of practice. However, most forms of action research are more deliberate in their pursuit of understanding. What is most important, frequent critical reflection is a formal and central part of most action research while most practice is much less reflective and if it does use reflection, is neither as deliberate nor as critical in its use.

Figure 2.5: A range of staff development sessions for professional development



The professional development project cycle model has seven focus stages (informed by Zuber-Skerrit, 2001: Section 2, p.8). The stages are:

- 1) Establish needs and negotiate a team that will collaborate and participate.
- 2) Prepare for the observations in the process to come during a start-up session or workshop.
- 3) Develop a conceptual strategy for the process and action.
- 4) Act during the project following the planning. Often a number of intermittent workshops are necessary.
- 5) Documentation is vital and there is a stage where the focus is on collating all the material gathered. Work sessions allow the team to observe the evidence and discuss its relevance and comprehensiveness according to the focus questions of the project. We may still conduct additional documentation such as interviews.
- 6) A final set of workshops focuses particularly on the presentation of the documentation and the process. Critical reflection is paramount and the team has to focus on sharing its experiences and views in an open debate.
- 7) Publishing and processing form the final step of the process.

2.6.3 Roles and relationships in course teams

Participants are faced with role choices such as teacher, participant, observer, interviewer, reader, storyteller, advocate, artist, counsellor, evaluator, consultant - and other roles. We may sometimes prescribe and sometimes restrict these roles. However, styles vary - and the roles may consciously or unconsciously change depending on the decisions the researcher makes concerning the emphasis given. Sometimes there is no choice concerning the chosen role because the circumstances direct it, or others determine it because of pressure or negotiation. In some cases the person simply does not know how to act differently. However, the role should always be an ethical and honest choice. Role definition should, if possible, focus the project so that the issues can be identified better.

Some of the roles are more attractive or suitable to different team members and researchers than others. The team has come to a shared understanding of the roles and to agreement on which roles each member will fill. Team members are role players that require skills of each member. Heese & Van Zyl (1997:95-97; Hawkrigde (1994:97)) name a typical team roles - namely the course chair, course manager, instructional design expert, academic authors, editors, graphic designers, critical reader, learner evaluator, external evaluator, media specialists, and other DE practitioner-specialists.

Roles in a team are often fluid or interchangeable. They may know the instructional designer as course developer, teaching advisor, facilitator of the team, or instructional development specialist. This person engages in several intellectual tasks in the design of a course of which he or she may have very little personal knowledge. The person might interview experts, read texts and journals, or employ techniques to gain an understanding of unfamiliar content, its nature and the characteristics of the particular discipline and knowledge field.

We considered the roles presented by Cronbach (1975), Stake (1995), Denzil & Lincoln (1994) and we concluded that learning advisors have choices concerning their roles in teams. The role choices allow learning designers to collaborate in research either directly or indirectly. Following the distinctions that Gold (1958 in De Vos, 1998: 60-61) made concerning the master roles, a qualitative researcher may perform different roles.

- 1) **The observer.** Striving to be a complete, objective and invisible outsider, the observer may function as:
 - a) A *teacher* to inform, to make the research more sophisticated, to assist in the increase of competence and maturity, to socialize and to liberate (see also Cronbach, 1975).
 - b) An *advocate* to carry the message and findings to be extrapolated, interpreted in various circumstances, and accommodated into theoretical discourse.

- c) An *evaluator* where the focus of the evaluation is on the programme, person or agency. The search is for the merits and shortcomings of the particular case.
 - d) A *biographer* where they describe the person(s) as a biographer would do. Smith, in Denzil and Lincoln, (1994) describes these methods more fully. We often call biographies "life histories" which we explore within a theme or issue-approach in the life of a person.
 - e) An *interpreter* where the case researcher seeks to recognise a problem, explore it, find connections, and interpret it in all its complexity and newness. This process may facilitate new meanings for the reader that might not even be comprehensible to the researcher. This role is central (Stake 1995:9).
- 2) **The observer-as-participant.** She creates a friendly atmosphere and observes the setting and processes without becoming part of the group.
 - 3) **The participant-as-observer.** She interacts closely with participants without participating in activities and therefore obtains an insider view without becoming a true member of the group.
 - 4) **The participant-in-team.** She is a full collaborator and participant in the central activities and processes taking place in the team.

Different professionals work in a team to address these team roles to harmonize during course design processes and to make changes effective (Polka et al., 2001:1). Concerning the input, variations are necessary as time, expertise, and budgets do not always allow individuals to work on all the components - lecturers often have to do most of the preparation and presentation themselves. However, research has suggested that a technology expert (such as an instructional designer) and an instructor should be included in a project team (Kelly, 1990; Moore, 1987). Learning developers should assist faculty members (lecturers) in the facilitation of effective learning. The focus should be to design a distance education course and to develop distance educators course design skills. This is often very stressful (Polka et al., 2000:7; Douglas, 2000:1).

The project management of a team is usually left to the project manager. A project manager may use a model to inform his/her management of a team. Zuber-Skerritt suggests a Figure Eight of the Strategic Project Planning model (in Chapter 1, Figure 1.1, Zuber-Skerritt, 2001: Section 8, p. 3 as adapted by the author) which shows initiating the problem analysis and plan with the team, visualising the actions and results from the interventions and designing to improve the practice. Observing the design and evaluating the results of the intervention and change is also part of the process. The course team leader needs management skills, administrative skills, people skills and conflict management skills.

A core team could invite more people that will use the course or system. Additional people may participate in the development, or engage in the process as co-researchers, such as learners or DE administrative staff (see 5.2). It is a developmental process and involves reflective inquiry and

collaborative discourse (Evans and Nation, 1989:37). This enables the developers to realize developmental qualities in their practice better.

Course development with a reflexive focus tries to change the learning environment for learners. Questions direct the inquiry about course design and team work, while boundaries and practices in the course design processes change. People constantly try to understand the course development processes, good learning practices and team dynamics which inform the changes made. The development team may invite learners to engage in the process as co-researchers during informal discussions.

These processes are complex and project management skills are crucial. Project management is the systematic planning, organisation and control of resources and time for a short period to achieve a specific aim or objective. It is characterised by a multi-disciplinary approach, which means that members often are crossing functional boundaries, both in the team and in the organization (Heese & Van Zyl 1997: 154-155). This boundary crossing is a minefield requiring careful co-ordination and management. Zuber-Skerrit (2001: Section 8, p.3) provided an adaptation of the management model to direct action research projects. The SWOT analysis of the model did inform the course design process, but was later adapted by the researcher (see 9.3.3) (Figure 2.6). Action research processes where learning improves can be extremely educational for all parties, however difficult these may be. Each time there is any intervention, change takes place. This research project describes a course teams reflections on such a process where all the components of a managed project is present (as discussed in the research results in Chapters 5-8).

2.6.4 Team strategies to enable change

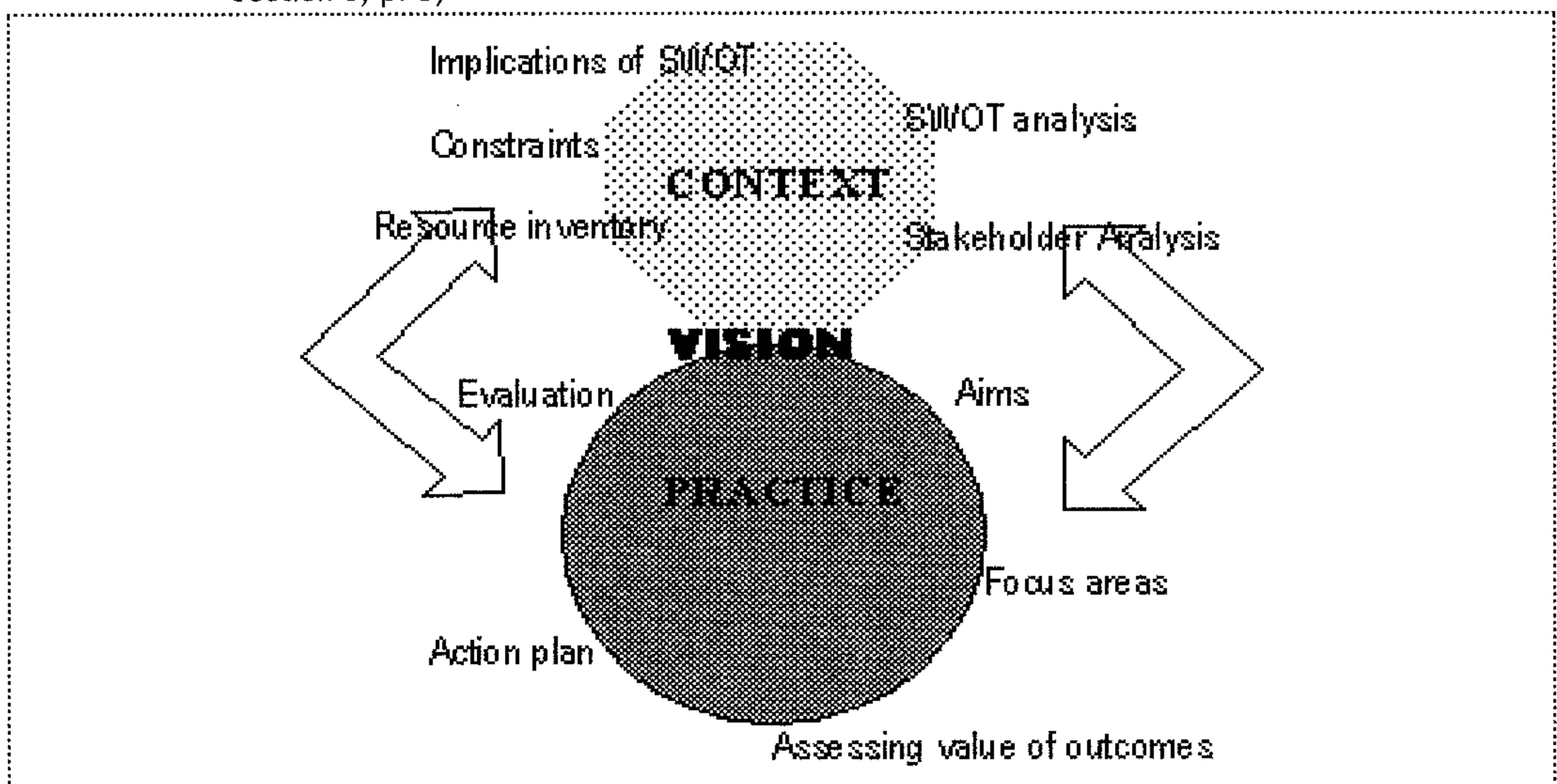
Course teams and researchers may use action research projects during course design or professional development. If the focus is to change the learning environment for learners, questions about course design should be posed. The team, course team and the researcher should consciously strive to change the boundaries and practices of course design processes at an institution. They should constantly try to develop an understanding about the distance education process, better learning practices, and course design. Austin (1998:13) believes that "collegial conversation" can be both a metaphor of what academic staff development should include and a strategy for organizing various kinds of academic staff development. At the heart of "collegial conversation" is active inquiry, dialogue and connection through relationships, each of which is essential among the academic staff in an institution of higher education engaged in significant transformation or change. Figure 2.6 illustrates the components essential for change.

A course team may also purposefully use the process of professional development (refer to the argument of McGill & Beaty, 1995). The researchers could become aware of their teaching practices

or their abilities as course developers, thus becoming more reflective practitioners. The outcome of such personal and professional development could be to their advantage if it results in some form of publication.

The course team and researcher used a case study. Altrichter et al. (1991) used a case study of course production in distance education to describe and understand the process of developing and producing a new course in a specific context. The focus was on informing policy and practice in distance education, and the theory thereof. Their main question for this research was: How did the course come to be produced?

Figure 2.6: The Figure Eight strategic planning model for action research projects (Zuber-Skerrit 2001: Section 8, p. 3)



This research perspective is similar to Meek (1983: 3) and Giddens (1976: 161) where the focus on the "duality of structure", which seeks to explain how, within the case study description, structures are constituted through action, and reciprocally how action is constituted structurally. It is imperative to use the historical perspective to inform the analysis of the complex interplay between human action and the social structure. No situational structure, where there is an interplay of people, is static at any time. Particular historical circumstances provide structure and force conflict and change.

Stake (1995: 95) says clearly that differences in description or conclusions are accepted in qualitative research. These phenomena need accurate description and observational interpretation to portray the mood, the experience, and the intention of the researcher. This research is never value-free. It is important to realise that qualitative research does, however, strive for validity of

description and encourage advocacy. These elements are always present, but should move away from invalidities, advocacies, and presumptions of sterility.

Case studies are not evaluation methods, but interpretations by a researcher focussed on the qualitative measures of the case. A case study researcher should choose specific criteria or a list of interpretation aspects by which strengths and weaknesses, successes and failures can be exposed. When emphasizing productivity and effectiveness criteria in a narrative description and interpretative assertion, the researcher is more qualitative in nature. However, there should be a description of context, multiple points of view, and specifically triangulation to make the reader understand the merits, issues and criteria that influenced the conclusions.

In view of the abovementioned problems educators should assess their own teaching methods, in order to provide quality education to more students. The focus should be on an interdisciplinary team that designs interactive texts for self-paced study for students.

2.7 Success through an action research project team

The success of an action research project and action learning project depends mostly on the extent to which the team adheres to action research values in practice. Also, the project should ideally yield results, answering some questions. Even if the answers are unwanted, the project is successful as learning and deeper understanding take place. What is essential to the project and the institution is the reflection following the project, with the public sharing of insights. (Refer to 9.3.)

The task that successful educational advisors need to reflect on is whether the research or project improved the professional quality of the transactions between practitioners and clients/colleagues. High-performance teams identify with the task so strongly that they cannot define themselves without the task, so their identity is no longer separate from the task (according to Maslow, in Senge 1990: 208). A shared vision elicits an immense amount of courage which drives them to perform exceptionally. A visionary can take his vision to the people and ask for support, tell them that he believes in the idea, explain how it could bring them closer to their clients - and that the merits could be tested at low risk. The question that arises is whether you are willing to test the idea in order to learn from his vision. As soon as the response is "How can we make this happen?" the process is activated. In order to work, the focus should be on it being everybody's vision, not just the visionary's.

The task in this study was to address the design and development of a particular Unisa course. The course design focussed on the materials and methodology that may be employed, using the instructional design strategy of activities in the text. This was done to change the actions, dialogue

and structures in order to affect the learning and practices of mathematics teachers and to change the course design and development practices of the distance educators. (Refer to Figure 3, Section 3.10.)

In any social arena such as a project team the language used, the activities it promotes and the social relationships fostered are closely related. For example, any mistake in understanding terms, misunderstood or ineffective role definitions, disagreements or ill-perceived activities will have a dramatic effect on the success of the project. Often, a professional development period is required to establish a basis for shared language, activities, roles or relationships (see Figure 2.5).

As in the team, the institution is affected by the finely tuned dynamics between the accepted discourse, the social relationships (as manifested in the organisational structures) and good practices. When the discourse is altered, the relationships and team roles are under pressure to change, along with a change in method and product. Only when all three aspects align, will the tension be replaced by successful and lasting change. It will be up to strong strategic managers to direct the movement of change and new learning brought about by a number of projects, some more successful than others.

Action learning and action research is driven by competent managers and change agents. The workgroup-specific competencies applied in action research are, firstly, to manage and relate to people with an outward orientation. Secondly, a pro-active approach to get things done or to change the *status quo* is required. The personal attributes of a mature person show a leader and manager. Co-operative skills are considered important, while competency in seeing the bigger picture provides vision. Lastly, conceptual and analytical competencies are required, skills which are often the focus in traditional research.

Where people encounter one another there is a fluid, ongoing process of formation and reformation where learning takes place (according to Kemmis & McTaggart, 1988:39). Whether people participate or not, situations change because of these interactions. Any apparent stability would be created through contestation and consensus - for example agreements to disagree, the living out of opposition, and the daily rejuvenation of roles that structure social relationships in an institution. In order to contest the current situation, there must be shared activities, forms of language, and a community with relationships. Therefore, contestation and institutionalisation, although linked, are at the same time *dialectically* related.

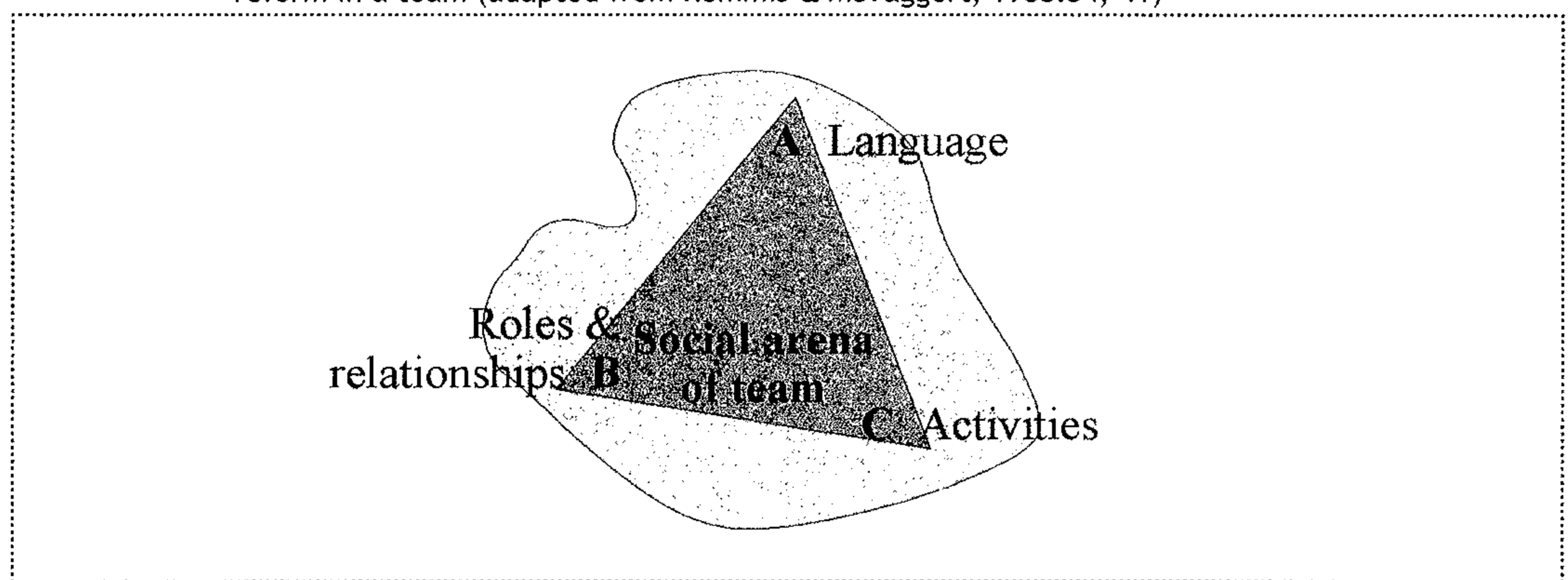
If an individual or a group of educators engages in critical analysis, they affect the language, activities and role relationships. The three aspects/domains of social and education life are interdependent and all contribute to reform, and are described by Kemmis & McTaggart (1988: 34,

41) as:

- A *language* to describe, explain and justify the individual. In an institution, orderly forms of language, if purposeful and conceptualised, become a *discourse*.
- The *actions* which constitute social life and its formation, such as administrative activities. Activities becomes institutionalized as *practices* when they are specific, purposeful and conceptualised.
- The *patterns of social relationship* which form education. In an institution orderly forms of social relationships, if specific, purposeful and conceptualised, become *forms of organisation*.

The course team, in its micro-context, depicted these patterns (see Figure 2.7).

Figure 2.7: The interdependence of the three domains of social and educational life that contribute to reform in a team (adapted from Kemmis & McTaggart, 1988:34, 41)



2.8 Conclusion

In this chapter the focus was to contextualise the research and development of this project. The macro-context demanded that Unisa change course materials by carefully considering needs when designing course materials.

The Mathematics Subject Didactics Course development is an example of a Unisa course. This course was developed by a course team. The educators were profoundly affected and their professional development played a very important role in the overall change process. The team members had different roles. Success in a project team and success of teams in an organization can be fostered through action research projects.

To summarize, this section demonstrated the diversity and complexity of the problems that DE practitioners are confronted with. Course design for self-study tests at Unisa is complicated because

of factors such as the wide geographical distribution of students. This contributes to the isolation of adult learners trying to study in English which is rarely their first language. Other complicating factors are difficult living conditions, heavy personal responsibilities, few tertiary study skills, and heavy course workloads. We agree with Rowntree that *"open learners often need help and advice on matters that have nothing to do with the subject matter they are learning about"* (Rowntree, 1992:83).

These factors were considered in the arguments concerning learner independence, autonomy, dialogue, communication, learning structure, active learning and life changes (De Joy & Mills, 1989:41). Course design (Chapter 3) focusses on the interplay between these aspects and how the design of a course strives to address these problems and needs of adult learners. Against the background of selected learning theories, knowledge and skills development is explored by means of the use of activities imbedded in distance learning texts.

II: Chapter 3

Active Learning design

3.1 Introduction

Distance education self-study environments require considered design to give learners a structured environment within which a sustained dialogue enables active learning. Caring DE practitioners in this study explored various strategies, tools, and devices to better the self-study texts. As we have already discussed, the DE context is unique (Chapter 1), the adult learner has unique characteristics (Chapter 2) and the DE institution and course teams are specific in their structures (Chapter 2).

This chapter explores the teaching approaches and theories that may have an influence on self-study texts in distance learning. The researcher will examine different approaches to knowledge and the paradigm shifts towards knowledge learning required in education. These approaches have a distinct influence on the dialogue that takes place in distance education.

"Our typical unidirectional view of behaviour as a dependent variable misses the real dynamics of the interaction in which behaviour is a determinant as well as an outcome" (Mckeackie 1976:829 in Bell-Gredler 1986:68).

The role of learning has become contentious. Learning is no longer viewed as the transmission of knowledge (Van Niekerk, 1996: 30 focussing on South Africa) but as a process influenced by culture, society, educational dialogue and the student's ability to make the knowledge his/her own:

The process of selecting from culture what students shall learn is not as simple as it reads. It is caught up in the controversy about what constitutes knowledge, who makes the decisions, about what shall be taught and learnt, and what criteria are used in the selection (Gatawa, 1990: 10).

Learning theories "help to describe and explain a phenomenon", unlike instructional theory that is more prescriptive (Moore & Kearsley 1996:211; Bell-Gredler 1986:70). A number of theories have been proposed to help describe how learning takes place by people like Skinner, Bandura, Tolman, Vygotsky, Piaget, Bruner and Freire (Collins et al, 1973:76; Rowntree, 1981:153; Page

et al, 1977:202-203, Bell-Gredler, 1986).

The relationship between a particular ontology resulting in a corresponding epistemology is an illustration of a specific paradigm. A paradigm is “the particular conceptual framework through which the community of researchers operates” (Carr & Kemmis 1991:72). Such paradigms, according to Carr and Kemmis (1991:74), are “informed by a whole complex of beliefs, values and assumptions, which are never made explicit in the theories produced by research, but which nevertheless structure the perceptions of researchers and shape their subsequent theorizing”. When we examine the influential work of Kuhn on “scientific revolutions” (1970, first published in 1962), one comes to realise that he supports the statement that paradigms are to be questioned. He argues that a paradigm is not questioned at the height of its influence to the extent that normal research is.

In this chapter the researcher, as learning designer, looks at learning and instructional design theories in her quest for understanding the planning and designing learning environments.

3.2 Mental structures of knowledge & learning

Research approaches are influenced by a researcher’s paradigm because of imbedded views of reality and knowing. The reasons lie in the inherent philosophical differences. Knowledge and the structure of knowledge rest on some fundamental notions such as causality, permanent objects and the self. These notions impart a basic structure to our knowledge, within which we understand specific events, facts and objects.

Different views on qualitative and quantitative research (discussed in Chapter 4), affects and changes the type of research underlying the learning approach or paradigm (McTaggart, 1993: 10-11). The dominant approaches in the social sciences are the positivist approach, the interpretative approach and the critical approach (Collins, Du Plooy, et al, 2000: 22).

The earliest questions about learning and teaching recorded in the West were formulated by the Greek, Plato, and his pupil Aristotle (C. 427-327 BC). Plato viewed human knowledge (reality) as ideas present in the mind since birth and saw learning as the development of these ideas by the mind, by turning one’s thoughts inwards and by developing a “mental discipline” (Idealism).

Plato’s view was opposed by Aristotle. Aristotle who saw human knowledge or reality as deriving from the physical environment while learning was seen as sensory experiences, derived from the environment, then organised and structured by the mind (Realism).

3.2.1 Knowledge premises imbedded in objects

In the 17th Century, Plato's realism gave rise to René Descarte's rationalism. Rationalism considers knowledge to be developed through deductive reasoning from a few basic ideas. Hume's analysis of rationalism, which assumes that knowledge is valid if it can be logically supported, indicates that one cannot deduce knowledge about the existence of a thing, although a valid logical argument may be true. He describes it as necessity carrying a logical force, but not an existential one. Therefore, according to Hume, the structural elements of knowledge cannot be reasoned or analysed. Reason or analysis may be sound. Nevertheless, we are unsure about how our knowledge reflects reality.

Three research-based theories developed up to the 1930s. David Hume's (1711-1776) radical-empiricist analysis of knowledge is based on the structural elements of knowledge as indicated by the empiricist as located in the object (Bell-Gredler, 1996:70). The notions of knowledge (causality, objects and the self) are "read into" experience, not as aspects of reality, but subjective contributions from the mind as the way the mind tends to associate and relate experience. Following this argument, causality is the tendency of our minds to associate contemporary events (conjunct events in space and time). Objects repeatedly presented with the same combination of internal or external impressions make us come to expect the combination without necessarily having experienced the object(s) behind the impressions. We also experience the self not as the underlying self but as a series of psychic events such as desires, feelings, thoughts, etc.

The Behaviourist theory believed behaviour should be reliably studied and measured. Note that some believe the functionalists (Thorndike, Skinner and Hull) and the associationists (Pavlov, Guthrie and Estes) to be, in essence, behaviourists (Collins & Du Plooy, et al., 2000: 24).

These two schools thus assumed that knowledge must conform to objects and that reality is constructed of an external realm of objects and events that stand apart from the internal realm of the subject knowledge. No objective knowledge is possible and the structural elements of knowledge cannot be located within the objective realm.

This thought was later opposed by Thomas Hobbes, John Locke and David Hume with British Empiricism. In this view empiricist ideas - the building blocks - are developed through the experiences of sensation and reflection. This explains higher mental processes while relying on experience and the formation of associations. David Hartley was the founder of the English associative school and believed experience led to knowledge. Hume insisted that associations are formed through correspondence, contiguity and the cause-and-effect relations of stimuli. This led to the formulated Stimulus-Response (S-R) law of learning by Pavlov, Thorndike and

Skinner, the Behaviourists. Skinner's Stimulus-Response (S-R) theory was refined by Hull's concept of drive and intervening variables.

Interpretative approaches believe that social reality is inherently meaningful and that, by participating in a situation, people can attribute meaning via interaction within the situation. (Collins, Du Plooy, et al., 2000: 26).

A popular philosophical approach, the critical approach, argues that social reality is multi-layered within which the dominant discourse by the most powerful represents reality. We argue that we each perceive reality as our own realities and we make our own meaning. We are trapped within this reality, and therefore our social reality is inherently meaningful because of our interactions within our situations. Using logic, reasoning, and critical reflection the abstract framework can be exposed and the hidden dynamics of the reality can be revealed. In the context of the team the researcher actively engages and critically debates issues with fellow members of the course team. Objectivity is not a goal because team members have a moral commitment and the freedom to challenge any inequalities and domination. A democratic, successful team emancipates human beings.

In the post-modern view there is no universal truth or objectivity in a diverse and fragmented social reality. Discourse and actions are culturally constructed and imbedded within particular social and historical contexts. The discourse includes a discourse on the subject and of the subject. The boundaries between disciplines reflect both conflict and consensus, and the boundaries are shaped by these processes over time and by the social reality (Goldenberg, 1988: 4 in Collins, Du Plooy, et al., 2000: 39). This duality is an underlying issue in this study and one that caused us to have great difficulty in our attempts to describe all the disciplines separately as is expected in a traditional thesis.

Views of knowledge as the construction of reality and thus, the understanding of experiences (Stake, 1995 and in mathematics by Steffe & Kieren (1994)) are in contrast with the view of some current qualitative researchers who see understanding as discovered. As far as Stake is concerned (1995: 100), similar experiences are not registered, but the interpretation of human knowledge and understanding is constructed from experiences. A researcher's view of knowledge and reality would influence decisions on her role and contribution to the experience of readers. All views are not equally important in case study research and the experiences are relative (Stake, 1995: 102).

3.2.2 Action for independence and autonomy

In the last four decades a fierce debate raged in DE circles about the independence and

autonomy of the adult learner. Wedemeyer (in Keegan 1992:77) proposes three dimensions of learner autonomy that should be promoted in DE texts: 1) self-pacing; 2) individualisation (where the individual should be able to follow his or her own course of study); and 3) freedom to select their own direction by setting goals, choosing activities to reach these goals and evaluating achievements.

Wedemeyer (in Keegan 1990:60) mentions several serious obstacles to achieving learner autonomy in DE environments. He states that problems exist in:

- Developing and sustaining sufficient interest and motivation levels in the learning opportunities.
- The readiness to study by means of DE texts. This is evident in the high drop-out rates and high non-starter rates at DE institutions. (A non-starter is a student who enrolls for a DE course but cancels without even attempting to study. Drop-outs are students who enroll, attempt the course, but do not complete their DE studies.
- Students being unable to grasp the subject structure.
- Assessing learning programs within a DE course.

An important reason often cited as a problem is the isolation of individuals in the DE learning situation, both the lecturer and the learner. This may be due to the domination of individual through, political structures, organisational structures, material constraints or power (for example of the lecturer over the learner). Freire (in Heaney 2002: online) calls it alienation, a term derived from Marx which separates the person from his labour. It interferes with the development of an authentic culture. Alienation can simultaneously create conflict and distance that might be below the surface, conscious or unconscious. When alienation remains beneath the surface of consciousness, it results in boredom, passivity, submissiveness, and anxiety (Heaney, 2002:online).

When alienation becomes conscious, it provokes anger, aggression, hostility, frustration, and fear. We argue that this might be a reason for an individual in DE, either learner or lecturer, becoming conscious of the inherent loneliness in the environment.

Self-conscious alienation can lead to critical reflection on reality in for DE and then lead to action. Action will effectively overcome alienation to the extent that it can reduce conflict by eliminating the distance through adaptation or compromise. Action may also increase the distance through movement outside the sphere of "oppositional influences", or by neutralizing the opposition through superior power or force.

We argue (following Heaney 2002:online) that, in DE, below-the-surface alienation may be

counteracted by eliminating alienation through accommodation and co-optation. These strategies overcome alienation by a positive and creative affirmation of position. Creative alienation is self-conscious, maintaining continuity with one's own identity and principles and building upon them in consistent ways. Self-consciously alienated people learn to fight back, to resist their oppression.

However, Heaney (2002:online) warns that creative alienation is not to be confused with marginality. For some educationists the experience of alienation provides stability--a corrective for bureaucratic systems which prescribe the future as a continuation of the past an "institutionalised" alienation. Would this underlie the DE organisation?

Some of the reasons for individuals to overcome or resist alienation could be social protection of the individual, in the institution itself or in a family. Another reason might be a psychic insulation and the capacity to endure over long periods of exposure to the problem. Some find a solution through postponement. Some individuals prefer the tension rather than reducing it. Others might seek a solution in sensitivity to cultural incoherence, the capacity for self-validation (which in other circumstances would be condemned as arrogance), and the ability to exist without the constant flow of validation which is a pervasive part of non-alienated life and the absence of which can be so destructive. Independence and remaining truly based in the local community may be traumatic, but the survivors value their sense of alienation and take pride in their uniqueness and marginality among adult educators. Students that complete their studies through DE do take pride in their newly found status.

The development of skills such as problem-solving, is truly effective when it is applied by or in the context of the community. It is least effective when directly managed by large, bureaucratic systems of schooling. Where skills are linked with other activities, there is a change in the conditions of oppression (Adams, 1974; Freire, 1972) and alienation. Problematization is the antithesis of problem-solving because in problem-solving, an expert distances herself from reality and reduces it to dimensions which are amenable to treatment as though they were mere difficulties to be solved.

Strategies to foster autonomous learning include the application of the models of autonomous learning (Peters, 1998: 90-94). The models include the humanistic learning and teaching model that creates a learning environment to provide "space" to learners an employ and "enabling pedagogy". Project-oriented studying provides learners with a framework for tasks and topics, then draw upon problem-solving to provide evidence of the results of their work. Contract learning affords the learners with total freedom to provide evidence that they have reached the agreed outcomes. The most extreme form of non-directive autonomous study is the "examination

preparation" model where learners receive examination regulations and reading lists to sit for an examination. The MMAT course addresses the two pedagogically sound humanistic and project-oriented autonomous learning strategies.

3.2.3 Action for dialogue and guided didactic conversation

Imbedded in a shift towards providing and expecting more autonomy on the part of the learner (Wedemeyer in Keegan 1980: interview), there is the notion of an altered dialogue. In DE dialogue mainly describes the process of direct and indirect oral written forms of conversation and communication where representatives of an interest group (the lecturer or a learner) when they actively exchange ideas during the making and exchanging of meanings (Moore, 1993: 24; Evans & Nation, 1989: 37). This open-ended and unstructured discourse is a characteristic of dialogical learning (Peters, 1998: 33) which is in contrast to one-way communication perpetuating domination and oppression. Without dialogue there is no communication, and without communication, there can be no liberatory education (in the Freirian sense, see 3.2.11).

The development of dialogue fosters understanding of the subject matter in an environment of partnership, respect, warmth, consideration, honesty and sincerity (Peters, 1998: 33).

Contemplating these issues, and seeing how difficult it is for both learners and lecturers to participate in the process of dialogue in self-study text, the researcher felt that this was a challenge not to be ignored. In this study we consider the dialogue between the full team members, between the core team and the students through discussions, e-mail, and the portfolio letters and mindmaps, and between the students and their community.

In distance education simulated communication (according to Holmberg, 1995: 105-6) is characterised by a conversational writing style in order to involve the learner emotionally in the study. The student is addressed personally and consistently has to react to questions. In-text tasks may include reactions, views, experiences, and questions. "The author might well say: 'Here you could hesitate. Can you follow the same principle again? Compare what I wrote in Course Unit X about a similar problem before you make up your mind'" (Holmberg, 1995: 105). The guide and the textbook in the MMAT course has evidence of simulated communication (Addendum A).

An experienced lecturer might address mistakes the learners regularly make by directing the in-text discussions in such a manner that it exposes these pitfalls in order for learners to become aware of them and so avoid the mistake. One could say, for example:
From your point of view it may seem logical to apply the x-rule here, but perhaps the approach discussed in the previous section is worth considering. For which of the alternatives are the prerequisite conditions given?

Some learners might think some questions, explanations, expressions or words redundant, but the flow of the argument will read better. It also makes learners feel that they are privy to an dialogical discourse where ideas are exchanged. This empathy with different views has proved to enhance motivation and learning (Holmberg, 1995: 46-55).

The distance and time separation between students and tutors calls for effective dialogue between these parties. Instructional activities provide the vehicle for the dialogue. The dialogue could take the form of the tutor's responses to instructional activities set for the student (e.g., assignments or research project) or need for clarification from the student regarding a given topic or problem. This kind of feedback provides the assurance and cultivates confidence in the student as evidence for the successful acquisition of knowledge and the application thereof. The resulting confidence may translate to increased productivity at the student's workplace.

Wilson (1998:7) indicates that teaching and learning at a distance eliminates interactive communication cues, such as pauses, intonation and gestures, normally associated with the face-to-face method of teaching but is present in video conferencing (Peters, 1998: 35). This is particularly so with the exclusive use of print media. Instructional activities built into the instructional repertoire may provide this missing interaction between the student and the teacher. Therefore, the use of instructional activities to effect better distance teaching is not optional, but essential. Successful writers of distance education self-instructional material and tutors need to master the design and application of this useful teaching and communication tool. Instructional activities should be varied in order to assess the different facets of the domains of learning.

Interaction (or lack thereof) influences the guidance the learners receive and ultimately the accuracy and diligence with which they complete tasks and actively participate in their learning. Therefore it can be expected that, within an active and comfortable learning climate, learning activities should be carefully planned to guide learners through the learning texts, enabling them to learn more effectively (Wheless 1975: 132-133, Moore, 1996: 126-7). In Chapter 2 some problems learners experience and some tentative solutions for these problems were discussed.

In DE the study text manifests the dialogue as attempts to enable students to become active participants in determining the implications of the new knowledge on their lives. We can argue that our learners are able to be in dialogue by *actively doing* something as prompted in the text, either something practical, or something mentally (psychomotor or cognitive involvement). The text has to compel the adult learner to enter into a conversation (Holmberg 1982:7 & Rowntree 1974:119) and "engage and involve them in deciding what and how" (Henderson 1989:2), when, where and why they learn, especially with the freedom they have in DE.

In enabling learners to become active participants, the curriculum drastically influences the design and development of the self-study package (Moore 1987:59). It includes the instruction of the forms of communication within student support and the interaction planned within the study package (Moore 1989:8). (The study packages that were designed are provided In Addenda A, B and C.)

3.2.4 Action for integrated synergy

The Gestalt perspective sees the whole as being more than its parts. These theorists' research gave rise to the development of a "Tutor Drum" by Sidney Pressey (1926) which was the first teaching machine and the major contributor to the start of computer-assisted learning as we know it today. Today "the 'art of teaching' by the teachers in the distance-teaching universities is now based not on their rhetorical qualities, ... but on how they combine in their teaching texts the functions of imparting, explaining, and controlling, and how they structure them with regard to the cognitive requirements of their students." (Peters, 1998: 80). The MMAT course development strove to reawaken the "art" of fostering a guided conversation, structuring the learning experience, and making explicit the required actions in text.

Another aspect of this reality construction is that new perceptions mix with old. They might mix with knowledge gathered by internal deliberation. If qualitative research wants to strive towards scientific acceptance, it has to build universal understanding - the unique understanding of individuals combining into a collective construction - clarifying descriptions and complex interpretations - a well-tuned reality which will bear up to scientific scrutiny and challenges. However, we cannot generalise from a particular case such as MMAT00-8. It is through "thick description" (as used by Clifford Gertz in 1973) that the reader interprets his own experiences while reading through the text and is then allowed to interpret or "construct" his own understanding.

3.2.5 Action allows for feelings and motivation

Jean-Jacques Rousseau (1712-1778) as romanticist philosopher added feelings as an element of knowledge. He agreed that knowledge conforms to objects, but assumed that feeling coincided with the structure of things in reality. However, feeling that something exists or is true is not the same as an object actually existing or being true. This includes feelings of self existence, existence of the universe, capacity of the mind to judge, necessity of a first cause and the existence of God. For Rousseau, the subject has an expanded role to play in knowledge by becoming the reference point for determining truth and falsity. Thus, either knowledge was not possible, or the structural elements cannot be located independently in either the subject or the object. (Bell-Gredler 1996:67.)

This duality, the two levels of reality existing independently from one another as matter and mind (like two perfectly timed clocks), emanates from Descartes. As rationalist he argued that true knowledge comes from reasoning alone (Bell-Gredler 1996:70).

In contrast, Baruch Spinoza (1632-77) argued that there is only One Substance: "*Deus sive Nature*" (God or Nature) as God and the Cosmos are one and the same, therefore, mind and matter are just attributes of the single substance. To be active we must understand our passions in the wider system of causes and effects. We must dispassionately find our true place within the causal system of nature.

Immanuel Kant (1724-1804) disclosed a new level of reality called phenomenon. This describes how the object appears to the subject. The process of gaining knowledge happens firstly, within a *a priori* pure intuition state that is an absolute (ie independent of and comes before sense impressions) and, secondly, by way of grasping reality through categories of thought. Kant insisted that "synthetic *a priori*" statements were possible, i.e. one can reason, independently from experience, to what extent a synthetic proposition can be true.

Knowledge comes from synthesising experience and concepts. This process is argued to be a "unified" one involving perception, imagination and understanding (sensibility and understanding were in inter-action). Thus, the structural elements of knowledge are located in the phenomenal realm and are mental structures which organise our experience and define the structures of knowledge. The function of these elements in experience is to interact between subject and object.

A result of this argument is that if the mind adds anything to an object, it does not necessarily become a subjective idea, but the universal nature of what the mind does to construct phenomena makes knowledge objective. Kant said in *Critique of Pure Reason* that our experience is always in the form of objects because there are structures of space and time in our minds. In other words, our perceptions of things are spatially and temporally structured as objects by our minds. Kant agrees with Hume that we cannot actually experience the objects, but he expands on Hume by arguing about the certainty of the knowledge of an object in the structure of mind in space and time. Kant argued that the mind imposes concepts or categories upon perceived experience in space and time. Once objects are perceived they are understood through the mind structures like number, quantity, classification, possibility, necessity, and causal relationships. Kant has a further condition of experience: that there is unity during all acts of thought between the person knowing and an awareness of the self.

Kant indicated limitations to knowledge by distinguishing between *appearance* (in the

phenomena realm) and *reality* (the world of *noumena*) because he argued that the object itself was unknowable. Any attempt to go beyond the phenomenal world, beyond the limits of reason, the practical sphere, and to apply concepts outside the limits set by their empirical application (such as arguments about the soul, immortality, God and free will) inevitably leads to paradox, fallacy and contradiction. He argues in "*Critique of Practical Reason*" and in "*Foundation fo the Metaphysics of Morals*" that morality comes from reasoning and that there is a pure rational element in moral judgements. The basic axiom "*Categorical imperative*" is to act as if the maxim from which you act were to become you through your own will (Bell-Gredler 1996: 84).

The writer of distance education self-instructional materials should provide instructional activities that generate interest from the students (motivation). Therefore, instructional activities that elicit students' curiosity may be presented to achieve this objective. Equally, interesting media, such as computer graphics with special effects, can capture and maintain students' attention throughout the learning process. Students' prior learning experience forms the foundation which enables them to perform instructional activities while course objectives help students to focus on central themes and principles that form the basis of the curriculum (objectives and prerequisites). Instructional activities should relate to the information and knowledge of the particular section in which they occur. In short, students should be assigned relevant instructional activities. These instructional activities should be illustrated with examples from their immediate environment (information and examples). Instructional activities should ensure that students perform certain tangible procedures in order to illustrate principles covered in the study.

Learning-by-doing is the major emphasis of the recommended instructional plan in order for such instructional activities to ensure the transfer of knowledge (practice and feedback). The success with which students perform their assignments should be determined so that they can be better assisted. In addition, this approach provides information that assists in the revision of self-instructional materials in distance education (students' evaluation and remedial input).

3.2.6 Action in historical and social relations

There are a number of parallels between Piaget and Kant. The first is that they centralise the role of mental structures in knowledge. Piaget explains that "our experience is assimilated to the forms of space and time and to the categories of the understanding". Kant (above) indicated that our experience is always in the form of objects because our minds have the structures of space and time. Objects are then understood through the mind's structures. (Bell-Gredler 1996:72.)

Both thinkers locate the concept of object in the mind's structure - Kant through forms of space

and time, and Piaget through the schemes of coordination of the infant's actions which culminate in the scheme of the permanent object. Piaget's intellectual operations in developing children are similar to Kant's categories of understanding since they show how the relations among things are used as tools to understand the world. Unconscious elements in cognition contain ordering principles which must be applied to a given experience in order to be recognised. Both Kant and Piaget indicate that due to constructive activity on the part of the subject, there is consciousness of the self and the differentiation of the self from the world of thing and others. (Bell-Gredler 1996: 87.)

Kant and Piaget differ from the Empiricists in stating that mental structures must interact with sense data for knowledge to exist. The mind cannot know things beyond experience, nor is it merely an empty vessel. Kant and Piaget both use the assumption that reality is constructed to become the phenomena we experience. (Bell-Gredler 1996:88)

Most of the lessons learned during the 1980's were conceptual ones (refer to Rhys, 1988:299). This includes the importance of approaching learning holistically - including the appropriate choices of methods, hardware and software, the importance of training educators, the crucial importance of a small core of expert teachers that can contribute ideas which are often used for many years, the integration of all aspects of the teaching-learning environment, as well as the importance of excellent and guided exposition of content in the study package. A holistic approach to learning is occurs when the individual adopts a global approach to the learning task. This is in contrast to the serialist strategy which tends to proceed in a step-by-step manner (Quinn, 1988:107).

The major influences on self-paced learning or the autagogical approach came from learning theorists such as Skinner, Ausubel and Egan.

Skinner's stimulus-response theory on the shaping of desired behaviour with ratio and interval reinforcement (as an alternative to punishment) (cf. Bell-Gredler, 1986:82-92) was called the contingency theory. Skinner's theory can be applied to develop a technology of teaching that includes managing the learning environment.

Ausubel's information-processing theory focuses away from rote learning towards meaningful assimilation of knowledge by means of a well-structured and meaningful presentation of knowledge. Meaningful assimilation means that "the substance of the material is assimilated nonarbitrarily and is related to the individual's past knowledge" (Riley, 1983:139). Rote learning is "bits of material, or 'associations' [which] are memorized arbitrarily and verbatim" (Riley, 1983:139). Students can acquire new information when lecturers (i) guide the reception of new

stimuli, (ii) facilitate the encoding of messages, and (iii) facilitate the storage and retrieval processes. This is made possible if study packages are designed to state objectives and advance organisers (as Ausubel modelled it) to assist in the meaningful acquisition of data into prior knowledge structures (Ausubel 1968:186-212). He believes most of the psychological learning principles (like small learning steps, repetition, etc.) have less effect during the meaningful assimilation of knowledge.

3.2.7 Structured action and support for learning

Egan's Gestalt-type structural communication model, describes the pathways which can be used for complex material which is written in the form of study units. Study units are divided into sections: Intention, Presentation, Investigation, Response, Discussion, Viewpoints (Egan, 1972:63-70). A dialogue is stimulated between the student and lecturer (as the author) which guides the learning and compels the student to actively participate. The lecturer structures the learning in order to provide feedback after each session in which effort was expected. Independent thought is especially prevalent in Egan's model for study units. During the investigation section problems are stated and discussed on different levels. Different viewpoints are provided and the student is deliberately guided to independent thought. Educationists elaborated on this by probing deeper into reflective thought. Reflection is different to a reflective learning style. Reflection is to reflect on current actions while reorganising them on a more logical level is referred to as reflective abstraction. This latter process involves thought processes 'reflecting on themselves', as described by Piaget in 1980 (Bell-Gredler 1986:202-203). This process of reflective abstraction uses internal experiences or knowledge, therefore it is called endogenous knowledge, and this endogenous knowledge is formed by coordination of the student's actions into more logical patterns of activity and a new cognitive organisation. Reflective abstraction can exist in a totally pure form as reflected abstraction. The way the new knowledge develops is termed logico-mathematical experience. Reflection is seen as another word for meta-cognition (Quinn 1988:110). Rehearsal and mnemonics are both strategies of meta-cognition. A reflective learning style is the tendency of an individual to come up with an answer to a problem after spending time in reflection before providing the answer (as opposed to the quick way which is a impulsive style).

Refined behaviourism developed during the 1930-40's with the research of Hull, Guthrie and Skinner (Bell-Gredler, 1986:49). A strong opposition group formed that believed the cognitive or knowledge aspects should be stressed. These cognitivists included Lewin, Tolman, Brunswik, Piaget, Bruner and Ausubel. (Bell-Gredler 1996: 13.)

By 1950s the move towards research in the classroom became more prominent, away from a

laboratory approach. The major movement was a refined behaviourism. The Gestalt opposition was still strong. In 1954 B.F. Skinner described "operant conditioning" as the basis of his philosophy, a major model in the movement. Norman Crowder's branched programming in followed in 1958. Since then, various developments led to the phenomenal new machine designs in the 60s (Bell-Gredler 1996:14).

Skinner's neo-behaviourist theory was the only one to survive after the 1960s. During the 70s and 80s, Skinner's principles were gradually being replaced by newer cognitive research in instructional and experimental psychology. Interest surged in different areas simultaneously - in Bartmann of the Gestalt psychology, in information theory with H. Frank, in cybernetics in Germany, in programmed instruction with Hawkrige at the Open University, through the Russians interest in cognitive psychology, and in Egan's structural communication developed in 1972. (Bell-Gredler 1996: 54.)

Bloom (Bloom, 1956) started the bulk of his research at the end of the 50's, but even today his hierarchical classification system for teaching and learning objectives is relevant and often used. It is structured to address the cognitive level (intellectual knowledge), affective level (values) and psychomotor level (skills). Bloom's taxonomy gave rise to many other developments. One of the developments that followed after Bloom's research was Gagné's five domains where learning processes take place (cf. Behr, 1980:65): (i) motor skills, (ii) verbal information (iii) intellectual skills, (iv) cognitive strategies (v) attitudes. Davies (Davies, 1971:175) related different teaching methods and media to Bloom's learning domains (Davies, 1971:121). Dale then set up a cone of experience incorporating a number of the teaching-learning principles indicating reality as more concrete and easier to learn in the learning experience if compared to abstract visual and verbal symbols (Dale, 1969:107).

However, the visual and verbal symbols, concepts and rules of a subject area have to be transformed in order for the student to interact with the material and understand it, on a logical and psychological level. As described by the information-processing research movement, logical meaning is "*the relationship between the symbols, concepts, and rules of the subject area*" (Bell-Gredler, 1986:178). This movement had little direct impact in teaching but it did provide rich results in the following areas: (i) the processing strategies students use during learning as can be seen by Gagné, Larkin, and Resnick's research (Bell-Gredler, 1986:170), (ii) the awareness to teach cognitive processing skills directly (organising one's knowledge and methods to correct errors in understanding) as proposed by Greeno in 1976 (cf. Bell-Gredler, 1986:170) (iii) the use of semantic networks to assist curriculum organisation and content analyses, according to Posner (1978).

“Semantic networks may be used to ... compare instructional material with the knowledge structure of the field” (Bell-Gredler, 1986:170).

Jean Piaget’s cognitive development theory (approximately 1975-1980) is a rich source for application in distance education and self-study today. Intelligence and knowledge are seen as processes, not product concepts. This complex theory deserves more serious attention by educators to enable them to comprehend and utilise the areas Piaget defined. This includes (i) the relationship between the learner and the institution, (ii) support for learner research as compared to “direct teaching” and (iii) the use of active methods of reconstructing or rediscovering truths. Some of the world’s best open learning material is constructed applying these principles, first devised for pedagogics, then adapted by various researchers to the field of andragogics. (Bell-Gredler 1996:188)

In developing curricula, different models appeared, the best known one being the product or behavioural-objectives. This is usually ascribed to Ralph Tyler’s book *Basic Principles of Curriculum and Instruction* (1949) and incorporates Bloom’s taxonomies of educational objectives, taxonomy by Krathwohl, Bloom and Masia, taxonomies by Simpson and Harrow, and Mager’s contribution on the construction of objectives (1962) (Quinn, 1986:238). A rigid model, although useful. *The process model of curriculum development* was developed by Stenhouse in 1975. This model allows a more open ended outcome with the emphasis on the development of self-appraisal in the student (Stenhouse, 1979: 95). The cultural-analysis model of curriculum development was designed by Denis Lawton (1983). It analyses the culture and plans the curriculum on the basis of this analysis of the society in which the education has to take place. A interesting fourfold model of the curriculum by Beattie (1987:31 in Quinn, 1986: 241) suggests four different approaches when planning a curriculum: (i) a map of key subjects (ii) a schedule of basic skills (iii) a portfolio of meaningful personal experiences (iv) an agenda of important cultural issues. There are three application methods: (i) eclectic curriculum: a even mix of the four aspects (ii) negotiated curriculum: negotiate according to what the educators require (iii) dialectical curriculum: engage in a deliberate, principled and committed struggle to challenge and contest the dominant codes of the curriculum. The Greaves 4x4 matrix model uses a matrix. On the X-axis is the four elements of the nursing process (assessment, planning, implementation, and evaluation) and on the Y-axis is the four components of the rational-curriculum model (objectives, content, methods, evaluation). These are some of the curriculum models that had a profound influence on educational technology in the educational process and educators need to be aware of the models in their subject field.

The programme philosophy may change with modularisation; moving from an objectivist theory of teaching and learning to a more constructivist view of learning (Nightingale, 1996: 5-7).

Peters (1998:45) regards the intellectual challenge imbedded in structured writing a pedagogical requirement that allow the learners space for developing important elements of autonomous learning in an open style.

3.2.8 Action for mental growth and schema development

The work of Jean Piaget (Inhelder and Piaget, 1958) with his Cognitive-development Theory refers to mental growth as the development of increasingly logical, complex and numerous schemata. Both Piaget and Rumelhart & Norman (1978), sometimes called interactionists (in Bell-Gredler 1986:156), did work on ways new knowledge can be incorporated into existing knowledge or cognitive processing.

The central bond in all the cognitive research is that:

- learning originates as a mental activity, an internal structuring or transformation of information, and a construction/reconstruction of knowledge in the form of schema (also refer to West et al. 1991: 7 and Gardner 1987);
- cognition emphasises cognition (which includes perception, comprehension, learning and recall) as wholes; whole-to-part, then part-to-whole (as opposed to behaviouristic part-to-part then part-to-whole view);
- cognition views knowledge as abstract (the wholes, patterns and schemata) and not necessarily beginning with concreteness;
- cognition is a constructive/reconstructive process (rather than a discovery/retrieval process as in behaviourism). In other words, cognition is the creation and recreation of knowledge where humans construct knowledge through mental interaction with the physical and social world;
- the mind is seen as a complex, fluid medium, not a print or assembly medium;
- cognition focuses on the process, not the final outcomes.

Other researchers such as the Gestalt psychologists Koffka (1935), Kohler (1929) and Wertheimer (1945) also investigated aspects of modern schema theory such as the ideas of “wholes”, “patterns” of organization, “structures” and “insight” which are the forerunners of the modern “mental operations” and internal mental constructs.

We can define schema as mental data structures of how to represent our knowledge about objects, situations, events, self, sequences of actions, and natural categories which are like the scripts of plays. We could also compare it to theories, packets or bundles in which the mind stores knowledge, patterns, structures, or scaffolds. (Refer to West, 1981: 7.) This is called data or state schemata. Process schemata are the procedures or ways of how to process and organize information (West 1981: 9).

Both types of schemata will direct our perception (West 1981: 8). Perception is an active,

constructive, selective and internal mentally schema driven process in which the individual selects cues from the environment and draws inferences from these in order to make sense of his experiences. Perception is the process of matching new stimuli received from an event with our existing understanding (or schema) in order to prevent misunderstanding or confusion. (Also refer to Doyle's schema definition and Quinn's perception definition in Wilson, 1989). This matching of the new to the old is determined by the existing dominations in the mind called perceptual sets. Some of these sets or laws are emotional and some are intellectual. We can identify sets such as similarity, relationship, and closure (Quinn, 1988 in Wilson, 1989).

The activation of the "right" perceptual set does not always happen because of the complexity of perception; and this has profound implications for learning, instruction and the instructional design of learning.

To construct meaning is essential in learning; it is basic to the recall process. There is little perception without schemata, and no learning without perception. Therefore, for a specific event it is imperative to trigger the "best" perceptual set (nature of the information) within a appropriately constructed schemata for learning and comprehension (processing of that input), for recall of what was learnt, and for the learning to be meaningful. West (1991) indicated that it is probable that the more complex the event or experience, the greater the influence of the schema. However, there is no one or best way to represent a schema or use a strategy, there are many ways. There should be agreement between experts concerning these aspects. Mental models may be constructed using mindmaps.

The task of instructional design is to focus on constructing a learning environment, for example to pre-test for appropriately constructed schema, thus directing the learners' perception and allowing them to actively mentally process the knowledge (Andre and Phye, 1986: 2). Schemata aid perception thus learners need to:

- construct perception schematically; and
- use it selectively to attend to the important and required aspects.

Schemata aid learning, comprehension and recall, so instructional design needs to:

- provide ideational scaffolding for the assimilation of events, text and information;
- allow for inferential elaboration;
- allow orderly and consistent search of memory;
- aid editing, abstracting and summarizing (recall);
- permit inferential reconstruction (West, 1981: 10).

Piaget (1952) coined two kinds of cognitive processing:

- Accommodation, which is the cognitive operation of the mind by which it conforms to the demands of the environment. This is similar to forming new schemata. This type of learning generally occurs less often and is considered more complex and difficult than assimilation. The point where the modification of the schemata becomes reorganized into new schemata, different from the old one, is termed restructuring (Rumelhart and Norman, 1978) or accommodation (Piaget, 1952). This difficult and significant kind of learning takes time and effort, sometimes even years.
- Assimilation, where the environment is fitted to the demands of the mind. This is similar to adding facts, concepts or detail to an existing schema. Two types of assimilation processing was identified, namely accretion when adding detail to a schema (the knowledge structure) and tuning. Accretion is routine factual learning. Tuning is more complex and involves minor modification of the schema (Rumelhart and Norman's (1978) elaboration on assimilation type learning).

West (1991) sees this kinds of learning as a continuum: from adding detail (accretion), through tuning, to restructuring; a gradual adding of facts, details and concepts, to the new schemata which are adequate and accommodating. This process goes on until the existing schema is inadequate to accept the additions, then the schema is restructured to fit the knowledge (accommodation), such as learning a new field and adapting to social changes. He says that this process is a gradual adaption of old schemata to the new field. A quick formulation of new schemata does not always occur, but a new field does require the formulation of new schemata. It is a gradual progression: accrete, tune, then restructure the schemata.

3.2.9 Action towards active learning

Learning and instruction has been debated repeatedly. For Gagné instruction was important because it "is a human interaction whose purpose is to help people learn" (Gagné & Briggs 1979: 3). Gagné decided on instruction because of the focus on the events during a formal learning period. The focus is on the use of media. Gagné's Task-cognition theory of learning conditions was a major contribution to instructional design.

The last four decades indicated a change in the philosophy of cognitive science - in its metaphysics, its metaphors and its assumptions. This change is also reflected in the shifts in instructional design strategies where the focus is on the internal representations and active intellectual processing. Therefore, in the instructional design of a course such as the one in this case study, the whole learning experience is important in each chapter of the course, rather than breaking it up into component parts and then building it up. In the design of this course, the instructional design did provide learners with "tools" to learn, an assortment of intellectual strategies. Techniques such as concept mapping, framing, metaphors, chunking, rehearsing,

imagery or mnemonics may be employed (as described in West et al., 1991: 2; Peters, 1998:45; and incorporated in MMAT 1996a (Addendum A)).

3.2.10 Action for critical consciousness and reflexivity

Critical consciousness is a level of consciousness characterized by depth in the interpretation of problems, through testing one's own findings with openness to revision, attempting to avoid distortion when perceiving problems and preconceived notions when analysing them, receptivity to the new without rejecting the old because it is old. In striving toward critical consciousness, the individual rejects passivity, practicing dialogue rather than polemics, and using permeable, interrogative, restless, and dialogical forms of life. Critical consciousness is brought about not through an individual or intellectual effort, but through collective struggle and praxis (Freire, 1973 as indicated by Heaney, 2002: online; section 1.7.1).

In order to adapt or change as an individual or as a group one has to be conscious. To learn Freire argues (1973) that an individual has to be critically conscious. Consciousness of and action upon reality are two components of a critical relationship with the world. Consciousness that does not challenge an individual's reality is therefore uncritical and intransitive, for it does not act upon the world as an object. Total intransitivity is not a form of consciousness at all. Freire suggests three stages in the progression by which critical consciousness is attained (Freire, 1973 as indicated by Heaney, 2002: online). The first of these stages is "semi-intransitive consciousness". Verbs, which do not act upon an object, are "intransitive". Therefore, the first phase in the emergence of consciousness is, for Freire, semi-intransitivity. Semi-intransitive consciousness is the state of those whose sphere of perception is limited, whose interests centre almost totally on matters of survival, and who are impermeable to challenges situated outside the demands of biological necessity.

The second stage of consciousness is "naive transitivity". Freire (Haene 2002:online) characterizes this stage of consciousness by an over-simplification of problems, nostalgia for the past, an underestimation of ordinary people, a strong tendency to gregariousness, a disinterest in investigation, a fascination with fanciful explanations of reality, and by the practice of polemics rather than dialogue. The third and final stage is "critical transitivity". This stage is characterized by depth in the interpretation of problems, by testing one's own findings and openness to revision and reconstruction, by the attempt to avoid distortion when perceiving problems and to avoid preconceived notions when analysing them, by rejecting passivity, by the practice of dialogue rather than polemics, by receptivity to the new without rejecting the old, and by permeable, interrogative, restless, and dialogical forms of life, attained through a collective struggle and praxis (Freire 1973 as discussed by Haene 2002: online). The challenge is

to foster such a struggle and praxis in self-study text.

Liberatory education holds no monopoly on fostering the three stages of consciousness as the values to which all learning can subscribe. Neither are the three stages mutually exclusive - they are degrees on the vertical plane extending from semi-intransitivity to critical transitivity, but on a horizontal plane as well, which would indicate the direction and focus of consciousness. It is perspective or "window" which is the horizontal plane on the matrix of consciousness. The vantage point of liberatory education as political point of view affirms the transforming role for humankind in history and culture and supports the political apparatus by which this role can be exercised. Liberatory education encourages learners to challenge and change the world, not merely uncritically adapt themselves to it. The content and purpose of liberatory education is the collective responsibility of learners, teachers, and the community alike who, through dialogue, seek political as well as economic and personal empowerment. Programs of liberatory education support and compliment larger social struggles for liberation.

3.2.11 Actions to liberate and empower

Empowerment through education is more than Rowntree's view (1981: 75) which refers to the product of successful learning. Successful learning includes how a person has been brought up, other social processes and is usually, but not necessarily, aided by teaching. Learning includes knowledge, skills and attitudes, improving human ability and behaviour, achieving social competence and individual growth. What is learned should be worthwhile to the learner (in the view of whoever is using the term) in such a way that the learner can express his own individuality through what he learns. He must also be able to subsequently apply it, and adapt it to situations and problems other than those he considered in learning it.

Empowerment is a consequence of liberatory learning (section 1.7.1). Power is not given, but created within the emerging praxis in which co-learners or practitioners are engaged. The theoretical basis for this discovery is provided by critical consciousness. Its expression is collective action on behalf of mutually agreed upon goals. Empowerment is distinct from building skills and competencies. Action for empowerment focusses on groups (rather than individuals) and in its focus attempts to transform culture (in contrast to social adaptation). This case study seeks to provide evidence of such empowerment.

Liberation through education links learning with action through which transformation can and does occur. It neither submerges human will under psychological determinism, nor does it subordinate it to divine or mechanical imperatives. It finds hope neither in the unconscious within, nor in providence beyond, but in historical participation in the creation of a just and a free society. It proclaims the future as ours to determine and seeks the liberation of the human

will to do so through learning and social action.

“Education for liberation provides a forum open to the imaginings and free exercise of control by learners, teachers, and the community, while also providing for the development of those skills and competencies without which the exercise of power would be impossible. Empowerment is both the means and the outcome of this pedagogy which some have come to call liberatory education” (Freire, 1973 as indicated by Heaney, 2002: online).

3.2.12 Action for contextually focussed change

Change takes place as part of the process of education and is a result of the process of education. In Freire’s view of education, learning to take control and achieving power are shared and collective actions (Freire, 1973 as indicated by Heaney, 2002: online). Freire’s argument is focussed on the pedagogy of social change as a critical consciousness. The learning environment is where power and control is shared in aspects of the curriculum, its contents and methods, and over the coordination of all learning activities. In this case aspects of this shared power and change become evident in the words of the learner.

Cognition means a coming to know and includes internal processes such as learning, perception, comprehension, thinking, memory and attention. In contrast to behaviourists who emphasize observable behaviour, cognitive theorists focus on internal processes and knowledge representations which are impossible to observe directly but are only inferred from the context.

The role of learning has become contentious. Learning is no longer viewed as the transmission of knowledge (Van Niekerk, 1996: 30 focussing on South Africa) but as a process influenced by culture, society, educational dialogue and the student’s ability to make the knowledge his/her own:

Culture includes human fabrications, provisions, projections, articulations, conceptions or directions. Culture includes materials (for example buildings, artifacts), immaterials (value systems, morals) and material gains (social class, political order). Certain pedagogical techniques include reflection on experience, the use of discussion groups (Freirian “cultural circles”) to engage in dialogue, and the use of “people’s knowledge” as the basis of the curriculum.

The process of selecting from culture what students shall learn is not as simple as it reads. It is caught up in the controversy about what constitutes knowledge, who makes the decisions, about what shall be taught and learnt, and what criteria are used in the selection (Gatawa, 1990: 10).

Socio-cultural views the teacher uses the culturally established external mental function of mathematical meanings in the society (known as enculturation) as a starting point to mediate students' personal internal mental functions for meaning (Magadla, 1996:86). This mediation focusses on determining developmental levels to discover the actual relations of the developmental process to learning capabilities. "The zone of proximal development is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers." (Vygotsky, 1978: 25).

3.2.13 Action towards an occupational relevance

In most cases, distance education students have formal employment and their activity-related assessment should be relevant to their normal occupational tasks. Such instructional activities may be identified by writers of self-instructional materials or tutors, in consultation with managers. This task is more difficult when students come from different organisations or have diverse occupational needs. However, this approach is important in order to add quality to instruction. If the course is generic like mathematics or communication, instructional activities set for students should be modified and maintained to suit the specific needs by tailoring assignments. (Peters, 1998: 81).

The MMAT course expected comment on the suitability and success of instructional activities in students' work situations. (See Chapters 6 and 7.) Activities could be in the form of tests, assignments or work related projects as students need to see the relevance of the course as the knowledge gathered and skills learnt enhance their performance and productivity in their professional assignments and duties at work. These types of activities should be followed with appropriate responses in the text or by tutors. Recent structured DE text innovations should *"include the help that is provided to students so that they can evolve their own learning activities and change their own cognitive structures"* (Peters, 1998: 68).

3.2.14 Action to measure progress

Students enrol in distance education programmes for self-actualisation or to gain skills that are of immediate need. Therefore, there is the need for students to measure their progress. This process is facilitated by the tutor who provides feedback responses in the form of assistance in tackling assignments or general counselling. As a result, instructional activities set in the module in the form of assignments could also be viewed as part of students' guided support. As students work through assignments, they gain the knowledge and ability to work on their own. Successful use of instructional activities assists learners to take charge of their learning and to attain some self-directedness. The major part of success in distance education depends on the student's

ability to follow a guided and stimulating study process independently in a learning environment that provide them didactic space and a reference to achieve (Oosthuizen, 1997: 81).

3.2.15 Action to direct open learning outcomes

Instructional activities should be informed by the course objectives and prerequisites in order to *"identify the problems, to think them over, to be creative in finding solutions and to pass reflective judgements on other options."* (Peters, 1998: 44). Objectives assist students to understand the scope and relevance of activities assigned to them. They also help writers to develop activities aimed at achieving a specific level of competency and to accurately determine the prior knowledge base of students. The focus on the learners' work and professional life makes the activities and objectives "unstructured" in terms of the outcomes of the experiences determined by the learners during the process of contextualising and reflecting the focus of a particular unit.

3.2.16 Action to assess learning

Assessment instruments reward deep learning in order to encourage learners to use participation opportunities to learn to analyse, synthesise, validate and judge. When activities, assignments and examinations require only factual or descriptive responses, students tend to adopt a superficial approach to learning (White 1992). Authentic assessment focusses on real-life problems that are interesting, relevant and progressively ill-structured. An example in course design includes the use of vignettes or case studies that learners engage within real life from which self-assessment and critical reflection often follow naturally (see Chapters 6 and 7 for examples from this case study). Assessing the effectiveness of instructional activities at the work environment such as the school, should assist the course developer to know how well skills and competencies gained are utilised and evaluating their worth. Therefore, student assessment could be a joint effort by the course developer and the employer. The various models of autonomous learning (Peters, 1998: 90) may formalise the students' learning process (see 3.2.2).

In-text activities are not assessment instruments if they are assignments, examinations, clinical texts, or practical work IF they fail to foster dialogue, require no feedback and is not contextually relevant. Activities must be designed with, and follow onto other forms of assessment as they constitute steps leading to the final aim (Wilson 1995: 6) into a coherent synergy (see 3.2.4). Activities should be seen as continuous assessment and tutors should provide assistance by supplementing the role of activities and working towards course outcomes. Tutor feedback is an integral part of the dialogue with the learner. Lengthy periods for feedback between the interactions in a dialogue (such as the delayed turnaround time in assignments) may de-motivate students. Feedback enables remedial opportunities to be more meaningful e.g.

tutorials, which should ideally be conducted on a one-to-one basis to ensure that each student receives individual attention.

Assessment instruments should be designed to measure and establish reflection, knowledge, skills and attitudes following an activity in a particular context. Such assessment may include case studies, modelled situations and descriptive or illustrated experiences. A portfolio is an excellent assessment type as it allows for the inclusion of many such authentic exercises. Carefully constructed paragraph essays, multiple-choice questions that focus attention on higher-order thinking and relationship building may also provide insight. In DE, authentic assessment is more difficult to manage and provide feedback on because of the unique nature of the organization.

Dick and Reiser (1989) recommend the adoption of an instructional plan to inform the genesis and assessed outcomes of instructional activities. The process involves generating instructional activities that ensure and maintain students' motivation, clarification of learning objectives and prerequisites, information and examples, practice and feedback, students' evaluation and remedial input. The use of media is also planned.

In-text activities are often in different formats, indicating their function in the text, such as learning or progression activities, self-assessment questions, content summaries, test-yourself questions, focus activities, enrichment activities, examples with some activity, to-do items, or simple questions. The MMAT course evaluation focussed on a number of assessment relations such as learner-learner, lecturer-learner, learner-course and lecturer-course assessments.

3.2.17 Action to solve problems

American research into patterned or structural problem-solving was stimulated by Miller, Galanter and Pribram (1960). Their successes with domain-independent strategies seem to point to the critical nature of human problem-solving and learning. The failures indicated that learning and problem-solving strategies are sometimes domain specific or tailored to the type of knowledge being acquired or manipulated. Using computers, researchers probed the knowledge structures of experts and novices in a subject field, and made specific distinctions with regard to the nature of knowledge.

The first person to observe that subjects often reported previous knowledge rather than what was observed, was the German Structuralist E. B. Titchener in 1910. He called it stimulus error, but today it is the basic nature of perception and comprehension. Today this is known as schema theory or the structure of the consciousness or mind. The person that coined the phrase "schemata" was the Englishman Bartlett (1932). He found that people seemed to be guided by

pre-existing knowledge or themes when interpreting text passages. Structuralists are seen as part of the cognitive movement according to Bell-Gredler (1986:70). (See 3.2.8 for a discussion on schema development.)

Ausubel (1968) researched the subsumption theory and the advance organizer. Bandura (1971) included imagery into a social learning theory. Chomsky (1951, 1965) moved linguistics towards Structuralism.

Almost all educational theories from the past have had an impact on contemporary educational practice. The problem with constructivism as a framework for designing instruction is that no clear, practical examples or guidelines exist on how to construct such constructivist learning environments (CLEs). Although Jonassen & Rohrer-Murphy (1999:61) mention Reigeluth's work (1999), they consider its non-explicit methods for needs or task analysis "inappropriate for designing activities".

Today the emphasis of educational technology is not on any one approach, on feedback, or media (hardware or computers) or just on individualised learning. It is on an integration of a variety of these and other methods and media into an appropriate and effective learning environment catering for the specific needs of learners.

3.2.18 Action for change

Adaptive learning creates change because of external factors. It is possible to change without a vision or belief. Generative learning is when you are "expanding your ability to create" (Senge 1990: 206) and therefore, generative learning occurs only when people strive to accomplish something that really matters deeply to them and something they can get excited about. When this feeling is shared among people, this shared vision focuses their energies and creates a common identity among diverse people.

A group of learners can be motivated by forces which are either intrinsic or extrinsic. Extrinsic reasons may include competing with another learner, completing a course to get recognition, or being number one in the group. External motivation rarely calls for inner standards of excellence and perfection, or a goal to creatively building something new (Senge, 1990: 207).

3.2.19 Structured action to address different kinds of knowledge

What influence do the different kinds of knowledge have on learning? Several kinds of knowledge have been identified (Gagné, 1970) such as the following:

- Declarative (factual or propositional) knowledge that is stored, or represented, in memory in the form of propositions and networks of propositions. Concepts and facts often make sense within more complex principles or connected concepts; an interactive web of

networks. These networks may be semantic (a list of disjointed information, elements and lists, connected in space) or episodic (connected chains of facts as in historical or story narratives, connected by time). Declarative knowledge which is patterned may be equivalent to state/data schemata. A mindmap or a vignette are examples.

- Procedural knowledge is knowing how to do things, how to perform the sub-tasks in the stated and required order. It is order-specific and time-dependent. For example: perform A, then B, then C. Examples are study skills, problem-solving skills, role management skills and others. We argue that such a structure may be within a study package or unit (the visible structure), but even more importantly, overarching study units or a group of resources and experiences.
- Conditional knowledge is knowing when and why to use a procedure. This knowledge is appropriate within certain contexts and circumstances and is also called meta-comprehension. Examples of conditional knowledge is the ability to compile a portfolio, to describe a learning experience or deciding which strategy to apply to manage a classroom or mathematical problem.

West (West et al. 1991:3) considers the change in psychology from behaviour to cognition to be an evolution. This is in contrast to Gardner (1987) who argues that it is a revolution. Cognitive science includes many fields that aim at a better understanding of the nature of the mind at the physical and abstract levels. It explores the ways in which people come to know things, such as linguistics, computer science, neurology and cognitive psychology.

Jerome Bruner (1973) an American, worked from 1940 to 1986 to validate internal constructs. His work deals with categorising strategies, the role of theme in learning and thinking, and the representation of knowledge.

Some suggest course designers should use Gagné's observations and hierarchy about different types of learning to sequence and organise subject content and related learning activities (Gagné & Briggs, 1979: 57). Gagné focuses on the individual in the instructional setting. When using this suggested hierarchy to present topics, it has to include all four levels and establish conditions for successful learning. The four levels are:

- factual foundations: basic terms and facts relating to a topic;
- conceptual understandings: grouping facts with common features under a generalized name;
- principles and rules: high-level generalisations with statements showing relationships among two or more concepts;
- problem solving and content applications: using the above in various situations.

Do different types of knowledge have specific structures? Researchers have identified different

structures:

- logical knowledge domains, such as mathematics and natural science, called well-structured knowledge domains;
- less logical domains, such as psychology, called ill-structured knowledge domains (Bell-Gredler, 1986: 107).

3.2.20 Action integrated into media experience

Activities can be identified on various levels. Identifying activities according to the medium of presentation is one level that may be used. Subject developers may use audio tapes, videos, self-study guides, instruction guides with visuals, or any other medium suitable to convey the message.

The distance education teaching repertoire involves extensive use of self-instructional materials, be they in print or other media. These materials are designed to achieve certain pre-determined learning outcomes, namely, goals and objectives that are contained in an instructional plan. Since the teaching process is effected over a distance, there is the need to ensure that students actively participate in their learning by performing specific tasks that help them to understand the relevant concepts. Therefore, a set of exercises is built into the teaching repertoire in order to link what students and tutors do in the framework of the course outline. These could be in the form of students' assignments, a research project or a science practical exercise. Examples of instructional activities in distance education are too numerous to list. Instructional activities, when used in this context, help to motivate students and will guide and measure students' performance (continuous assessment).

Galbraith (1991:1) is of the view that adults do not only interact with instruction but also with other resources in the learning environment, such as other learners, new ideas, values and knowledge sources. He considers adult learning to be an "active, challenging, collaborative, critically reflective, ... transforming educational encounter and a transactional process". These ideas could be extended to distance education practise, particularly when an interactive instructional approach is used to write self-instructional materials.

In conclusion, we argue in this case study that ID learning design tools can provide structure and guidance into exploration. Through imbedded textual activities learners are given opportunities to engage and act, improve their internal dialogue and dialogue with others, and take steps to reduce the distances, both psychological and physical, in self-study. There are areas of agreement and similar emphasis among the learning theories from which generalisations can be made concerning the conditions for, principles of and kinds of learning.

3.3 Learning development and design in DE institutions

Slattery (1995: xii) defines postmodern curriculum development as “an effort to prepare a space that is conducive to students constructing a series of synthetical [simulated/imitation] moments”. In curriculum design in distance education environments for higher education there is a deliberate effort to prepare a space in textually guided activities and other learning opportunities to enable adult learners to construct a range of real or simulated moments relevant to their world.

3.3.1 Learning design processes in DE

The principles of curriculum design (according to Carl, 1995: 65-69) are a scientific approach, the starting point, a process, cooperative development between the learners, management, communication between educators, practitioners and experts, relevance to the problems/issues of the context, trends, developments, contexts, integration of theory in practice, networking channels, student-centred, problem-based, innovation, research, and evaluation.

Resource based learning was identified as a priority (NCHE 1996:119-123) as was course teams. (The intensiveness of the MMAT development process has been demonstrated in Chapter 7 where a team developed a course.) Instructional design (ID) requires the design of learning experiences. The understanding of our practices and the concepts that underlie them includes that: “the meanings and norms implicit in these practices are not just in the minds of the actors but are out there in the practices themselves, practices which cannot be conceived as a set of individual actions, but which are essentially modes of social relations, of mutual action” (Taylor, 1985:36).

We included in the case study the curriculum development process which focuses on “moments” where particular aspects are investigated. The mutual actions of the team and their praxis was a defining feature of this research study. The process takes time and expertise (as described in Chapter 6).

The “moments” in the process of ID include a analysis/exploration of the situation with stakeholders, planning, design, development, maintenance, and evaluation or assessment. All the projects with this developer included these steps in one way or another, depending on the team. Within these stages a number of important issues are dealt with every time. Where any of these themes are neglected, the course design and development becomes ineffective or dysfunctional (Tennyson 1995:121-124). The Tennyson model has two major components namely situation analysis/evaluation and the knowledge base component which considers the “authoring skills” in the process and “activity tools” for the course team (the process elements

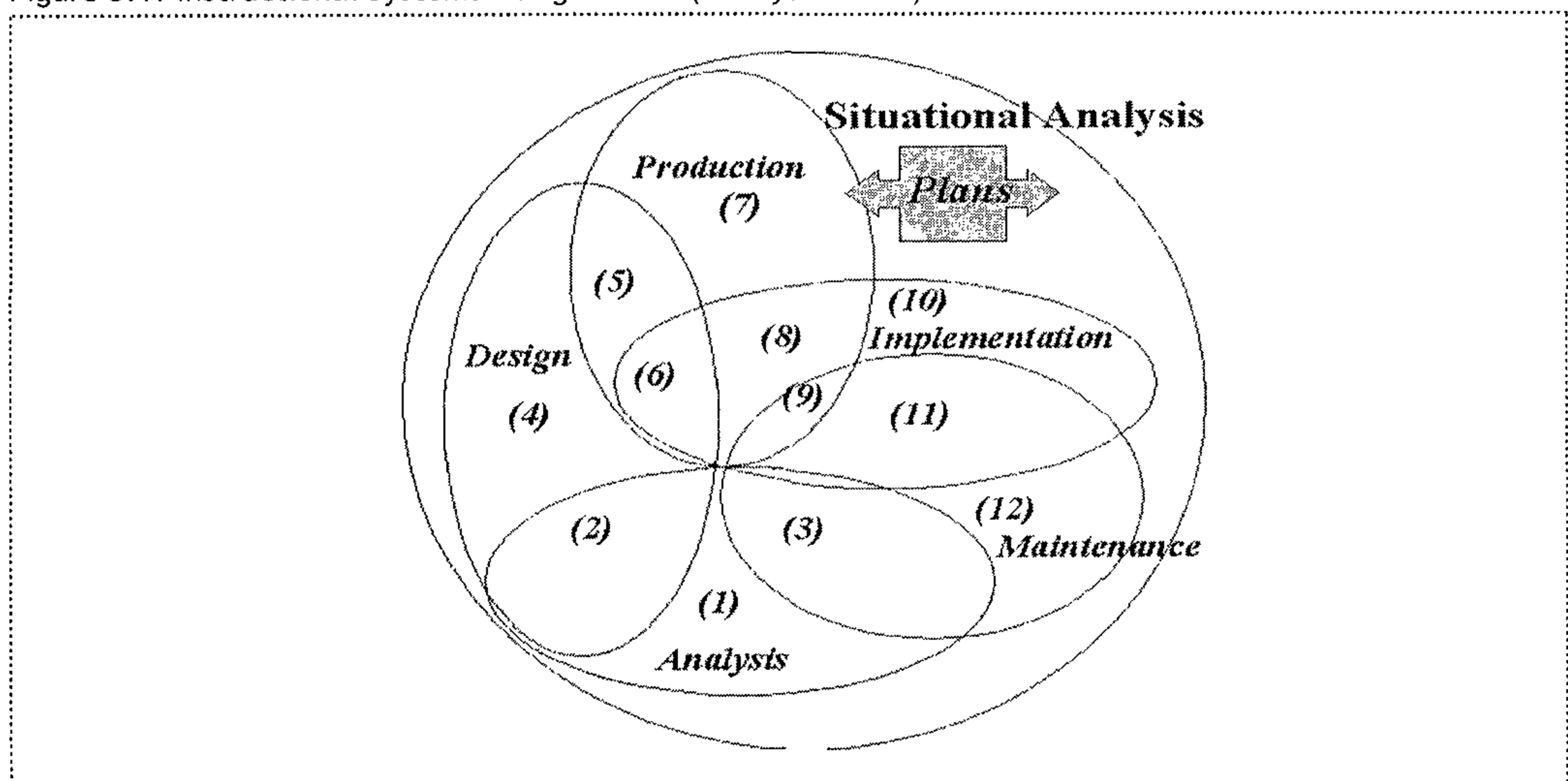
or components that have been described by earlier ID theorists). The team is required to immerse themselves in the process of solving the problem of designing a learning environment that promotes engagement in active learning, dialogue and role development.

This, in line with the postmodern curriculum, focusses on problem-solving approaches as defined by Slatterly (1995: 76) and Peters (1998: 70-78). Evolving from distinct steps (1st generation) to a flowchart (2nd generation) to planned piloted and implemented process (3rd generation), it is proposed to use system-based rules within a dynamic context (4th generation). It moves away from rigid abstract or expert controlled procedures during instructional design (ID) and development to a "system of explicit rules dynamically controlled by contextual or situational problem solving evaluations" (Tennyson 1995:121). The problem is not defined and understood as a given as reality of learning does not relate to a rigid scenario. ID, as it is understood in the 4th generation development, allows for adjustments to the process as variables and conditions that change over time influence it. In distance education both learning and open distance learning theories are relevant. This is congruent with the philosophical underpinning of action research and action learning.

3.3.2 "Moments" in the design of the DE learning materials

An overview of the questions that direct an ID process will now be discussed. The reader is referred to Figure 3.1 for an overview of the ID process following a post-modern model of Tennyson (1995). We were influenced in our choice of this model as Tennyson suggests ID practitioners to ask questions during the "moments" of learning design. The "moments" in Tennyson's model was adjusted by the researcher for the UNISA context.

Figure 3.1: Instructional Systems Design Model (Tennyson 1995)



(1) Exploration-needs analysis-planning:

Who are the Unisa learners taking this course and what problems do they experience? What philosophical approach is used? Who are the stakeholders? What are the relevance, competencies and learning of the course? What is the nature of the course, professions, student, lecturer, institution, society, i.e. SAQA qualification registration, Senate and course curriculum documents? What are the constraints and risks? What are the course plan and course considerations (meso-level), ID considerations (meso-level), student considerations (micro-level), teaching considerations (micro level), institutional considerations (macro- level), profession considerations (meso- level) and societal considerations (macro-level).

(2) Planning-design:

How did the team develop? (Team processes and actions/functions of typical team members, typical structure/roles in a team with requirements in the Unisa setup, process/dialogue with conflict management supported by SD) What was the nature of curriculum (core, hidden)? What documents were available and are they validated? What were the required knowledge and skills? What structure was used (built, pruned, overlaps)? What were the focus, goals and outcomes (what would be assessed)? What external structures/requirements were required (OBE, SAQA, modularisation)? What information is available in the subject field? How would the learning strategies provide the necessary learning experiences? Will a pilot resource package fulfill the needs and requirements?

(3) Analysis-maintenance:

How should the team provide formative and summative evaluations? How could the team update the learning product based on the evaluations? The following five steps represent essential steps in any evaluative process, and are therefore applicable to the evaluation of learner performance or achievement, as well as for distance education courses. When evaluating, different questions need to be answered:

- For what purpose are we evaluating?
- What criteria shall we use to evaluate the object or performance?
- How will we gather information about the object or performance ?
- How will we make a decision (value judgement)?
- What actions will result from the value judgement?

(4) Resource design and development:

What existing materials were used? What knowledge, skills attitudes required (conceptual, procedural, theoretical, metacognitive and motivational social), and resources? Other issues are important (differences, giftedness, at-riskness, special needs, disabilities, culture, learning style, experience, motivation, literacy, aptitude)? What instructional interferences should be considered? (pre-assessment, formative assessment for learning, remediation to restore

equality, enrichment to restore equality, tutoring by peer and volunteers for equality, prerequisites and admission to establish limits, goals/outcomes and criteria should set the optimum). What progression interferences should be considered (grade retention, tracking, group work, drop-out, acceleration)? Who and which processes coordinates all resources, tutoring, contact, and evaluations? What should be altered or added to human resources, equipment, facilities, hardware and software, and teaching approach? Which study units can be built and fleshed out concerning motivation, analogies, organisational content, prerequisites, support, content, and summaries? What assessment instruments have to be developed? What links, overlaps, follow-on, "knitting" or "chunking" are there?

(5) Design-production:

How should the self-study environment be constructed? This includes guides, tutorial letters, textbooks, contact sessions, workshops, practicals, media, workbooks, article "stacks", readers, dialogue in study units, readability), learning increased (through instructional devices, activities and feedback, reading skills, writing skills, critical thinking skills), assessment system (activities, assignments, examinations), assessment types (objective assessment, subjective assessment), media selection and integration. What should be considered for graphic design, editing, scheduling, print preparation, printing, and distribution? How should one flag/identify/improve the reception of instructional devices, activities, feedback or assessment? What should be considered in the delivery of materials in appropriate format (print, web, writing for the layout, preparing a document for printing)? Which processes and structures would be involved?

(6) Design-production-implementation:

What should be done for learning support, moderating/tutoring, assessing, evaluation, analysis for feedback, monitoring/shifting of goals/outcomes and management of the whole process? How should the instructional interferences (pre-assessment, formative assessment for learning, remediation to restore equality, enrichment to restore equality, tutoring by peer and volunteers for equality, prerequisites with the establishment of pre-knowledge for admission to establish limits for admission criteria, goals/outcomes and criteria) and progression interferences (grade retention, tracking, group work, drop-out, acceleration) be applied?

(7) Production:

Which printing equipment and processes should be used? What number of copies are required for the shelf according to enrolment, shelf-life and production determinants? What print layout process will be appropriate? What time schedule is required?

(8) Production-Implementation:

Do the pilot. What was the outcome of the pilot? What revisions would be necessary or feasible?

(9) Production-Implementation-Maintenance:

What was required concerning formative, summative, developmental and pilot evaluation including the curriculum, study resources, change processes, student learning, and project costing? What was the outcome of the team approach? What data set types were used (questionnaires, focus group interviews, other)? What was the student learning evaluation and assessment? What was the study materials evaluation? What was the course and curriculum evaluation?

(10) Implementation:

Was the product produced on time with sufficient quality? How will and should the support services support the product and process? Who will teach, mark/assess (prior-learning, examine, MCQs, essays) and provide feedback? Who will approve, validate, confer, credit?

(11) Implementation-Maintenance:

What was the outcome of the project process evaluation? What was the project costing evaluation? What was the value of the evaluation phase? What was the stakeholder group input? What was the total quality assessment and criteria for quality assessment and management?

(12) Maintenance

How would one design a system to maintain the quality of the learning environment? Who report on the course to whom? Who is responsible for new cycle?

Following these systematic processes within a large DE institution such as Unisa, the self-study packages have a specific structure and systematic development. The MMAT course team was confronted with all these questions. The success of a course is partially dependent on addressing these questions.

3.4 Self-study packages

DE study guides are often the core component of the study package as it is the text containing the "teacher talk". The study guide consists of a number of elements compiled to allow learners to take control of the pace of their studies. These self-pacing elements may be contained in modular study units.

3.4.1 Modules and units

Unisa's course design and developers concur with a number of international authors (Shore, 1973:681; Helm 1988:192) and the South African Qualifications Authority (SAQA: 1998:online) document which states that *"a module is a coherent, self-contained unit of learning, designed to achieve a set of specific learning outcomes [which covers a discrete area of knowledge/competence] which are assessed within that unit of learning. A module is the*

building block from which a programme (and its qualifications) is constructed". Modules may follow themes, a chronological development or a factual description.

At Unisa there are many components to the study package. Some of the most used components are: a title page, a content list, an introduction, a statement of the course aim, statements of learning objectives, a rationale for learning (addressing some misconceptions or reasons why the topic is important in the wider scheme of things), preconditions (what should be done or known in advance), specific instructions (for doing the section or unit), pretests (to establish clearly what is understood about the topic and to establish entry), activities (to explore and test understanding), evaluation questionnaires and assignments (to finally provide feedback about the course and the level of understanding reached).

A study unit or learning unit (as part of a bigger course or standing alone) should be (according to Parsons et al. 1976:31; Pascal, Geiss & Notal, 1977:15):

- self-contained and to be learned in one study session (with some exceptions to the rule acceptable);
- specific to the subject matter;
- convenient to use for students at their own pace (usually in a few hours or days);
- used by student groups or as individuals;
- based on objectives which the student may easily identify in the material;
- directive to guide students to all learning materials;
- sequenced in some order (depending on the presentation style, content, and aims);
- provide feedback to students on how well they are doing in that course or in their studies as a whole.

Variations on this are often found as indicated by Le Roux & Wilson (1994:1).

The distance education study package usually contains a number of study units, with each unit planned to support a single study session. Good writing practice is to structure a presentation around an introduction, body and conclusion. In the *introduction* the instructional events should (1) gain attention (2) inform the learner of the objective (3) and stimulate recall of preknowledge. This phase also gains by the inclusion of the rationale for learning, preconditions, specific instructions, and/or pretests. In the *body of the study unit* the instruction should include (4) the material to be presented (5) guidance to learning (6) performance to show depth and breadth of acquired knowledge and (7) feedback on learning and performance. In the *conclusion* of the instructional event (8) performance should be assessed and (9) retention and transfer of information to new situations should be enhanced.

A module inherently motivate as small chunks of clearly set out text are completed. When

- **Tutorial-in-print:** "Tutorials-in-print" study guides allow the learner to be in dialogue with the lecturer, while the lecturer provides frequent guidance in the form of activities, question, tasks, exercises, or assessment questions (to keep students purposefully engaged with the materials and to compel them to make personal responses). Feedback on these (which then create a discussion of possible answers and compelling questions as to where these discussions might lead) should also be provided.
- **Reflexive-action:** A "reflexive action" type of guide can perhaps be viewed as a type of guidance offering advice on students' learning actions and prompting the setting of students' own parameters. The guide stimulates critical thinking and offers guidelines and suggestions, often provides criteria, but almost never provides answers or direct feedback. Resource material has to be gathered by the learner. Learners have to assess and provide their own answers and therefore this type of guide can be very demanding and time consuming.
- **Dialogue:** "Dialogue" type guides, involve "human dialogue" to make and exchange meaning through discussions. This could provide students with excellent guidance but they are themselves responsible for their learning actions. In contrast to the textbook, the dialogue causes the creative process to become transparent to the student. Analyses are provided but specific content is omitted. As it is not complete, students have to add to them. Various points to ponder are provided and students have to provide their own views. Processes are described and, for example, the process of inferring is not completed and the student is compelled to infer her own material.
- **Other:** a mixture of the above. In practice, guides in distance education are often a study-guide-as-text book type, or a wrap-around-to-the-text book-mixed type.

Tutorials-in-print guides are probably the easiest to change to for most subjects and lecturers. A dialogue type guide could be very interesting and challenging. The reflexive-action type guide would be ideal for advanced learners. The study-guide-as-textbook type guide is similar in function to a text book and serves as a reference text. There is little learner support and this type of guide does not provide sufficient guidance to insecure learners. The wrap-around-the-text book type guide refers to this learning source in particular and provides guidance as to the interpretation of this source. The choice the course team make depends on the target group, the level of the course, and the subject matter. These choices might compel the learning designer to change from one style to another. The MMAT course is a mixture of the above types.

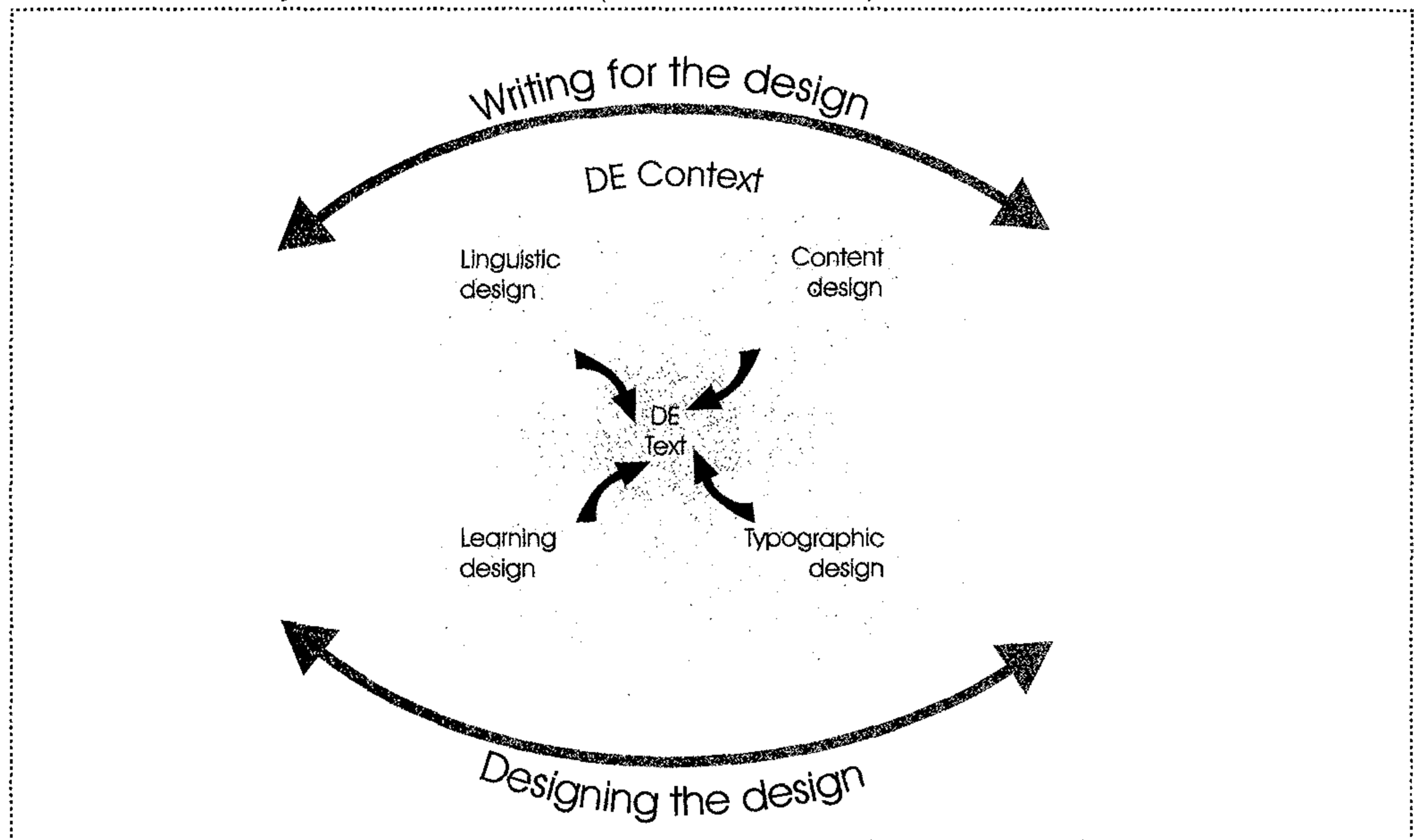
The question is how do we promote active learning based on learning and curriculum development theory in the unique distance education environment? All the aspects have to be considered in detail for the development to be successful (see 3.3.2).

3.4.3 Components of DE textual design

The constraints and characteristics of ODL play a formative role on traditional disciplines involved in textual design. As a learning developer, the researcher suggested various focus areas to better the textual interface. The aspects under discussion were (1) philosophical arguments underpinning learning theories and DE theories, (2) topographical design (integrating text and graphics), (3) content focus (aims) and specifics in the field of investigation which include the assessment of learning in the field and (4) writing for the learners. Lastly, the process that had to cohesively knit these individual aspect together, namely course design and development. Macintosh (1998b: 10-11, 29-31) describes how the textual design components of distance education texts include the four main disciplines of visual design, instructional design, subject field content design and language design. Each of these disciplines interacts with and affects the other on an infinite number of levels. The processes involved in developing DE materials are the design of the course and the writing work for the course. Figure 3.2 illustrates the interaction matrix of the different areas of expertise as they function in a recursive, layout design approach. The final product in the process is the DE text (internal circle).

We agree with Macintosh (1998b:30-31) in his descriptions of the elements of textual design. There is a cradle of support, guidance and counselling that is embedded in these disciplines. This is a complex area where a balance between the dimensions and a recursive interaction between the elements are important. Therefore specialists in these areas are needed in a carefully managed team (Chapter 2). In the following section, we will provide a cursory overview of the different design elements that played a role in this researcher's case study experiences.

Figure 3.2: A theoretical framework for the understanding of the relationships and processes of the four main disciplines in the practical design of text in DE, attempting to explain and analyse its recursive nature (Macintosh 1998b:29).



- **Content design**

Content design relates to the nature and structure of the specific subject being taught. The subject often requires specific content structures and learning tasks. This study included content design of the mathematics as a teaching subject but our focus was on the ability of the course material to engage the learners, irrespective of the mathematics curriculum topic they chose.

- **Linguistic design**

The linguistic design refers to the effective use and structuring of language for the distance learner. The language structure is used to enhance retention, recall, and understanding. The readability and reader-friendliness of the text is directly related to the linguistic design. Goodwin-Davey (1997:286), as a writing specialist, considers writing as a mode of learning and as a process of dialogue. Macintosh (1997:194) only discusses the role of linguistic signalling to indicate the role of structure in text by means of a numbering system with headings and subheadings (with no typographic feature such as bold type). The fields and theories of applied linguistics and communication are closely related. Heese (1996: 274) discusses reading as a strategy for reflection, therefore, to be involved in a "discussion" through the text. The learners are good barometers of how effective the linguistic design is. Although this study did

not focus on the linguistic design, we found that much was said by the learners on this topic (Chapter 6).

As a distance education lecturer Aristotle's wisdom [with my own additions] may be of particular value when he said "Think like a wise man [woman], speak [write] like a commoner". Thinking wisely involves the inclusion of all knowledge and skills in a conversation between the subject specialist and the learner. To speak like a commoner in distance education texts means to write in a language style that is similar to the common discussion.

- **Typographical design**

The visual design and typography of the DE text has an important role to play in the perception of the message and learners' understanding. Typographical elements enhance readability, legibility, access to the text, and reader-friendliness. Macintosh (1997:192) further describes macro-typographical elements (such as cover design, page layout, binding formats, etc.) and micro-typographical elements (such as typeface and size, line and letter spacing, colour and shading). There is much experimentation with layout design at Unisa, based on either icon-based design or visual backdrop design (or a combination) (refer to Macintosh, 1997:192-221 for a discussion of elements). This study focussed on typographical elements only in order to make the content, the dialogue, and structure more accessible and visible for learners.

Access devices make the content and structure of a text more accessible to students who are studying independently. Access devices include:

- (a) Introductions including overviews of the course, module or package and it's role, the structure and order of the course package, workload, icons, materials needed, assessment policy; tutorial support; assumptions, misconceptions goals and end results.
- (b) Preliminary material including table of contents, overview; aims and objectives (cognition and skills), time allocations, notes on working strategy and diagrammatic representations.
- (c) The teaching material body including title pages, chapter and section numbers, page numbers, paragraph numbers, space, coded pages to indicate sections, marginal notes, key words or items, running headers, headings and subheadings, introductions, summaries, cross references, the index, glossary, font changes, highlights and symbols.

- **Learning Design**

Our focus in this study is on the learning design of a specific course text. The learning design considers the design of effective learning experiences, in the case of Unisa mainly through text. The theories that underpin this design field include learning theory, instructional theory, psychology and cognitive psychology, all nested within philosophical notions of reality and knowledge.

It has been repeatedly stated that, in the past, students tended to spend more time focussing on surface level thinking and the transmission of factual knowledge (also known by lecturers as “rote” learning) than on fostering deep and critical thinking. So what is the problem if we have these high ideals in mind? It seems that often, even with these high ideals and a focus on learning outcomes, the learners’ experiences of their studies and the assessment requirements seem to encourage a much more limited learning experience - often just the regurgitation of facts and processes. Biggs (1987), and Gow and Kember (1990) (in Johnston, 1995) said that there was little evidence that specified goals are achieved in reality.

How do distance educators design DE textually based materials to support development or extended growing through a learning experience?

3.5 Active learning strategies, tools, resistance and benefits

Active learning as a learning design strategy has certain advantages while at the same time resistance against it. Active learning strategies are defined as instructional devices which “involve participants in doing things and thinking about the things that they are doing” (Eison and Bonwell, 1988).

3.5.1 Active learning strategies

Once a faculty is ready to address the new learning needs required by active learning, there are several active learning strategies that can be employed to involve learners in the distance learning process. What are the types of active learning strategies used in distance learning? The following strategies should be considered (Entwistle, 1996: 107):

- There should be a purposeful structure to the design of study material;
- Students should be guided through the learning process;
- Students have to be actively involved in the learning materials;
- Only the learner can effectively make meaning, understand and apply concepts, skills and competencies in their everyday lives.

These strategies should be combined in the distance education environment to address the different student needs, aspects of the course content, as well as environmental factors such as the environment. Some of these strategies will be combined in the course’s study guide, others will be addressed as an extra, optional component to the learning. An example is group discussions where the time and place bounded characteristics of the activities may clash with the open distance nature of Unisa.

An important step would be engaging learners in activities rather than requiring them to read long passages of text.

- The course writer should design activities which explicitly acknowledge and use the collective experiences and pre-knowledge of the targeted learners, or require the learners to write down such experiences or expertise. This could then be incorporated into later activities.
- The course writer should place greater emphasis on influencing participants' attitudes or values and developing participants' skills than on transmitting information.
- The learners should receive immediate feedback on the course material from the course writer. Such a writer could share his/her previous experiences with other learners.

3.5.2 Benefits

Appropriate use of instructional activities in learning situations encourages learning by doing as opposed to the memorisation of facts. The interactivity between the learner and instruction often takes the form of the learner being asked questions or given assignments or a set of procedures to perform and then being provided with appropriate responses and helped to work through alternative responses (Schieman, 1990). In addition, Schieman (1990) is of the opinion that interactive instruction is a superior philosophy of teaching at a distance, compared to teacher centred pedagogues, in that it *"can release them [students] from a situation of dependence to one of individual initiative"* (p.74).

Advantages of interactive instruction are the ability to encourage learners to be more self-directed, being problem-centred and its ability to address the social needs of students.

Instructional activities also provide immediate feedback on the students' learning progress. They keep the students interested in the learning process and elicit active participation from students. In addition, they allow students to share their experience with their tutors in the learning process. In this way the learning process becomes a co-operative endeavour that is also student-centred.

Activities focus the learners' attention on aspects and tasks by asking them to stop and think. According to the instructions, the learner will then have to react and engage with the material. Activities are compelling or prompting because of a number of aspects. In the distance education guide, activities are essential components because interaction forces the learner to react with the study material in one form or another. These activities focus the learners' attention on aspects and tasks by asking them to stop, think, and react. The learner will then have to engage with the material following the instructions. Activities should, for maximum effect, be interwoven with all the instructional events.

In-text activities are not assignments (or other forms of assessment such as examinations, clinical texts, or practical work).

Activities must be designed with all forms of assessment as they constitute steps leading to the final aim. There are different names for activities such as learning or progression activities, self-assessment questions, content summaries, test-yourself questions, focus activities, enrichment activities, examples with some activity, to-do items, or sometimes questions merely posed in the text.

Activities tend to:

- integrate the learning actions with content (combining knowledge, application, and synthesis);
- present the content to be learnt in a compelling format (providing clues as to how important and time consuming tasks are);
- give the material an accessible structure or “friendly face”.

According to Eison, Janzow, and Bonwell (1990: 82) some of the major characteristics associated with active learning strategies in a contact learning situation are that:

- the participants engage in activities rather than listening passively;
- the facilitator designs activities which explicitly acknowledge and use the collective experience and expertise of the participants;
- the facilitator may place greater emphasis on influencing participants’ attitudes or values and developing participants’ skills than on transmitting information;
- the participants can receive immediate feedback from both the facilitator and other group members.

This approach provides unique benefits for students who have a specific preferred learning style. Learners favouring innovative and feeling learning styles enjoy the discussion sessions, which focus on meaningful applications of the material, and private discussions with the lecturer. Learners who favour analytical and thinking learning styles tend to enjoy the lectures most. Those learners who use common sense and sensing learning styles will enjoy the demonstration and “how to” material found in the study guide, as well as the problem-solving activities. Their fellow learners who prefer dynamic and intuitive learning styles will favour the pre- and post-test section in the guide and the self-discovery material.

The proliferation and internationalisation of distance education courses has led to intense competition among institutions. In the management by objectives (MBO) approach, there is need for institutions to insist on the assessment of the attainment of knowledge and skills due to the training intervention, as part of their quality control exercise. Quality here is defined as “fitness for purpose”.

This scenario presents distance education institutions with the challenge to consciously build quality control initiatives into the writing of self-instructional materials, administration and teaching repertoire. Therefore, there is a need for quality assurance as an integral component in the design of courses and their delivery in distance education. Instructional activities may be a tool that is used to improve the quality of self-instructional materials. They can act as quality control measures in that they help the institution to improve the quality of instruction while they also assist the students in measuring their progress. Therefore, instructional activities are programme evaluation and student assessment tools, to measure how these accomplish tasks outlined in the course objectives.

The distance education teaching repertoire involves extensive use of self-instructional materials, be they in print or other media. These materials are designed to achieve certain pre-determined learning outcomes, namely, goals and objectives that are contained in an instructional plan. Since the teaching process is effected over a distance, there is the need to ensure that students actively participate in their learning by performing specific tasks that help them to understand the relevant concepts. Therefore, a set of exercises is built into the teaching repertoire in order to link what students and tutors do in the framework of the course outline. These could be in the form of students' assignments, a research project or a science practical exercise. Examples of instructional activities in distance education are too numerous to list. Instructional activities, when used in this context, help to motivate students and will guide and measure students' performance (continuous assessment).

Galbraith (1991:1) is of the view that adults do not only interact with instruction but also with other resources in the learning environment, such as other learners, new ideas, values and knowledge sources. He considers adult learning to be an "active, challenging, collaborative, critically reflective, ... transforming educational encounter and a transactional process". These ideas could be extended to distance education practise, particularly when an interactive instructional approach is used to write self-instructional materials.

3.5.3 Resistance to the use of active learning strategies

In research that Fox (1983) did where he asked newly appointed polytechnic teachers what they understood by "teaching", he identified four basic informal theories which underlie teaching approaches. These are remarkably similar to Clark's four instructional or operational principles that control and personalise knowledge (Clark 1998:4). The first two are "simple" theories. The last two theories describe the relinquishing of power and control by the lecturer. This situation requires guidance with regard to the context of learning.

- (a) **Recursive:** The transfer theory (according to Fox (1983 in Johnston 1995: 1-2)) views the subject matter as a commodity that could be transferred into an empty vessel, the student's mind, waiting to receive it. If the vessel did not receive it (ie, the student does not learn) then the vessel was "leaky". It was thus the student's fault that he did not learn. Teachers considered that they have done enough if they imparted the material, organised it, and prepared it.
- (b) **Directive:** The training theory focusses on a process through which the student can be "shaped" into some predetermined form. These teachers use verbs such as "develop" and "produce" to indicate the learning outcomes of their teaching. Layout design could be an indication of directive or training as the underlying approach. In our experience the typographical design does not equate the learning design - these two design areas are easily confused.
- (c) **Guided discovery:** Teachers with a "developed" theory view the student and teacher as fellow travellers on a journey of discovery, a "shared adventure" (developed by Baird, 1992). During this journey the knowledgeable and experienced teacher acts as a guide and fellow explorer within the subject area. In this view there is no "correct" body of knowledge and exploration is the focus for both the learner and the educator. Svensson and Hogfors (1988 in Johnston, 1995) indicated that their encouragement of engineering students to consider various alternative conceptions was an important element that may bring about lasting conceptual change in their learners. We believe the socio-constructivist view more appropriate to embody the extended growth from and within a context.
- (d) **Exploratory:** In an "extended growing" theory, students make a significant contribution to developing their own understanding according to their own explorations. Learners grow from their existing or past experiences, learning and knowledge. They grow at their own pace, in their own direction, toward their own outcomes and following their own process. It is an "open environment" with an unspecified outcome which they determine both in its direction, extent and level. The educator has to be very responsive to the context in which the learner develops.

The last two instructional principles should include learning with conceptual understanding, critical analysis, and various life skills, which can all be applied in real-life situations. Evidence to support the successes of the last two theories need investigation.

3.5.4 Learning (instructional) devices and activities

Distance Education self-study environments require considered design to provide learners with a structured environment within which a sustained dialogue enables active learning. In this study caring DE practitioners explored various strategies, tools, and devices to better the self-study texts. As we have already discussed, the DE context is unique (Chapter 1), the adult learner has unique characteristics (Chapter 2), and the DE institution and course teams are specific in their structures (Chapter 2). This chapter explores the teaching approaches and theories that may have may have an influence on distance learning. Instead of instructional tools we use learning tools in our quest to be learner-oriented. The structure of DE course materials is, to an extent, similar in different institutions.

A *learning tool* should be a device that enables learners to engage in active learning (Eison and Bonwell, 1988). Building on their argument that learning is a means of subtracting from existing knowledge (Morgan 1991 in Altricher, Evans & Morgan, 1991:27), in a manner that makes a learner question or confirm his/her point of view, a learning (instructional) device or tool should expose the knowledge or its absence in a variety of forms. Learning devices are sets of teaching techniques, educational strategies or learning tactics. In a self-study context, learning devices would be integrated into the text or other media. The design of learning devices should strive to improve the anticipated learning (Macdonald-Ross 1978:247). Learning devices include objectives, advance organizers, graphic organizers, pretests, overview, and activities in the text. Our focus in this study is on learning activities. We feel that however specific the other instructional devices might be, our view is that activities supercede the basic question-answer or do-something or think-about tasks.

The researcher defines *activities in interactive texts* as those learning opportunities in the dialogue that is built into the independent study material that enables, guides, cajoles, coaxes, motivates, reasons with or bullies students into becoming actively involved with the topic on various levels. These actions may be on a cognitive (knowledge) acquisition level, sometimes on a psychomotor (physical) level, or on an affective (emotional) level. These learning opportunities are questions, rhetorical questions, demands, tasks, or assignments. In distance education, activities-in-texts are an essential component because the interaction forces the learner to interact in one form or another with the study material. This "reaction" is informed by and informs the roles and structures, the language and discourse, and the actions and activities within a DE learning environment (see Chapter 2, Figure 2.3).

Lockwood (1992: 22-23) states that in international terms activities posed in self-instructional texts vary depending on the teaching model adopted, the layout and design of texts, the demands they make, and the way they are signalled in the text. He describes why the term

activities are used by saying that “these parts of the teaching material are identified by a variety of terms. In some contexts they are called ‘self-assessment questions’ (SAQs) in others, ‘in-text questions’ (ITQs). The general terms ‘exercise’ or ‘question’ are also used. ... The terms ‘adjunct aid’, ‘embedded question’ and ‘mathemagenic device’ are often employed ... I have decided to use the term ‘activity’ to encompass all of these.”

Activities should, in our view, be used to maximum effect. The researcher in her experience can only relate the integration of activities to the interwoven of the study package components as “coloured strands of skills and knowledge”. We may find them in the introduction, rationale for learning, advance organiser, pretest, the overview, objectives of aims, the content, and all feedback and discussion sections. Activities might be indicated through typographical devices, are made understandable through linguistic design, and are found within the dialogue in knowledge fields (content is some cases). Activities have a role in structuring learning experiences, but do not necessarily enforce structure. This researcher’s investigations in active learning in Unisa Course Materials for the Department of Nursing Science, between 1987-1993 (Wilson, 1990a; Wilson 1990b), inspired her to investigate the use of activities as instructional devices in text-based course materials at Unisa. She, and later her colleagues, presented workshops for the wider Unisa community on the use of activities in Unisa texts in 1994 and more work followed (Wilson 1993; Wilson 1994:Handout; Wilson 1996; Wilson 1997; Wilson & Heese 1996; Wilson & Heese 1997; Wilson & Goodwin-Davey 1997). Any analysis and discussion of activities is complex because they relate to so many other devices and aspects in DE (a view reiterated by Macintosh, 1997:174).

Since the early 1980s a number of reports have addressed the concern of a group of people for improving teaching and learning in higher education and getting students involved in actively learning. Although the focus of the reports varied greatly, all endorsed one important consideration, namely the use of active learning strategies. Cross (1987), for example, noted that “when students are actively involved in the learning task, they learn more than when they are passive recipients of instruction”. Chickering and Gamson (1987) indicated that students “must talk about it, relate it to past experiences, apply it to their daily lives. They must make what they learn part of themselves”.

This is where our quest for answers starts - Within which context would a device be able to expose different types of knowledge in its many forms? We questioned the ability of the activities in the text to get the learners actively involved, to structure the text, to promote dialogue, to allow learners to reflect on and self-evaluate their learning, as well as to provide them with opportunities, skills and attitudes to change their professional praxis (see chapter 1).

Some answers were provided through the experiences of our learners and our own experiences and knowledge from the literature (see Chapter 6).

3.5.5 Value and relevance of learning

It was obvious in the research analysis of Marsh (1987 as cited in Johnston, 1995) that students' evaluations of tertiary education courses identified value, relevance, workload, clarity and organisation of the material as the most important aspects that influence their studies.

Students' perceived the interest value of in a course and the relevance of the content are of vital importance. If the students perceive the course to be interesting and relevant they will be challenged to use deep learning techniques and employ purposeful enquiry (challenge here used as first described by Baird, 1992). Also if the tasks are set too high, the content is too difficult or not comprehensible within the life-experiences of the student, students will be discouraged and will move to surface-level learning. In contrast, if the level is too low they could become bored and uninterested, with the same undesirable result. The MATOO-8 case study showed some tasks as too comprehensive, some as repetitive, some as impractical in certain environments, and some as too trivial. The workload and tasks were adjusted over the years to refine it (an aspects that was part of the action research cycle) (see chapters 5-8).

Since the early 1980s various report addressed the concern of a number of people for improving teaching and learning in higher education. Although the focus of the reports varied greatly, all endorsed one important consideration, namely the use of active learning strategies. For example, Cross (1987) noted, "When students are actively involved in the learning task, they learn more than when they are passive recipients of instruction." Chickering and Gamson (1987) indicated that "*They [students] must talk about it, relate it to past experiences, apply it to their daily lives. They must make what they learn part of themselves.*" The inclusion of activities makes learning an active process requiring effort on the student's part. An Old Chinese Proverb says

I hear, and I forget;
I see, and I remember;
I do, and I understand.

3.5.6 Workload, clarity and organisation of material

Workload is a difficult issue; since on the one hand the course has to have a suitable standard and less work may lower the quality, on the other hand an excessive workload is definitely associated with a surface approach to learning (as the research by Chambers, 1992, Entwistle & Tait, 1990 indicated). What is the nature of this association of workload with a surface learning approach? This is unclear - it could be that the learners' perceptions could influence it, or it could be that the actual heavy load leads to a quickly -learn-the-facts-attitude. March's research was based on good classroom teachers (1987) which can easily transfer to DE. The factors that affect the workload in a course positively or negatively includes:

- Reducing unnecessary facts and more reflection. If educators focus on analysing the type of work inferred in the curriculum, they could probably expose purposes and the nature of the learning that they have imbedded ('hidden') in the curriculum. This will enable them to change tasks that promote surface learning.
- Supporting learning with resources that include proven conceptual knowledge with clear descriptions and explanations
- Proposing a clear structure. Students need a clear and organised framework within which to develop knowledge and skills within which students may place their knowledge and skills. Organisation is a paradox: too much structure might give too much, "spoon-feed" lead to little reflection and knowledge construction, while too little structure might lead to the construction of ill-structured mental "maps" with resulting confusion, misunderstanding and an inability to see relationships and discouragement.
- Pitching the materials at the right level. Workload and reading-ease calculations can assist designers in assuring that they correctly pitch the course materials.
- Pacing it appropriately.
- Purposefully addressing changes in attitude, involvement and a sense of responsibility.
- Being motivational, enthusiastic and empathetic.
- Employing information retrieval, study skills, and learning management strategies.
- Demonstrating well integrated and applied media skills (i.e. writing text or contextualising in a video).
- Increasing reflection.
- Making written and audio-visual communication meaningful by the most appropriate medium.
- Assessment instruments which reward deep learning.

Factors such as these have a direct influence on the design of a self-study text. The question that faced the course team was how to build learning experiences into a self-study course such as MMAT.

3.6 Building learning experiences into a self-study course

Building learning experiences into a self-study course according to constructivist principals and post-modern approaches to learning is not easy, but complex. It is like tediously making a colourful needlepoint article where each colour represents a design aspect. The manner in which the design is done, determines the resulting picture. In the view of this researcher (as learning developer) this is the "art" in designing distance learning materials.

3.6.1 Position-based functions of Activities

Activities can fulfil most important functions, depending on their positions in the study package (Wilson, 1994: handout) such as:

- Pre-tests.
- Learning activities or progression activities: these are activities students have to act on to reach the objectives and to acquire certain knowledge or skills.
- Self-evaluating activities: this self-test or control point is an activity that the student does after learning activities to get more feedback on his/her progress. Students can monitor their own progress, for example through a written or practical test. If the student cannot meet the defined criteria, he or she will repeat the activity to master the objective. The self-test must have a direct relationship with the objectives providing answers as reinforcement.
- Monitoring activities.
- Summarizing or focus activity between the learning activities and the end of the learning activities, summarising the key concepts of the content is necessary up to that point. The purpose of the summaries is to encourage mastering of the content and to enhance a global view of the content. We could call it a focus activity and applications in life situations are especially useful. Summarising activities can be similar to other activities, just on an appropriate level of understanding. We can also use activities within the assignment system.
- Practice activities.
- Alternative activities.
- Application activities.
- Enrichment activities as optional activities for the student to broaden his knowledge or depth of knowledge. The content of the activity can be an extension of concepts, skills or values included in the unit or it can deal with related issues. The types of activities can be similar to learning activities, just on an appropriate level of understanding, in order to provide the student with that little bit of extra motivation.
- Rhetorical questions.
- Alternative "voices" engaging the student in mental activity.

Choosing the right in-text activity and sequencing it for a group is both the art and the science.

3.6.2 Writing an activity

The activity may be formulated in the following ways. For example create a learning opportunity which requires the learner to experience setting up group work in the mathematics classroom. This activity may be stated using the following "formula":

Experience [typical tasks/ problems/ research findings/ evidence]

One may formulate more activity examples in the same way for example:

- Provide your own [solutions/ answers/ explanations] to [problems/ situations]
- Logically analyse [features of an argument/ evidence for argument/ conclusion/ causes/ if-then situations]
- Infer/ conclude/ predict/ explain/ hypothesise [from examples/ premises/ data/ applications/ theory]
- Engage in [dialogue concerning controversy and new concepts]
- Recall or refer to [own experience/ ideas/ theories/ research data/ stages/ options] and compare/contrast it to a [new concept/ situation]
- Critically think and supply reasons for [competing ideas and views encountered]
- Supply [themes/ ideas] from [facts/ sections of work/ syllabus]
- Verify [understanding/ judgement] by critically analysing, comparing, evaluating (against criteria) [content/ arguments]
- Show insight with interpretation of relationships between [new knowledge/ new skills/ terms/ definitions/ theory] to [everyday life/ examples/ interpretations/ meanings/ applications]
- Analyse [assumptions/ content/ applicable prior learning experience] to [content/ themes/ ideas/ theory]
- Monitor [the learning progress/ understanding of tasks or assignments or relationships/ study organisation skills]
- Analyse [personally preferred learning styles]
- Explore (respond to) [new learning styles]
- Monitor [the learning progress/ understanding of tasks or assignments or relationships/ study organisation skills] as a metacognitive skill
- Analyse [personally preferred learning styles] as a metacognitive skill
- Explore (respond to) [new learning styles] as a metacognitive skill

Activities such as the above provide a starting point to address the multitudes of knowledge, skills and attitudes that learners need to be confronted with and demonstrate.

One could put forward a "conceptual model" to direct the writing of an activity where the task specifies the skill and resource then placed in relation to the outcome and criteria.

Figure 3.3: A conceptual model to write an activity

[Verb] a [skill, knowledge or attitude] from [information/ ideas] THEN [verb] a [structure/ form/ illogical/ irrelevant detail] of [definition/ essay/ report/ article/ formula/ table/ graph/

We could state a number of specific examples to formulate activities. For example:

"Using different reading skills, identify the main ideas in our definitions. Which of the reading skills assist you in identifying: main ideas, irrelevant detail, the structure of the definition and illogical argument?"

"One uses different study skills to identify important information. Using a variety of such study skills, identify the important aspects in the article below. Identify the main ideas, irrelevant detail, the structure of the definition and illogical argument that is evident."

The MMAT study guide included a large variety of activities based on this proposed model (see Addendum A2).

As distance educators our experience confirms that students need to become actively involved in their learning (incorporating their own learning styles and different senses). A number of structural tactics may be employed:

- (1) Tell students to read some text with a particular purpose in mind.
- (2) Guide students to hear the words internally in their "mind's ears" and rehearse it.
- (3) Guide students on how to visualise the contents by constructing a vivid image in their minds.
- (4) Specifically guide students to activities that get them to "feel" the text. This could include acting out the key elements, presenting an argument to an imaginary audience, walking around while you read or listen, underlining the key elements, in some way physically involving yourself, writing out the key words in a colour, drawing a picture or map or writing some words backwards.
- (5) Give immediate feedback; either in the text or on a sound cassette. Plan this step carefully in the instructional design of the package. Add substantial learning advice to motivate the student to cope with potential difficulties. Here audio and visual elements can bring a different dimension into the learning environment.
- (6) Allow students opportunities to test their learning progress. Build prior positive learning experiences into the progression of learning.

Figure 3.4: Example of activity for structure

Introduction	1) Gain attention 2) Inform learner of aims and objectives 3) Stimulate recall of preknowledge	1) Practise... 2) Experience ... 3) Provide... 4) Logically analyse... 5) Infer/ conclude/ predict/ explain/ hypothesise
Body	4) Present material 5) Guidance to learning 6) Performance to show depth and breadth of knowledge	6) Engage in ... 7) Recall/ refer and compare/contrast ... 8) Critically supply reasons ... 9) Supply ... 10) Verify ... critically analysing, comparing, evaluating (against criteria)
Conclusion	7) Feedback on learning and performance 8) Assessment of performance 9) Retention and transfer of information to new situations	11) Interpret relationships between ... 12) Analyse ... 13) Monitor ... 14) Analyse styles ... 15) Explore and respond to... 16) Identify skills ...

Now think again:

You could have used any number of the above activities. Each should be used to achieve the purpose they have been designed for. It follows that you will not always use all of them, and some activities may be used more frequently. This list may assist you in setting activities by providing you with ideas. Some are difficult to set, but these are also the most challenging for students. You might even want to use reflections on daily life and dialogue on controversy to introduce a topic to the students. These activities can be introduced by asking students to conduct experiments, read books /newspapers/ magazines, watch videos, draw diagrams, study maps/ charts/ pictures/ photos/ paintings, or handle objects, etc.

Write the numbers of the types of activities that would be appropriate in each section of the presentation. Give an example from your own subject material. Write this on your own paper.

3.6.3 Writing a unit with activities

In order to write a self-study unit there are a vast number of small questions that need to be considered in each opportunity for learning. They all contribute to the synergy which is imbedded in the components of DE textual design and have links to content, linguistic, typographical and learning design. (See section 3.4.3.) In writing a unit the following questions should provide some direction within the complexity. They are not clustered because of their interrelatedness in the learning environment.

(1) Do you foster a dialogue or guided didactical conversation?

The researcher is of the opinion that the key to successful active learning pedagogy is to foster a recursive, but progressive dialogue. An activity is pertinent when the content or skill needs emphasis (not just trivial recall) and is important for later understanding. (Refer to the corresponding views of Moore (1977a), Evans & Nation (1989) and Rowntree (1992).

The "voice" of the lecturer as facilitator and co-participant in the learning environment of the student is so important that those who limit studies to the reception of printed materials damage the substance and scientific nature of the studies (Peters, 1998: 35). No "voice" dominate but space is allowed for all the participants. This voluntary listening to a partner with own control, should show a serious and real interest in a mutual environment where all parties confirm discoveries (Peters, 1998: 38; Jonassen, 1991:29; Honebein, 1996:11). There should be an intellectual challenge imbedded in the object, namely the printed text and the use of different media to extend and alters the communication.

There are a variety of approaches to understanding successful learning and aspects that influence poor understanding. Understanding can be described as "... a function of the number of elements of knowledge the person possesses about the target, ... and of the mixture of different types of elements and of the pattern of associations that the person perceives among them." (The target being a concept, a discipline, or a situation and is consistent with Ausubel, 1963, 1968). All these approaches can be incorporated into different forms of activities with the aim to expose the numbers of elements, the possible mixtures of elements and the patterns of associations within and between concepts (Murphy, 1997: online).

(2) Do you link activities with course objectives and aims?

Try to match activities with the aims and objectives stated, or negotiated, or derived by the learner in the course. Activities have strong integrating powers in a study package and can work as building blocks towards the completion of final activities or assignments. Allow the activities to follow up to a final focus activity (or review questions or even self-assessment questions) at the end (Wilson, 1997: online).

The activities can be *progressively stacked* by starting with fairly easy activities in the beginning of the first module, leading progressively to more difficult activities later in the study guide. Where possible provide less support as students progress. Activities need not be simplistic, but need to link students with past experiences in order to encourage personal involvement in the subject, and clearly identify important 'building blocks' for the module. Such guidance and preparation in using activities with feedback are the "bridges" or "scaffolding" as a process of guiding the learner from what is known to what is to be known. Seeing that student's problem-solving falls into tree

categories, namely skills which they cannot perform, may be able to perform, or can perform with help, scaffolding will allow learners to perform tasks that will normally be slightly beyond their ability without assistance and guidance from the more experienced person. Scaffolding prepares students to complete their assignments optimally in preparation for their exams (Vygotsky, 1978 in Murphy, 1997:online).

Outcomes and quality of the learning are influenced by aspects such as the following:

- The students' perceptions and expectations of the course,
- The teaching philosophy and total approach,
- Appropriateness and types of assessment instruments imbedded in the course,
- The cognitive and skills development of the student,
- The inclusion of questions in the texts (rothkopf, 1965 in rowntree, 1992:55)
- The institutional framework impact on the course presentation,
- The social and academic environment in which the learning takes place (also refer to Bowden, 1988, as cited in Sheppard & Gilbert, 1991).

When problems arise and give rise to much limited learning, errors, or unacceptable assessment experiences, the developers of the course have to look aspects such as the above. What the student brings to the process of learning is difficult to change or anticipate such as prior experience, expectations, development, or the social environment of the learner (Murphy, 1997:online). Factors within the teaching context that can be modified are approach, strategies, content, method and structure (also refer to Dart & Clarke, 1991).

Learning in science is more than just acquiring concepts that are applied to problems. The difficulties in understanding a concept seem to reflect not a lack of knowledge of specific details, but problems in realising what types of explanations and what modes of thinking are appropriate in a specific domain. Even what kinds of questions are legitimate and productive in the topic because these questions differ from those people ask themselves in everyday life. So can we propose to know which questions will be the most appropriate, legitimate and productive in the topic under discussion with the student if we do not know the student's exact situation and life experiences? (Meyer, 1997: online).

Using lesson plans, the author analysed the strategies teachers used to integrate Internet activities in the classroom, describes teachers experiences, and suggests that three main instructional approaches were used. The instructional approaches were interdisciplinary learning, problem based learning (utilitarian, academic and student centred perspectives), and instructional systems. Advantages of new knowledge presentation through computer discourse stated as this is seen as a solution to engage students and teachers as partners on the educational journey. (Kumari, 1996: online.)

Educators can influence the outcomes of learning (as Biggs, more than a decade ago in 1989: 33 suggested) in three ways: additively, interactively, and contextually. He suggested that it is within the participatory (interactive) area that surface level learning can be minimised. The interactive aspect should lead learners to actively experience all learning aspects and also foster a responsible attitude concerning their learning and all components thereof, such as organising, pacing and decision making. The strategies for deeper learning are all based on this premise and it makes sense to include these strategies in distance education materials to increase the opportunities for participation, especially in text-based materials. It then follows that all the tasks that create participation that students are expected to complete do have an impact on the quality of learning. Such learning tasks may include: text readings such as study guides, text books, or other required readings; oral work such as discussions or presentations; written work such as learning textual activities, self-assessment exercises, assignment work or examination preparation exercises; simulated experiences or actual real-life experiences with a particular focus, such as interviews, experiments, case studies, vignette analysis and application in a situation, or small research exercises.

(3) Do you write for the learners?

Activities can be set very formally, following the behaviouristic models' use of measurable verbs, defined content, and conditions of execution. This assists the students in reaching a certain level of attainment and goal. It is however, restrictive. Another way of stating questions is to pose more reflective, open questions, using "teacher talk" (Hanley, 1994: online).

Closed questions are multiple-choice questions, true-false questions, or content questions.

'Do you like being a student?' Yes / No / Sometimes. 'Choose the factors that influenced you during your studies from the list?' a) b) c)

In contrast, open questions are piercing or probing questions often exploring feelings, perceptions, values or appropriateness.

'What do you like about being a student?' 'How much do you like being a student?' 'When do you like the student life?'

In practice lecturers could ask the following open-ended questions:

What do you need to know to begin? How do you feel about doing this? How would you tackle this task? What are your concerns about doing this? What is the worst thing that could happen? What did you observe? How did you participate? Were there many surprises? How did you feel about other aspects? What does that mean for you? How might it have been different? What is happening here? Does this link with ... ? Does it relate to any other experience you had? How might you use these ideas when you.....? Is this reliable information you can use? Have you learned new concepts/skills/changed your attitude?

Open ended questions asking students' reaction to a situation or their opinions usually requires careful guidance before and after in the feedback to establish relevance and own unique construction of contextual meaning, remembering that adults often have unique situations and experiences. (Peters, 1998: 78-80; Rowntree, 1992:69).

(4) Do you have the right number of activities in a learning unit?

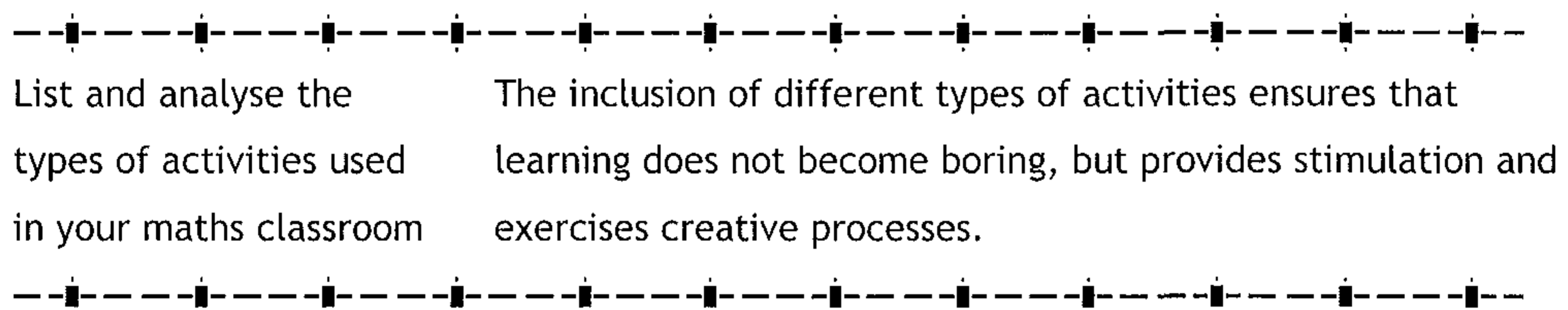
Lecturers can use any number of activities interspersed in the text when they feel it appropriate. Each should be used to reach the purpose they have been designed for (Rowntree, 1992:82-83). It follows that learners will not always use all of the activities - and some activities they might use more frequently as the learner is in control of the learning (Von Glasersfeld, 1995:10-14).

(5) Do you progressively build skills and knowledge?

The activities can be *progressively stacked* by starting with fairly *easy activities* in the beginning of the *first* module, leading progressively to more *difficult activities later* in the study guide, while providing less support at the same time. This will guide students through the work and prepare them for difficult assignments (based on the skills and knowledge gained in doing the activities). These 'fairly easy' activities need not be simplistic, but need to focus on linking the student with his/her past experiences to encourage some personal involvement in the subject (Ernest, 1995:485), and identifying to the student the most important 'building blocks' for the module.

For example:

Figure 3.5: Activity to link the student to past practices and the tasks already completed.



(6) Do you Indicate time requirements?

Students to get an indication of *time spent* on activities. However, the timing must be realistic and allow the average student to complete the task. If students take much longer on an activity or on activities in general (provided the timing is right), then it is an indication to the students that they tend to take longer to study than other students, or that they have a problem with that particular section. A very compelling aspect indicated by lecturers and students alike from data collected showed that a number of learners perceived reference indications to be compelling or a guide as to the perceived value of action against the time spent, as well as a reference to whether they did the other activities (Rowntree, 1992:95, 112).

(7) Do you use referencing techniques?

A reference number for activities provides students and lecturers with a common reference when they discuss (at a distance) a particular skill or cognitive ability students' need to develop when doing the activity (Rowntree, 1885:86)

Figure 3.6: An activity to indicate the required time and the activity number as references.

Activity 1.3 This activity could take you: 5min

You were exposed to a typical maths classroom situation of Mr Derrida. However, your situation is unique. What is your reaction to the role of a numbering system and the psychological guidance provided learners.

The reference number may use a numbering system that includes the chapter or study unit (as in figure 3.6) or sequentially throughout the module. Different terms may be numbered differently, for example all the Exercises and the Worked Examples may be on separate numbering systems.

(8) How are activities motivational devices?

Both the layout, types of activities and its accompanying learning opportunities have a definite motivational influence on students needing to work through the course content. You could include some external motivational devices such as:

- extra credits for sending in work, or
- include students as part of a research group, or
- frequent guidance in the form of feedback, or
- interesting work with the inclusion of, for example, a variety of interesting media.

These motivational and support opportunities are often rare, valuable and much appreciated by the learner. It provides opportunities for course developers and faculty in distance education to become more aware of learners, their needs and abilities (Rowntree, 1992: 72-77).

- Active learning strategies follow an approach has been synthesised from Kelly and Holmes's description of the Guided Lecture Procedure (Osterman 1984: 1985) description of active "lecture" approaches which were adapted for the distance education use. Repeat the cycle of steps with the next part of the presentation. The study material should entice learners to engage in:
 - a pretest
 - focusing on objectives, aims, and outcomes.
 - the types of outcomes to lead to specific skills and knowledge
 - design for outcome (from outcome back to basic building blocks)

- acquiring new terminology
- going through introductory materials
- suggested study activities such as
- intensive reading and thinking processes,
- taking notes and generating ideas (brainstorm phase),
- discussing the contents with other learners (if possible) or working through case studies to get more scenarios and perspectives or focusing on problem-solving scenarios (providing demonstrations, proofs and real-life stories), or discussing a question, paradox, enigma, compelling unfinished story which focus on the aim of the presentation),
- improving on notes (identify major concepts, arrange material in sequential order, draw conclusions),
- applying the textual (hermeneutical) technique of exegesis which models analytical skills,
- immediate feedback about the discussed questions etcetera.
- reflect more on the material after the learning session.
- brain-storm for novel ideas
- short writing activities
- self-assessment questionnaires
- group discussions or practical sessions

Repeat the above cycle of steps with the next section of the study unit.

(9) How would you sustain the dialogue in feedback?

Activities should match the *needs expressed* by the target group. This establishes the basis for a credible learning package, especially in today's educational environment.

Keeping the students in mind tends to force authors to write at a *understandable level* (Newton, 1990: 109) possibly because the student is considered more during the writing process and the first person 'you' is used more (Race, 1994: 59). On the other hand, friendly and frequent activities *motivate* students to persist through a study unit on a lonely night. This might be because, like pictures or graphic detail, graphically interesting activities tend to *lead the eye* over a page and *break text up* in more manageable, less boring, chunks of text.

We sometimes feel the 'you' and 'I' to be too informal, however, that is what students expect us to use and what provides the best 'tone' or 'register' for discussions to promote learning. In Afrikaans and English the plural might be the best form to also address the sensitive issue of gender bias.

The completion of a course should aim to apply new knowledge and ideas in the student's life (where applicable) to satisfy some of their needs for studying. Regularly asked questions from students are usually an excellent indication of their unexpressed needs.

The evaluation or feedback for activities is important, especially to learners. It is an integral part of dialogue. Activities are usually placed in the feedback throughout the text, especially after

activities, or in text paragraphs. It can also be placed in a separate booklet (including a Unisa tutorial letter) and in the beginning of the section (as pre- or post-tests). (Rowntree, 1995:83-86).

The feedback could provide specific answers or it could guide the student towards appropriate answers (especially if there is no one right or wrong answer). Feedback should address the correctness of the response in a sensitive manner to enhance intrinsic motivation. For distance learners, the reasoning for the answer is imperative (the /'Why?') and providing students with the principles and structure appropriate to their study (Anderson and Armbruster, 1985: 162). For example: *"Evaluate the feedback on activities used in your guide. Does your feedback concentrate on the content and expose the form and structure?"* This improves understanding and the student is able to monitor his/her own knowledge growth. Beware of being too prescriptive and try to cater for an heterogeneous group (according to your target group analysis). (Rowntree, 1995:41-49.)

(10) How do you manage difficulties with feedback?

Any feedback format can be a problem in distance education and attention to this aspect is essential. Lecturers can use answers on activities to provide feedback to students as part of a research project (for example the effectiveness of activities or the effectiveness of new study material). Feedback to lecturers can be in the form of simple questionnaires which provide them with valuable reference material about their students. Small focus group research can also provide qualitative answers to questions the lecturer might face.

Students can use their own answers and the feedback provided as topics for discussions between themselves, or between them and lecturers or tutors (if one is available). Students can use answers as feedback for discussion topics in their own peer groups, or they can include their reactions in a questionnaire attached to an assignment for the lecturer's notice.

(11) How do you position feedback to support guidance and action?

Feedback on the activities can be placed directly below or following the activity, or elsewhere (on cassette tape, or at the back of your guide). Guidance to answers can be concealed in the form of text. It often happens that students go back to the question to read it again, then read the answer, because this provides them with an opportunity to better understand the reasoning used in that particular situation. This is a form of dialogical conversation as a reiterative process.

Figure 3.7: An activity to provide a reiterative process in the text

~~~~~  
In your opinion, have you provided the students of your course with enough feedback on linear division? Discuss three possible strategies with them in your next planned lesson.  
~~~~~

Feedback is a necessary part of the dialogue. Your learners need to be given assurance that their opinions are in line with your criteria for acceptability. What are these criteria - what is "enough"? A number of strategies are discussed in your textbook. You need to adapt it for your lesson in the classroom to suit the concepts you are planning to present and the students' grade.

(12) Why and how do you leave space to make notes?

There is considerable debate as to whether to leave *space for writing* or not. Readability (such as large enough letter type and spacing between the lines) is probably more important than leaving space for answers in self-study guides (which we know tend to be filled in by only some students sometimes - however important researchers say it is. Writing space also takes up large volumes of paper). Large left margins in a 1:2 layout format provide additional writing space in the text (Rowntree, 1995:89).

The purpose of the question often determines whether to leave space or not. Research in each situation is essential (Rowntree, 1995: 89-95). Activities can:

- Enhance thinking skills: Use multiple-choice or open ended questions in the text to create a climate where thinking skills are enhanced.
- Increase cognitive recognition abilities: Use check lists, tables, or half filled in diagrams to improve basic cognitive abilities which underlay more complex tasks students are expected to perform),
- Improve analytical skills or problem solving skills: Measure the space used in the above activity and compare it to a similar activity on the next page. Can you see how much space can be used by activities depending on the layout and feedback space provided? Use small research projects as individuals and in the community, small group work, reflections from case studies or personal experience, reflections on daily happenings from diary notes to pace students through difficult analytical or problem solving skills they require in your subject.)
- Improve study skills: Use mnemonics, lists, or diary entries to improve study skills for skills necessary in your subject). Also compare the different layouts used for activities in the above four activities. How do you feel about them? What effect does the layout have on your compulsion to do the activities?

- Improve reading and writing skills: Use specific multiple-choice questions, brief writing outlines, reports, assignment writing to improve specific reading skills and particular writing skills),
- Improve listening skills: Use note taking on small note pads, interviews to collect specialist information incorporating a sound cassette player and note book),

(13) Are activities part of learner evaluation?

Rowntree (1995:22) states that activities are identified by a variety of terms for example Self-Assessment Questions (SAQs), In-Text Questions (ITQs), just Exercise and Question, Adjunct Aid, Embedded Questions and Mathemagenic Device meaning behaviours that give birth to learning (Rothkopf, 1970:325 in Rowntree, 1995:22). If assessment is considered as the judgement of actions that compel us to plan future happenings (see 1.7.3) and is therefore the judgement of the actions within the opportunity for learning. If an ITQ is "a learning tool that define and foster interaction ... engagement in a subject, ... being motivated ... and changes the way a situation or task is experienced by the person that produces that action" (see 1.7.3 (a)) then an activity in DE texts can be considered part of formative assessment (see (14) below) as self-assessment may be required. Activities require:

- action,
- should be part of the cognitive requirements of students,
- foster change,
- should be authentic because of its imbeddedness in socio-historical contexts (Murphy's analysis of constructivist learning environments that require authentic assessment interwoven with teaching)
- and assess learning (see 3.2).

Assignments at Unisa are tasks to be provided as evidence to objective questions, essays or project reports. They are both formative and summative tools depending on their role to create learning opportunities.

There are some broad categories of purpose that distinguish evaluation undertakings, regardless of their more specific goals. These are not rigid distinctions and there are often overlapping elements. Nevertheless, there are important differences. Thorpe (1993:8) reports that the development of a variety of approaches to educational evaluation has "*generated much debate within the literature on educational evaluation about what should be its proper tasks and purposes*". She emphasizes that "*this variety exists, that there is no one right model, and that we can and should choose one or a combination of approaches to the purposes and resources available to us at the time*" (Thorpe 1993:9).

(14) How do you include different types of evaluations?

Evaluation is always present, consciously or unconsciously. There are different types such as placement, diagnostic, formative, summative and program evaluation.

Placement evaluation determines where a learner should be placed in an educational environment. It is often a gate-keeping mechanism (ie. it is used to decide whether or not to allow learners on to a course). In the US, for example, the Scholastic Aptitude Test (SAT) is used to decide whether school leavers may be admitted to universities or not. It should also be possible to use placement tests to increase access to further studies. This should be the case if, for instance, learners who did not have university exemption were given foundation or access courses to study and then allowed to write an access examination. This is an important element of many open and distance learning institutions.

Diagnostic evaluation refers to assignments or tests designed to identify specific learner problems. A single diagnostic test may cover a range of skills. Groups of questions can be designed to test the level of proficiency in specific skills. After the test or assignment has been administered, learners should be able to identify the strong and weak points of their current levels of proficiency accurately. Using this information, learners can be helped to adapt their learning strategies to their specific needs. Diagnostic evaluations can also be used effectively as a technique to determine the prior knowledge and skills of learners.

A distinction is usually made between formative and summative evaluation of learners based in terms of different focuses, not clear-cut opposites. Formative or continuous evaluation takes place during the course or module while summative evaluation refers to learner evaluation at the end of a course or module. Formative evaluation still enables lecturers and learners to modify their strategies towards more favourable outcomes, while summative evaluation judges final outcomes. Formative evaluation involves the lecturer and the learners, while summative involves lecturers and external experts for verification of the standards. Formative evaluation may be formal or informal, values subjective input and objective checks while summative assessment strives to be objective in a more formal setting. Formative evaluation lends itself to qualitative methods while summative leans more to quantitative methods. Formative evaluation forms the basis for diagnosing problem areas to be improved (such as a component of promotion), while summative forms the judgement towards awards, promotion and certification, linking evaluation to the promotion of the accountability of institutions to outside stakeholders, governing bodies, to learners and to the public.. Formative evaluation (also called process evaluation or continuous evaluation) provides feedback to learners regarding their progress during their work on a course. In distance education, opportunities for formative evaluation are usually provided by means of in-text activities with

feedback, progress self-texts, or workbooks with answers provided, plus assignments. Each of these forms can be tutor-assessed or self-assessed (value judgement phase). If assignments are taken into consideration for a year mark which counts towards a pass, they are also serving summative purposes. In distance education, summative evaluation takes place when examinations are taken at the end of a module, course or programme. Learner achievement (or lack of it) also provides information to course developers and presenters as regards the effectiveness of the learning package.

Assignments (tasks that have to be handed as answers to objective questions, essays or project reports) should not be seen as only summative tools, but should create opportunities for learning. Sometimes instructors are not clear in their own minds about whether the assignments they set are simply testing mechanisms or whether they should also serve as teaching and learning aims. One way of ensuring that an assignment becomes a learning opportunity is to give extensive feedback with permission to resubmit in cases of poor achievement. The separation of teaching and learning in DE makes constructive tutor feedback on evaluation opportunities extremely important.

Programme evaluation looks at an existing programme or intervention, designed and developed before and evaluated by the researcher. Programme evaluation (or summative evaluation) research focus on process, not impact. The question is, however, how a programme should be evaluated and to what extent it is accountable. Accountability addresses the necessity of delivering a cost-effective service. Social change theory seems to underpin programme evaluation. This method has been around since the 1930s, but to a limited extent in South Africa (De Vos, 1998: 366). Rossi and Freeman (1989: 18) write that programme evaluation research is the systematic application of social research procedures for assessing the conceptualisation, design, implementation and utility of social intervention programmes. A great variety of programme evaluation types exists, such as needs assessments, evaluability studies (pre-evaluations), programme monitoring, impact studies, cost-effectiveness studies and utilisation assessments. During each of these the steps of the particular process should be implemented in order to execute the evaluation.

(17) Are your activities thought provoking?

The nature of activities should force students to stop and reflect on the implications of new knowledge in the light of existing principles, moving them to deep-level learning (as some of the studies of Marton and Saljo suggests adult learners should strive to learn, 1976: 11). Lecturers should start at any level they think is acceptable, and improve it with the insight they receive yearly. They can raise the standard of a course when they guide and lead students to improve their cognitive thinking abilities, their execution of skills or any other aspect they want to address.

Sometimes activities are difficult to set, but these are also often the most challenging for students, making them very interesting and compelling to do. In most cases a team approach is the only way to implement these skills within subjects effectively.

For a question to be effective, it must address the right issue at the right time, addressing the person in the right context. Different types of questions that could be included in distance education texts include (refer to Lockwood 1992):

- exploratory questions, such as "What are the facts?"
- challenging questions such as "Are the solutions or interpretations adequate to the problem?"
- contextual and relational questions such as "How is this similar to that? How is it different?"
- priority questions such as "Which is the best solution?"
- concluding and conceptualising questions such as "What have we learned?"
- Brainstorming
- short writing activities
- Self-assessment questionnaires
- Group discussions or practical sessions.

(18) Do your activities address diversity?

Different types of activities can address differences in the abilities of the student population. The variants in the learning is no longer the student's ability to establish what the lecturer wants, but the time a student takes to study the content of the package and the depth of insight attained (Rowntree, 1995:

(19) How can activities be presented in media other than text?

A variety of media cater for different learning styles and preferences. Activities can be included in a video programme, audio programme, computer-based animation and virtual reality. An activity can also be focussed on using a medium in context.

(20) How can variety and diverse interests be deliberately addressed?

Various learning strategies could also provide another level of identification. It has a definite influence on the amount of sustained interest created. The subject developer may use self-study, make journal notes, take notes, conduct interviews to get specialist information, make brief writing outlines, write reports and assignments, conduct a small research project as individuals and with other people in the community, work in small groups, reflect on case studies or personal experience, or reflect on daily occurrences from diary notes to explore the content to be studied. Appropriate strategies like the support of fellow students in study groups, tutor systems, group discussions or lectures are very effective, making studying interesting and challenging. This can also be very relevant to the society in which the adult student finds himself/herself. (Rowntree, 1995:61).

Using different types of activities prevents activities from becoming boring if the same thing is repeated (Rowntree, 1995:73), for example:

- filling in short questions or answering multiple-response questions,
- ticking off responses,
- reflecting on past experiences,
- making short notes,
- writing a longer paragraph in preparation for an assignment,
- conducting a discussion with an important person in the community,
- completing half filled-in tables;
- answering a question asking their opinion on a topic against the background of some information or a discussion,
- completing exercises which include learning techniques, such as drawing diagrams or completing labels for illustrations, completing or making mind-maps, and filling-in or constructing tables.

(21) Can activities indicate difficulty level?

Another level of identification can be the difficulty level of the activity and the amount of time related to it. Taxonomies of cognition, psychomotor skills, affection, management (and others where applicable) can be one level on which identification can take place.

The level(s) of each skill or ability determine(s) the learning outcome to a large degree. Lecturers need to establish the learning outcomes as far as possible.

Sometimes it is valid to group activities according to their ability to build different skills. Lecturers can start with life experience or with a low ability skill. While building towards cognitive skills, psychomotor skills or management skills, lecturers can include metacognition skills (the knowledge about their own knowledge structures) which often includes incorporating organisational skills such as reading, writing and study skills. The interaction of all these components should work together to guide students to reach the higher order skills. Thinking skills (such as critical analysis) and creative skills can be included in the philosophy if it is an aim of the course.

(22) Do you include a variety of skills?

Activities grouped as initiating activities, thinking skills, metacognitive skills and organisational skills may assist lecturers in setting activities by providing them with ideas.

Initiating activities are the lowest level of activities that lecturers must use to assist students to become familiar with the concept. The lecturers themselves also have to become skilled in the use of activities - this takes time and practice. Initiating activities can include all types of activities on any of the above levels of difficulty, skill or hierarchy. (Rowntree, 1995:91-92.)

The student could be asked to read a chapter in a book, skim a newspaper article, scan a magazine for relevant articles discussing the topic, watch a video, draw a diagram to provide an overview

over the study unit, study maps, charts, pictures, photos, paintings concerning the topic, or to handle specific objects that gets students involved in the topic.

From this list it is clear that all the senses can be involved in this initial phase. The five senses involves the student in the learning experience are the senses of sight, hearing, smell, taste and touch. Including the senses in the learning experience involves students in a holistic way and makes the activities required more compelling. The focus during evaluation may be on learner evaluation, lecturer or course evaluation.

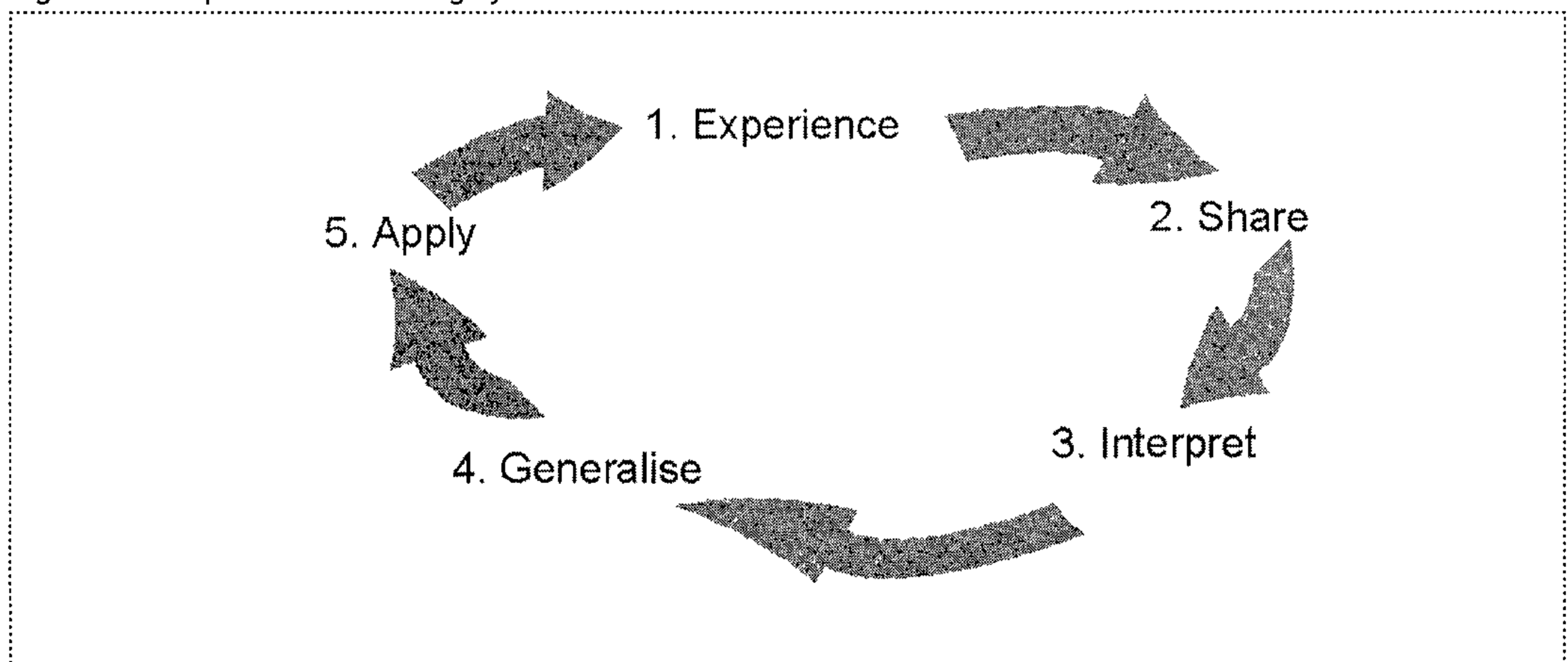
(23) Did you take the format of the activities in mind?

In-text activities are often in different formats indicating their function in the text such as, learning or progression activities, self-assessment questions, content summaries, test-yourself questions, focus activities, enrichment activities, examples with some activity, to-do items, or sometimes questions are merely posed. In-text activities (in contrast to the term holistic term "activity") are not assignments (or other forms of assessment such as examinations, clinical texts, or practical work), however, in-text activities need to be designed *with* these forms of assessment as they constitute steps leading to the final aim.

(24) Did you make a link with personal experience?

Adults have a lot of personal experience, sometimes of an appropriate nature to the subject and other times not directly applicable at first glance. When experience is applicable in the learning cycle, it involves different learning levels, as can be seen in figure 3.8. The stages are: (1) experiencing something (often getting interested in it), (2) sharing an experience (which might include reporting interest), (3) interpreting something (which means making sense of it), (4) generalising from something (like concluding from examples, testing data or hypotheses) and (5) applying new knowledge to something (which can involve reviewing the learning in a new area).

Figure 3.8: Experiential learning cycle



Prior learning experience is often useful to promote learning (Marton & Saljo, 1976: 4-11). Lecturers might want to use reflections on daily life or discuss a controversial topic as an introduction to a topic. Initiating activities can include asking students to conduct a very small experiment (smelling somebody's perfume or soap or deodorant) to link the concept to prior life experience.

The activities can trigger learning attentiveness and responses, but the type of response will vary. In the past the outcomes were considered to be relatively controlled, but this is not always the case. Differences in understanding need to be carefully addressed in the feedback as understanding is multi-dimensional, not linear.

(25) Did you cater for individual learning styles?

Apart from the type of response activities can elicit, their effectiveness is also dependent on matching the lecturer and the student's individual learning styles. Different activities can, by their very nature, restrict students to a particular learning style, such as asking to them to list or discuss something, both of which are linear formats. An activity can provide them with a variety of options to choose from. Here the example is: "Draw a mindmap or list or show in a table the relationship between concepts A and B". Even the layout of the activity can imply some format, such as dotted lines to write on which can provide (unknowingly) the length of the answer, the importance of the question and the time to spend on it, as well as a linear listing format.

(26) Did you model the use of different learning strategies?

One strategy which allows students to prepare, visualise, organise work and illustrate relationships resulting in deep learning is that of concept maps (Novak, Gowin, Johansen, 1983; Mayer, 1989). Concept maps are an ordered graphical representation of concepts, facts and detail, providing meaningful patterns or framework too newly constructed knowledge allowing recall, organisation, and exposition of interrelationships (Jegede, Alaiyemola, Okebukola, 1990). Concept maps are appropriate to enable learners to apply knowledge and skills in problem-solving. This strategy was devised as part of the learning tasks in the MMATOO-8 case study to encourage learners to become independent, to effectively organise their thinking and to track where they are and where they are going to.

In summary, 'Society expects its teachers to care for students, to care about their learning, to be knowledgeable about curriculum content and to know how to induce learning in others.' (Jeans, 1992 in Johnston, 1995). The epistemological assumption is that insight into other people's conceptions of reality provides a valuable tool in instructional situations. By understanding different modes of thought and understanding how explicit explanatory principles are viewed (which are characteristic of everyday thinking about the world), educational texts can incorporate

explicit attempts in the textual explanations and descriptions to address differences in students' reality visions that are valid in different sectors of complex societies. (Duit and Säljö, 1988)

(27) Did you flag your activities?

Activities can be imbedded in an icon, typographical or backdrop-based layout design. Reader-stoppers alert a student that action is required. The flagging of actions are dependent on the model or type of guide so a reflective action guide will be different to a tutorial-in-print (Rowntree, 1995: 86.). The most important aspect is that the flagging devices should be typographically be correct, should adhere to design principles, be culturally and contextually sensitive and focus attention without intruding on the dialogue.

3.7 Conclusion

In distance education situations we need to adapt the suggestions by Eison, Janzow, & Bonwell (1990:82). Practitioners need to engage learners in activities rather than requiring them to only read long passages of text. A question we asked in this study was "What processes take place during the course design (preplanning, design, development, management and evaluation) of a distance education course?" (refer to Chapter 1).

The implications for the course team are that they are required to be well versed with active learning and its implications in the structure, the potential for dialogue and the action it poses. The course writer should design activities that explicitly acknowledge and consider the collective experiences and pre-knowledge of the targeted learners, or asks the learners to write down such experiences or expertise. These experiences should then be incorporated into later activities.

The course writer should place greater emphasis on influencing participants' attitudes or values and developing participants' skills rather than on transmitting information as the research shows it to be an important contributing aspect in motivating learners to persist with their studies. The learners should receive immediate feedback in the course material from the course writer. This should include experiences that a writer can share from his/her previous experiences from other learners.

Writing to assist learners should focus on enabling them to direct their own cognitive growth and development by means of textual materials in distance education. This is no easy task. It is complex and fraught with difficulties.

In Part III we will describe the process during which this course was developed. The researcher describes such an attempt in Chapters 5-7 with the discussion of the action research project of the *Mathematics Subject Didactics* case study. This case study describes to what extent these issues are

addressed in this DE course. More research in the Unisa ODL environment in this regard is imperative and needs to be encouraged at course development level. This research into the MMAT00-8 course exposed aspects of the workload problem that were interesting and showed the complexity of this aspect area.

The next chapter will expose the participative action research methodology used during the case study that forms a large part of this research. In the research methodology chapter the researcher aims to provide a strategy for testing the use of activity in distance education self-study course materials.

II: Chapter 4

The action research process

4.1 Introduction

During this research the researcher aimed to investigate the processes that take place during DE course development where activities are used as an instructional design strategy in self-study texts. The focus was also on investigating processes which change the actions, dialogue and structure of learning. Another point of enquiry involved the practices of the learners as mathematics teachers. This last enquiry involved the practices of the course design team.

This chapter argues that action research is an appropriate scientific methodology seen against the backdrop of a particular view of reality, knowledge, theory and practice. The chapter also argues that one of the more successful strategies for change within a defined context is action learning projects (ALP). It goes on to argue that - if it is possible - one should formalize action research projects (ARP). A number of such efforts have the potential to move an educational organisation and its staff in a new direction (2.6.1). As AR methodology is very specific, this chapter explains the processes, steps, varieties, and characteristics of participatory action research enquiry. In addition, the methodologies behind the following are described: case studies, enquiry, critical analysis and reporting, analysing stakeholder letters, and interviewing.

The researcher-as-participant and the course team felt that the *status quo* regarding the instructional design of the course had to change to include in-text activities. Within various action research cycles the group asked pertinent questions about in-text activities and their ability to affect dialogue, structure, and action. Lastly, this project overview sets the scene for the descriptive chapters (Chapters 5-8) that follow in Part III: these describe the cycles and the outcomes of each phase of the research.

4.2 Action research (AR)

Action research means to act following deliberate planning for strategic action while rigorously observing the effects or consequences during the spiral of planning, acting, observing, and reflecting - and critically reflecting in a team on the phases, outcomes and the process of the

research (refer to Carr and Kemmis, 1987:7). This is in congruence with the requirement for research as a systematic enquiry that applies acceptable scientific methodology to provide answers to questions or solve problems and create new knowledge that is generally acceptable (Tuckman, 1994:4; De Vos, 1998:19). The answers from research may be abstract and general, as in basic research (where the aim may be exploration, description or explanation). It may also be concrete and specific, as in demonstration or applied research.

4.2.1 Reality, knowledge and change of context

Different views of reality and knowledge influence the researcher's research paradigm because of the inherent philosophical differences in these views. We believe that qualitative and quantitative research ultimately, affect society and that such research initiates change (McTaggart, 1993: 10-11; Collins, Du Plooy, et al., 2000: 22; Winter, 1987:32). We do not agree with the positivist approaches which say that social reality can be discovered (Collins, Du Plooy, et al., 2000: 24). In our view, both the interpretative approaches (believing that social reality is inherently meaningful, and people creating meaning by participating in and interacting within a specific situation) (Collins, Du Plooy, et al., 2000: 26) and the critical approaches have value. Critical approaches argue that social reality is multi-layered and that the dominant discourse of the most powerful constitutes reality. We argue that as researchers we each perceive reality as our own reality and we make our own meaning. However, we are captive *within* this reality. In the postmodern view we are part of a diverse and fragmented social reality. In this view, there is no universal truth - or objectivity. Discourses and actions are culturally constructed and embedded within particular social and historical contexts. The discourse includes discourses *on* any particular subject as well as the discourses *of* that subject. The boundaries between disciplines reflect both conflict and consensus, and the boundaries are shaped, over time, by these processes and by social reality (Goldenberg 1987: 4 in Collins, Du Plooy, et al., 2000: 39). We argue that we, as researchers, are able to expose the abstract framework and reveal the hidden dynamics of that reality. We can do this using logic, reasoning, and critical reflection.

Within the context of a team, the researcher is able actively to engage and critically debate issues with other members of the course team. Objectivity is not a goal because team members have the freedom - indeed the moral obligation - to challenge any inequalities and domination. A democratic, successful team emancipates human beings (Winter, 1989: 6.) There is a duality between the discourse on the subject and of the subject. Discourse and actions are both *constructed* and imbedded in the current social and historical context. The boundaries between these areas were an underlying issue in this study. They caused us great difficulty in our attempts to describe all the disciplines separately - as is expected in writing a traditional thesis (supported by Winter, 1987b:10).

In this study, as the researcher has shown, views of knowledge construct reality. This is in contrast with the current view of qualitative researchers where understanding is "discovered". As far as Stake is concerned (1995: 100) similar experiences are not registered; however, the interpretation of human knowledge is constructed from experiences (Guba & Lincoln 1982; Stake 1978; Phillips 1990; Schwandt 1994; in mathematics by Steffe & Kieren 1994).

Action research values scepticism in the sense that in pursuing knowledge it strives vigorously to destabilize present views, using evidence to do this. If science is systematic and sceptical then action research is "scientific". It can provide "realistic" explanations. If necessary, more traditional methods can then be used to develop causal explanations and to check how well any case can be particularized. With further qualification (called "petit generalization) and when a number of cases are the same, "grand generalizations" may be made. Much explanation and generalisation can be transferred to educational developments. We believe, however, that each case is context-bound and therefore always different. Action research is a science because it shares with other approaches the pursuit of understanding (Stake, 1995:36).

A combined research design takes the context into account and combines the descriptive-exploratory case with a quantitative content analysis of existing sources of data from the course material (according to Mouton and Marais, 1990: 22). Such a combined research design focuses on generalisable findings which are explanatory and descriptive. This contextualised research design may be defined by a text analysis, a historical description and a case study - by using interpretative, descriptive and exploratory research goals. Some researchers are of the opinion that qualitative and quantitative data ought not to be used in conjunction because they depend upon different philosophical assumptions. De Vos (1998: 359-62) clearly indicates how applied professional researchers have debated the combination of quantitative and qualitative approaches, and states that the phenomena which are investigated in the social sciences are so enmeshed that a single approach can most certainly not succeed in encompassing human beings in their full complexity. In this respect, curriculum and course design are similar to the social sciences. (Refer also to Mouton and Marais, 1990: 169-170.) By adopting the point of view of convergence with complementary issues, we as educators may be in a position to understand more about human nature, learning, and social reality:

By solving complex problems in totally new situations, collaboratively as a team, with everyone in the team being a "personal scientist" contributing in different ways but on an equal footing with everyone else. There is no hierarchy, but instead open and "symmetrical communication" (refer to Zuber-Skerritt, 2001:16; This approach is supported by Posavac and Carey, 1989: 242).

Professional researchers should enable participation and intervention, empower the research team and other participants to understand and solve their own situation and problems. Researchers should become aware of their own potential and regain their own sense of dignity, and take collective action for their self-development (De Vos et al., 1998; Grinnell et al., 1993: 67; Engelbrecht et al. 2001:2; Beylefeld 1998:168).

Carr and Kemmis (1983) and Mashile (2001:1) argued that AR and AL can be used in DE course development and can produce transformative practice. This contrasts with positivist or interpretivist research methods. They argue that action research can problematize the socio-historic context of research and can sustain a dialectic between theory and practice in ways that other methods cannot. Action research is well suited to distance education situations where the researcher and the course development team wish to bring about action. Stenhouse (in 1979) brought action research to the field of education in Britain and did much to popularise the idea of the teacher as a researcher, the classroom as a laboratory, and teachers as part of a "scientific community" (Stenhouse, 1979). Schön (1983) started to use this research methodology in professional development. Similarly, Carr and Kemmis (1983) explored the theory behind reflective practice, and the epistemology of using action research in education.

The approach to participatory enquiry may be co-operative enquiry, participatory action research, action enquiry, appreciative enquiry, "emerging varieties" of action research, applied anthropology, critical ethnography, research partnerships - and other approaches (Reason, 1994: 324-39). Co-operative enquiry draws on a fourfold epistemology of knowledge: experimental knowing; presentational knowing; prepositional knowing; and practical knowing (Whitehead, 1997: 22).

Another aspect of this reality construction is that the new perceptions mix with old; they might mix with knowledge gathered by internal deliberation. If qualitative research wants to strive towards scientific acceptance, it has to build universal understanding - the unique understanding of individuals combining into a collective construction - clarifying descriptions and complex interpretations - a well-tuned reality which will bear up to scientific scrutiny and challenges.

4.2.2 Guidelines underpinning action research

The guidelines that underpin the researcher's theory and practice (supported by McTaggart, 1991: 136; McNiff, 1992: 56) of action research are as follows:

- Develop skills of awareness so that we can be reflective in the midst of action, and, through this, can work to improve our own practice.
- Pay continual attention to our intent so that we can seek congruity between our actions and espoused values, or enjoy the excitement of the incongruities.

- Hold as important truth, freedom, equality, love, justice, beauty and wisdom in our work as practitioners.
- Appreciate that we live in complex, interacting worlds, and can seldom separate out issues from such contexts without damaging our understandings and abilities to act wisely.
- Recognise that we understand the world intuitively, practically, emotionally and spiritually as well as intellectually. This means not letting any one of these ways of understanding dominate the others, but creating ways of knowing appropriate to the circumstances, and finding ways to communicate such knowledge to others.
- Realise that we cannot be perfect, that we are living contradictions, often struggling to reconcile beliefs and action, personal needs and those of the wider community, and our desire for happiness with an appreciation of our shadow selves.
- Understand that we are often in organisational environments which are inhospitable to the above fundamental values.
- Understand that in a fast changing world an organisation and its staff have to address change in a focussed manner in order to keep pace with global and local innovations.

For these reasons we chose action research as a methodology for the course design team to use in its scrutiny of distance education study materials.

4.2.3 Applications of action research

The use of directed action learning and action research leads to increasingly real-life, relevant, and focussed investigations, and to an understanding of practice and change. It has a further advantage that this strategy develops managerial competencies and workgroup-specific competencies of the people involved in such projects. When these personal support capabilities develop, it is a sign of the development of a learning organisation (Zuber-Skerritt, 2000:42). In her teacher-user guide to action research as praxis and self-development, McNiff (1993) reviews a number of case studies of school-based action research. She bases the use of case studies on the premise that the nature of knowledge and how it can be generated from educational enquiry has an influence on action research. McNiff, Lomax and Whitehead (1996) also provide clear, basic, practical guidelines and suggestions for an action research project.

An interesting aspect of action research is that it allows instructional designers to plan because instructional design theories and learning theories are subject to subjective and value-based interpretation when selected and used. However, when theory is formulated it should be objective and value free (supported also by Reigeluth, 1983: 452).

An important aspect of action research methodology for instructional designers is that instead of focussing on one theory, they should "de-emphasise the unique or idiosyncratic characteristics of each theory and, instead, focus on ways by which practitioners can derive practically useful ideas

from various (ever 'competing') theories" (Goldfried, 1980: 22). Instructional designers should be provided with "an outline of the various agreed-upon intervention principles, a specification of varying techniques for implementing each principle and an indication of the relative effectiveness of each of these techniques together with their interaction with varying situations presenting problems and individual differences" (Goldfried, 1980: 23).

Action research requires that the participants seek to understand social reality, as well as their own role in creating it, in order to change. This change element is the key difference between action research and interpretative research. The participants in the system need to learn new ways of behaving and interacting, and of analysing their system to bring about change. Action research tends to transform the individual and collective practices within the group, the individual and shared understanding, and the situations in which these individuals interact. Argyris (1991, in Nightingale and O'Neil, 1994: 115) says that participants in the action research process are allowed to reflect on their own theories-in-use; individuals may shape and are shaped by the theories that are in use in the process and in the organisation. Whitehead's "dialectical logic" (1998:4) proposed an action research based on the interrelationships between dialogue and change as a strategy for metamorphosis. The new perceptions which the team gained brought about changes in understanding, relationships, processes, and practice (Whitehead, 1987a:29).

4.2.4 Action and "moments"

Action research means to act following deliberate planning for strategic action while rigorously observing the effects or consequences during the various "spirals" in a process (Figure 4.2). Each cycle includes the components of planning, acting, observing, and reflecting (Figure 4.1 based on Lewin, 1946: 55).

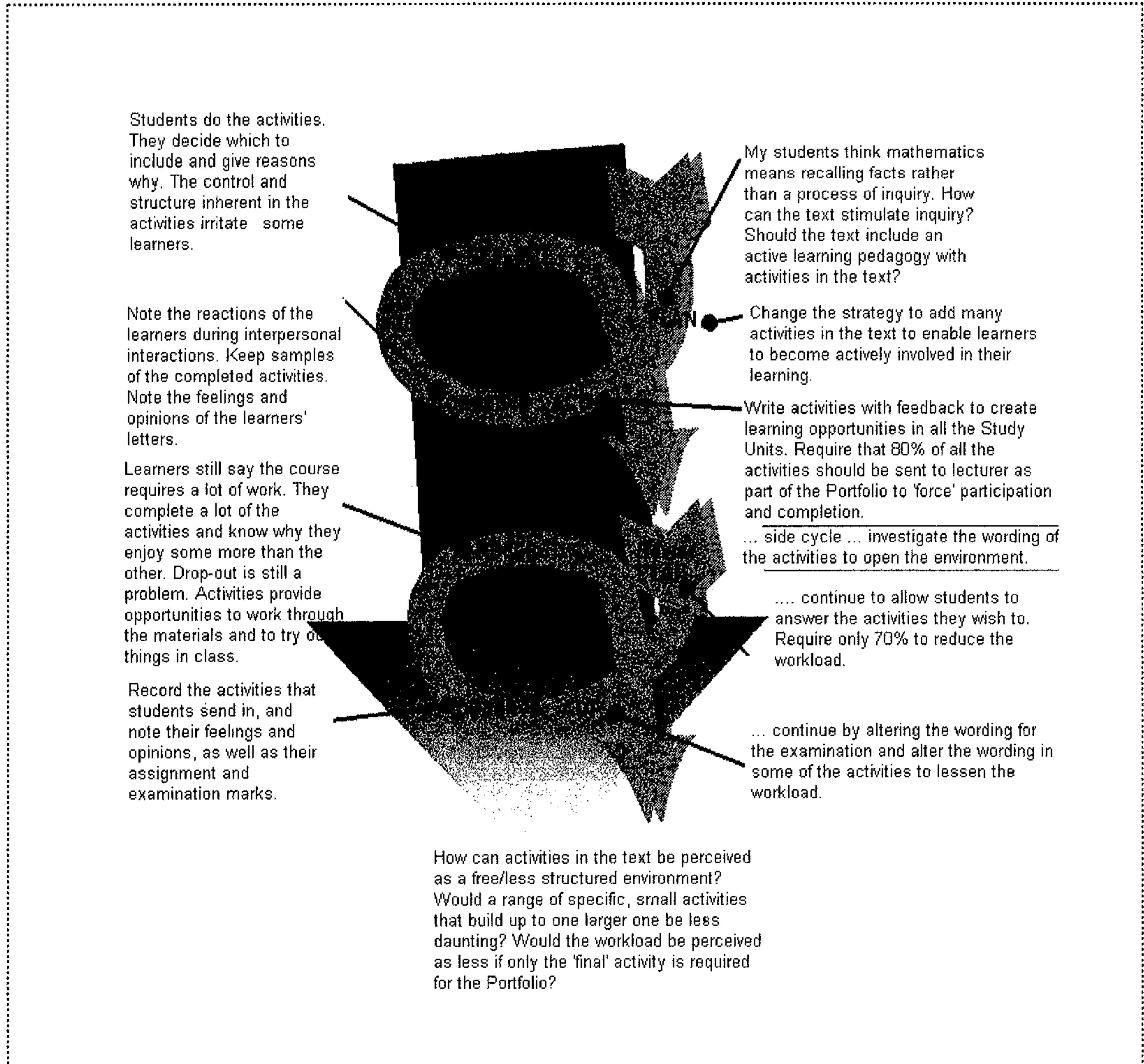
4.2.5 Action research steps

Any research needs to be systematic and a number of agreed upon steps have been identified for both quantitative and qualitative processes. The qualitative research process is no less scientific than quantitative research. It therefore also includes steps the researcher should follow. These steps differ substantially from quantitative research where the focus is on knowledge production (see De Vos, 1998: 39, Mouton & Marais, 1990; Mouton, 1996; Rubin & Babbie, 1993; Rothery, 1993, also Tuckman, 1994: 15).

Each spiral includes planning, acting, observing, and critically reflecting as individual or as a team on the phases, outcomes, and the process of the research (as stated by Carr and Kemmis, 1987:7; this is backed up by quality research requirements set out by De Vos, 1998:43, Mouton & Marais,

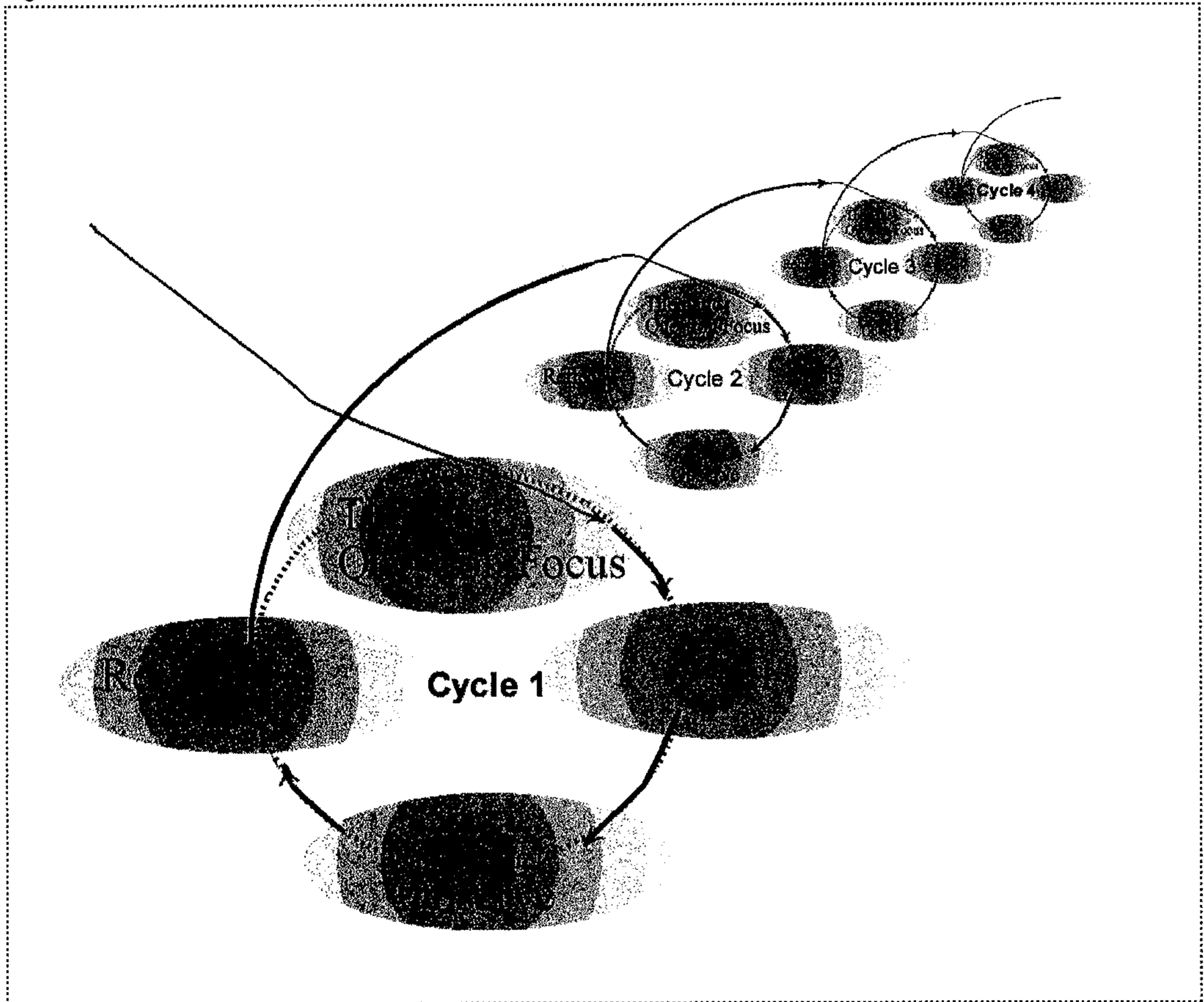
1990, Rubin & Babbie, 1993, Taylor 1993, Cresswell 1994, also Tuckman, 1994:15, Bailey 1992:28, Cohen 1989:47, Sarantakos 1998:38-39, in Collins, Du Plooy, et al., 2000:31).

Figure 4.1: Particular questions or "moments" during the action research process (according to Lewin's AR Spirals in Kemmis & McTaggart, 1988:13)



Action research means to act following deliberate planning for strategic action while rigorously observing the effects or consequences during the various “spirals” in a process (Figure 4.2). Each cycle includes the components of planning, acting, observing, and reflecting (Figure 4.1 based on Lewin, 1946: 55).

Figure 4.2: Action research cycles indicating the four cycles of this project



STEP 1: PLAN

1. Choose a researchable area or theme and formulate it as a researchable question. From here choose a potential research problem, theme or focus questions. Review the literature and relevant research in the area.
2. Formulate a number of problems for potential study and narrow down the relevant research.
3. Formulate a specific problem.

STEP 2: ACT

- Conceptualise and operationalize the problem.
- Define the central concepts in theory and in practice.
- State a hypothesis or focus questions for the problem: these should investigate the relationship between the concepts identified in the problem.
- Select a research design.
- Select the data collection method(s) and measuring instrument(s).

STEP 3: MONITOR

- Collect the data.
- Conduct a pilot study
- Draw the sample(s) where applicable.
- Collect the data (by conducting the research according to the chosen design).

STEP 4: REFLECT

- Analyse, interpret and critically reflect on the data.
- Process, analyse and interpret the data in a qualitative fashion.
- Critically reflect on the outcomes and implications.
- Write the research report.

In the MMAT case the inquiry followed the cycles as described above. However, specific questions with constant adaptations for this research can be demonstrated by looking at a specific question or "moments". (See figure 4.2).

4.2.6 Varieties of action research

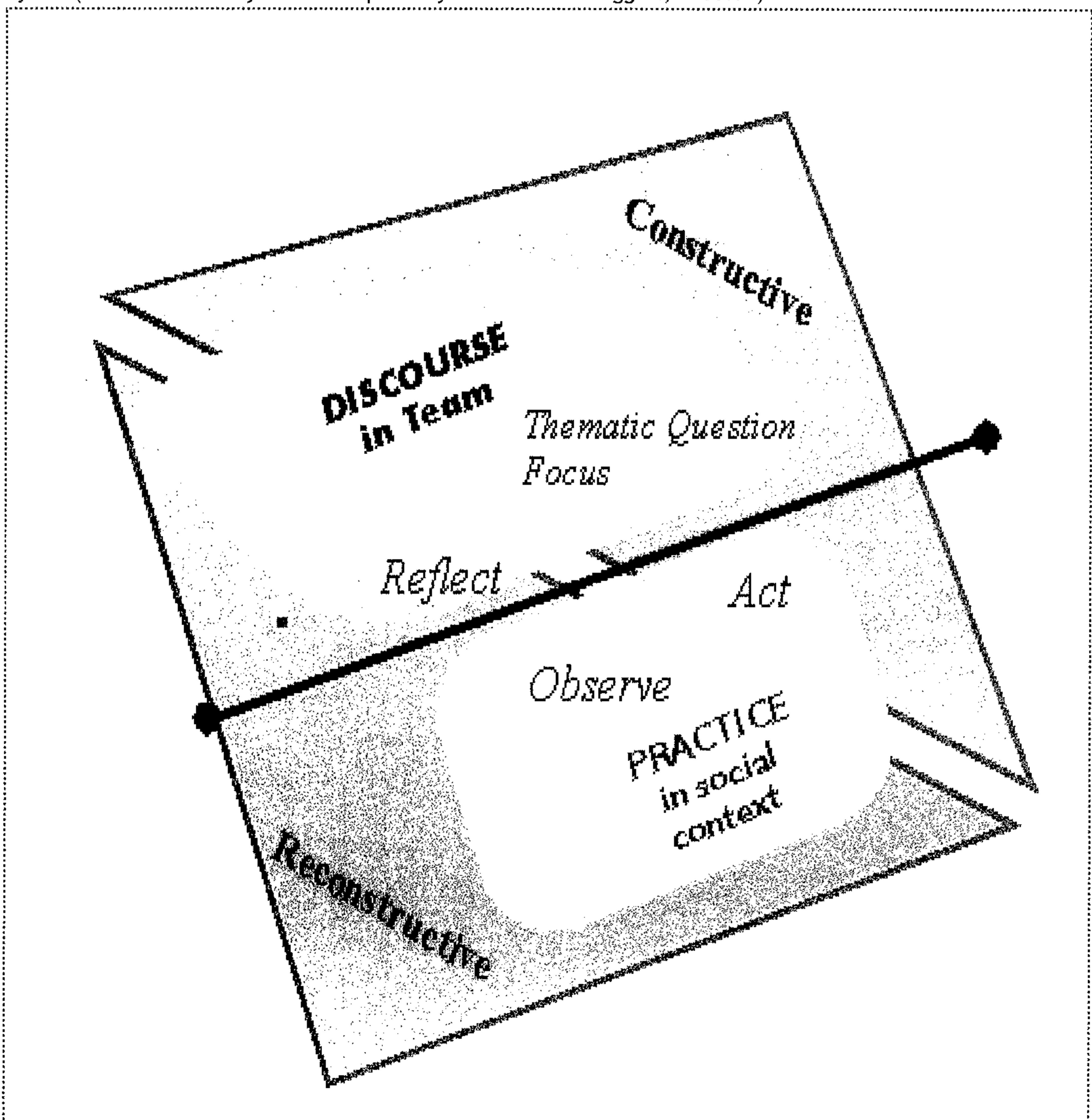
There is many varieties of action research within the action research paradigm. McTaggart (1993:25-31) summarizes the three different kinds of action research: technical, practical, and emancipatory. These kinds of action research often blend to some degree. Our research into course development is emancipatory.

Table 4.1: The "moments" of action research

	<i>Reconstructive</i>	<i>Constructive</i>
Discourse Among participants	4. Reflect retrospectively on observation (reconnaissance and evaluation)	1. Plan prospective to action (constructed action)
Practice In the social context	3. Observe prospective for reflection (documentation)	2. A retrospective guidance from planning (deliberate and controlled strategic

An extension of the components into defining "moments" of action research as it moves into a critical form (as described by Kemmis and McTaggart (1988: 10) is a useful improvement to understand the practice of action research better. Within this dynamic process characteristic of action research, the four aspects in the cycle are not complete, static steps, but are moments in the spiral of planning, acting, observing and reflecting. The aim is to bring together, through mutual attraction, *discourse* and *practice* (in the one dimension) and *construction* and *reconstruction* (in the other dimension).

Figure 4.3: The mutual discourse in the team and practice in the social context while constructing and reconstructing reality: discourse-practice and construction-reconstruction "moments" in the action research cycles (from the table by and description by Kemmis & McTaggart, 1988:32)



From this table the researcher constructed a cognitive impression of this discourse. This relationship between discourse and practice is described as follows:

The improvement in understanding will appear at first as a better developed rationale for the practice. The rationale is developed by being tested in practice; each proposition in the rationale can be checked against practice and against other parts of the rationale. In the long term, these propositions will develop into a perspective on the practice and on education itself, becoming a critical theory which includes consideration of such matters as how students learn and how the message systems of the school (curriculum, school, organisation, teaching and learning activities, and assessment practices) create meanings for students (McTaggart, 1993:32).

Carr and Kemmis (1986:7) view any type of participatory research as acceptable; our view is shared by Zuber-Skerrit (2000:138) that both practical and emancipatory action research is acceptable action research.

When a lecturer or learning designer wishes to change the learning design in a course he or she has to be aware of the changes that this will bring, not only for the learners, but also in the organisation. Any educational institution exists to educate individuals and to preserve, improve, or transform society. We argue that organisations do this in tandem with change agents, class, gender or cultural groups (as argued by Willis, 1977, Apple, 1979, Giroux, 1981 and Connell et al., 1982, related in Kemmis & McTaggart, 1988:31).

4.3 Dialogue, activities and structures in AR

Through AR and AR projects (ARP), team members and researchers can contest their roles through continuous critical analysis. In this "embrace", action and dialogue (especially a language focussing on action) allow educators to understand their roles and the dilemmas better. This includes issues in their situation, build social relationships, and effect change. During the fluid, ongoing process of formation and reformation, the "moments" of learning can be observed and noted (according to Kemmis & McTaggart, 1988:39).

The researcher collaborated, was linked and dialectically related to the course team. Institutionalisation and acceptance happens when stability, routine practices, and accepted patterns allow for newly established institutional discourses, and new practices and structures in the learning organisation (Somekh & Thaler, 1997: 15). We argue that AL and AR in Unisa project teams has the potential to establish routine practices and patterns to empower individuals, to foster change, to improve practice, to enhance understanding and to affect change in a particular context, and in the system as a whole. The researcher's experiences in this case, as well as the experiences of others (Wilson et al. 2002:1, Wilson et al. 2000:online) are in stark contrast to

Beylefeld's research (1998:171) which suggests that their reflections were received with scepticism - in some cases even with some resentment and ridicule.

Table 4.2: Types of action research and their main characteristics (after Carr and Kemmis 1986 in Zuber-Skerrit, 2000:95)

Types of action between research	Aims	Role of the facilitator	Relationship between facilitator and participants
1. Technical	Effectiveness/ efficiency of educational practice Professional development	Outside "expert"	Co-option of practitioners who depend on facilitator
2. Practical	Effectiveness/efficiency of educational practice Professional development Practitioner understanding transformation of their consciousness	Questioning role (Socratic), encouraging, participation and self-reflection	Cooperation (process-consultancy)
3. Emancipatory	Effectiveness/ efficiency of educational practice Professional development Emancipation from the dictates of tradition, self-deception, coercion Critique of bureaucratic systematisation Transformation of the organisation and of the educational system	Process moderator where the responsibility is shared equally by participants	Collaboration and participation

Researchers such as Hursh in Noffke & Stevenson (1980: 143) state the necessity to provide a historical overview of the development of course materials, of the daily situations lecturers face, and to sketch and understand the organisational structures. Our research is institutionally-based and analysed the role of participatory action research (PAR) in turning a Unisa team into a learning structure.

Organisational "structures" include the politics, ethics, philosophies, practices, restraints, and changes participants struggled with. It followed that in this longitudinal research into the development of distance education study materials at Unisa (a three-year course described also by Beylefeld (1998:167-168)) aspects of organisational structure were important in the course design process and were described in the action research report, particularly in the case study

description. The new languages, roles and actions in a number of teams - as described from as early as 1994 - became "best practice" at Unisa. The interrelationships are illustrated in Figure 2.5 which indicates the effect the process may have on change.

4.4 Characteristics of participatory AR

Action research has certain characteristics (supported by De Vos, 1998: 245; Hart and Bond, 1995; Kemmis and McTaggart, 1988; Oja & Smulyan, 1989: 54-96).

4.4.1 Praxis

The test for educational advisors is whether the research improves the professional quality of the transactions between practitioners and clients/colleagues. Therefore, action research close the gap between theory and practice, and fosters learning during teaching through critical reflection. After many years as an action research practitioner, McNiff (1993) critiqued certain models of action research (such as those of Kemmis, Elliott and Ebbutt) as not promoting sufficient self-reflexivity. Her approach is contrary to positivistic research methodologies (Winter, 1987: 11).

The theoretical underpinning of action research and its analytic capacities promoted reflexive action which treats "action" and "practice" dialectically with "research" and "theory", while at the same time being sensitive to context. As a research paradigm it allows practitioners to develop knowledge and understanding as part of practice through reflective enquiry. AR also allows research to be done in situations where other research methods may be difficult to use. During the research design of course development the focus on praxis is useful. Action researchers such as McNiff (1973) review a number of case studies of school-based action research which focus on praxis. She critiques the use of the "normative-analytic" approach, an approach which tests the processing of information but does not engage with the quality of education. She bases her critique on her view of a socially constructed knowledge and how it can be generated from educational enquiry.

4.4.2 Participants collaborate in a process

In action research an assumption is that the qualitative researcher cannot directly capture lived experience, but that the researcher is the link between the field text (as interpreted experience in text) and the community (researched subjects) who should become a "voice" as part of the research. However, the distinctions that Gold makes (1958 in De Vos, 60-61) allow the researchers to have primary roles as full participants. This research and development team was part of the institutional setting and became part of, and completely involved in, the central activities of the project. The team members were never outsiders, observers-as-participants, or participants-as-observers. The researchers were not objective, but were subjectively involved in the research

process - and they were part of the research by their own choice. The development team had to engage as individuals, as members of a social group, and as co-researchers in the change process (Nightingale and O'Neil, 1994: 103; Bless, and Higson-Smith, 1995:56). This does have the disadvantage as it is difficult not to be vulnerable to "experimenter" and "subject" effects.

4.4.3 Actions are needs-driven

The team's actions were based on a request for assistance from "clients". In our team the "client" was, firstly, the lecturer (as subject specialist) who had to design a course, and, secondly, the learners for whom a quality course had to be designed. Both the educational advisor and the lecturer had to be aware of the danger of patronizing their respective "clients" as they could state perceived problems and provide quick solutions to problems. The core team focussed on gaining information in order to become more aware. This has the advantage that team members could collaboratively formulate problems and respond to problems perceived in this particular environment and practice (Zuber-Skerritt, 1996: 24-25).

4.4.4 Collaborative action focusses on long-term solutions

The researchers and the participants in the project are equal partners who, together, plan and implement a project to investigate a problem and its underlying causes in order to take collective action with the aim to bring about long-term solutions (Winter, 1998: 46; Bless, and Higson-Smith, 1995:56; McNiff & Whitehead, 2000: 45).

4.4.5 Integrated approach

There is little separation between research from practice, or knowing from doing (Nightingale and O'Neil, 1994: 114-115; Gabel, 1995: 4; Schon, 1983). Action research is designed to allow simultaneous change and understanding through planned action which is purposefully researched. A systematic understanding arises from activities which are oriented towards change. Action research has a capacity to allow a response to the demands of the informants and the situation - a capacity which most other paradigms do not have (Zuber-Skerritt, 1996: 16).

4.4.6 It is not reductionist

Action research does not necessarily seek explanations at a more specific level than the phenomena it is dealing with. It tends not to be "reductionist" (Nightingale and O'Neil, 1994: 103).

4.4.7 Focus on understanding learning

Practitioners learn to focus on what promotes and inhibits learning and on how they can become agents of learning (Elliott, 1981: 18). Schon (1983) calls this the reflection-in-action model. In our own research the researchers and co-researchers regularly and systematically critiqued what they were doing in their own practice, in order to generate possible solutions from a body of knowledge. They refined the questions they were asking (the stated problem) and the methods they were using

to answer these questions. Their understanding of their practices and subsequent action plans developed accordingly (supported by Bless, and Higson-Smith, 1995: 61). This understanding is possible because of the cyclic processes imbedded in the action research methodology where planning, action, reflection and evaluation is an interlinked process.

4.4.8 Cyclic process

Action research is a spiral of steps that proceeds from planning, to action, to observation, and onto reflection. Lewin originally formulated action research for social problems, but educationalists have borrowed much from it and have suggested guidelines to implement action research in education (Kemmis and McTaggart, 1982; Carr & Kemmis, 1983: 55). They suggested a self-reflective spiral of planning, acting, observing, reflecting, and re-planning with suggested questions and problem solving scenarios. Action research therefore uses a research process which is modified “on the run” and in response to what happens. It is not standardised. All theorists of action-research offer models based on spirals or cycles in which thinking, doing and watching are interwoven and repeated throughout the research activity (McNiff, 1995: 153).

4.4.9 An ordered process

Action research commonly proceeds in an ordered fashion. The team as developers and researchers plan each step and carry it out. They meet, recollect and critique their experience. In the light of this they decide what to do for the next step: what information do they need, or what outcome should they pursue, and what method should they use. Thus, action research alternates between doing and critical reflection (Kemmis & McTaggart, 1982: 3; McNiff, 1995; 152).

4.4.10 Create knowledge for practice

Michael Scriven (1997:19-21) argues that educational research has a “duty” to society to create knowledge that can be put to practical use. If his parallel to medical research is correct, then educational research should aim to go beyond a sense of duty in its description and understanding of practices focussing on improving those practices.

During this action research project the development team focussed on the development of the course materials through which the learners had to develop into reflective mathematics teachers, and through which they were enabled to change their own practice. The development team had, therefore, constantly to intervene in the development process, and remain flexible. The team could do by following the action research process. The members created focussed questions, added components to the context, changed aspects during the long-term course development process, added their newly acquired knowledge to bring about change, and evaluated the outcomes of such

amendments. The development cycles typical of action research were apt as a research methodology because they created knowledge for use in their practice (Eames, 1995: 3; Eames, 1988: 213; Winter, 1998: 46; Bless, and Higson-Smith, 1995:56).

4.4.11 Focus questions

There is an assumption that research is necessarily the testing of a hypothesis. In action research the research *questions* are the most important. The researchable situation is often too ambiguous to frame precise questions, but these questions should be focussed around a problem of development, such as developing a dialogue with learners so as to allow the learners to get involved in other dialogues of their own choice. In new distance education course texts these are often very context-specific and future-oriented (Kemmis & McTaggart, 1982: 3).

There is an assumption that research is necessarily the testing of a hypothesis. In action research the research questions are the most important. The researchable situation is often too ambiguous to frame precise questions, but these questions should be focussed around a problem for development, as a thematic concern, questions that guide actions, the outcomes from reflections within repeated cyclical enquiry. Such critical "moments" are much easier to describe and write about.

Research demonstrated that research workers need interview or observe only a sample of the people or the phenomena involved in order to gain a usable idea of the characteristics of all the subjects (De Vos, 1998:42). In distance education course design a control group is often considered unethical and in this study no control groups were included.

4.4.12 Difficult to make generalisations

Researchers often state that action research only provides answers which are specific to the particular situation and which therefore cannot be generalised to other situations, especially if such generalisations have to have a global relevance. This lack of generalisability often becomes the basis for criticism against the scientific nature of the methodology. Although this is partly valid, the issue is more complex than it seems. It can also be argued that the global generalisations which experimental science provides are difficult to relate to, and that they are arrived at to the detriment of *local* social contexts because they disregard such situations (Kemmis & McTaggart, 1982: 3).

4.4.13 Context-specific

Action research pursues local relevance, if necessary, at the expense of global relevance. One can make claims only about the people and systems actually studied but it may not be true to assume that other people or other systems are the same. It may even be hazardous to assume that what is true of a particular case today will be true next year. This argument is often held to be one of the

major disadvantages of action research. However, if several studies yield similar results over a period of time, in diverse environments, and with different people, then action research results may generalise such cases (Carr & Kemmis, 1983; Alrichter, et al. 1991; Eames, 1988).

4.4.14 Action, not causal relationships, to justify conclusions

Action research contrasts with research where explanations are given in terms of causal relationships between variables. Understanding may be causal where people come to recognise that event A precedes and probably causes event B. As action research is intended to lead to action, the central emphasis is on the action and not the causal events between variables. Action research may then in contrast describe the causal connections between certain actions and outcomes. Such connections are then tested when the planned actions are carried out, and they are critically observed (Carr & Kemmis, 1986). Action research can justify its conclusions. As some systems-approaches state, in certain situations causal explanations are either not possible, or too cumbersome to be very useful. When a situation includes many variables and where these variables often interact bidirectionally and in complex ways, causal explanations are themselves likely to be very complex. Almost everything has an effect on almost everything else. It is often of little practical use to know that variable A influences variable B. However, it is usually helpful for the researchers to know what outcome can be achieved by doing a particular action (Carr & Kemmis, 1986).

4.4.15 Describes the social environment as influences

Following from the fact that action research includes an investigation into the social environment of a situation, causes influencing the research, such as socio-economic, political, and cultural factors, are often described and may become part of the questions for investigation (Carr & Kemmis, 1986; Eames, 1988: 214; Lomax, 1994: 2).

4.4.16 Experiences interpreted by the reader

Another characteristic of action research is that data are often not interpreted or analysed, but are gathered and presented in such a way that the subjects' experiences speak for themselves (also refer to Strauss and Corbin, in De Vos, 1990: 21). There is a dynamic process between researcher and participants, empowerment of all the participants, and a dynamic process between research and the resultant action. All the participants in the process (including researchers, lecturers, and students) negotiate meaning from the data and contribute to the selection of strategies for intervention. There tends to be a lot of communication between participants and the research tends to be validated because of unconstrained dialogue between the participants (Elliot in Kemmis & McTaggart, 1990: 122, cited by Gabel, 1995: 4). The lack of focus often prevents the singular findings from being generalised to other situations.

4.4.17 Multiple data collection for reliability of observation

Following De Vos's (1998: 359) suggestions research may follow a combined approach, identified by De Vos, (1998: 245) as the fifth movement in developments in qualitative research. The data collection includes the use of both quantitative and qualitative data, as well as summative assessment results, course materials, and reflections on audio tape, video tape, via letters, and notes.

4.4.18 Sampling directed by the purpose

In qualitative research purposeful sampling is commonly used. This sampling technique is directed by the need to develop additional theories in social sciences (Gilbert 1993: 74). During the description of the cycles of development of this particular case, the non-probability sampling used, was a combination of convenience, purposive or judgmental sampling, and quota sampling. The choices depended on the need. The researchers never knew in advance how many of the subjects were available. A disadvantage of this type of sampling is that serious bias can occur. Another disadvantage is that generalisation is extremely risky.

These sampling techniques had the advantages in action research that the whole population was described in the case. The techniques saved time and money. The lecturer and the instructional designer were the same during the whole course design cycle and this made it easier to reflect on developments and influences. During the description of the cycles of development of this particular case the non-probability sampling used, was a combination of convenience, purposive or judgmental sampling, and quota sampling. The choice of method depended on requirements and they never knew in advance how many of the subjects were needed (Giddens, 1993: 74).

4.4.19 Final report uses rich, uncontaminated texts

The last characteristic is that the final report of an action research project uses the words of the researcher supplemented by uncontaminated texts from the participants in the research. This indicates the differences in, for example, power and knowledge, between the researchers and subjects. All the aspects of theories used, the ways in which ideas were derived practically, an outline of the intervention principles, and an indication of the relative effectiveness of techniques - as well as their interaction with the problems and individual differences - should be documented clearly in the final report (Goldfried, 1980: 22).

Educational research descriptions should be as rich as possible in showing the research's progress (using both quantitative and qualitative approaches). It is therefore important to collect evidence (from logs, personal field notes, video observations, questionnaire data, valuations, performance measures, etc.) and collate these in a case study description.

A description of the organisational milieu is absent from the majority of the course production literature in distance education because researchers adopt a rational systems approach to curriculum design and course development. For example, the framework and emphasis for developing courses proposed by Rowntree (1982) follows such an approach. The questions Rowntree suggests a course team should address deal with objectives and in-text devices; such questions may include what to expect learners to learn from the course, and how the learners would be able to make sense of the course material - especially if it cannot be made sense of by intelligent people with a broad general knowledge who critically read the course material. From these questions it seems that Rowntree does not require these course evaluation questions to be contextualised. This decontextualisation may lead to an uninformed or misunderstood context where the realities concerning the practice prevailing at the time of course development would be unspecified. This "normative-analytic" approach is criticised by McNiff (1979: 25) as focussing on testing the processing of information, but not engaging critically enough to establish the quality of education.

Action research proposes that reality (lived experiences) cannot be created in any social texts written by the researcher. During action research the variables in the research are not controlled, but described in the report. Eisner (1997:4) suggests that writers have to take care to present data in alternative forms as data presentation can cause problems for some more traditional readers.

4.5 Methodologies for data collection

A number of techniques have been used to collect data: case study descriptions, interviews, critical analyses and reports, and analysis of stakeholder letters, or of assessment results.

4.5.1 The case study methodology

In studying cases we Stake (1995: xi) advises researchers to "look for the detail of interaction with its contexts" and study of the particularity and complexity of a single case, coming to understand the particular case's activity within circumstances. It should be a disciplined, qualitative mode of enquiry in this case a single case, MMAT case.

Researchers have different views on the roles of researchers. According to Stake (1995: xx) researchers only observe: they never get involved or alter things in the case. However, Reason (2001: 20) and Whitehead (1997: 4) see action researchers as "actors" that "direct and act" in a case study. They are studied and - in turn - provide critical observations and interpretations. They also assist in triangulating observations and interpretations. For "member checking" the "actors" could be requested to examine rough drafts of writing - the material may or may not appear in the final draft. Some people often do not provide a response; others read thoroughly and provide a thorough response. These reports have improved member checking.

The following issues are important in a case study, according to Stake (1995: xx): a commitment to interpretation, organisation around issues, the use of stories, care concerning the risks of violation of privacy, care about the need for validation, and aiming toward naturalistic generalisation. The process of critically analysing and reporting the collected data for the case study description - on a *regular* basis during the project - is important for action learning and research.

Stake's (1995: 52-53) suggested guidelines for doing field-observation case studies involve seven stages: anticipation, the first consultation, further preparation for observation, further development of conceptualisation, gathering and validating data, analysing data, and providing the audience an opportunity for understanding what has gone before. We included these guidelines in the four main steps of our own investigation.

Key questions should be formulated for a case study in order to illuminate the organisational context in which the course was planned, designed, developed and produced. The question for our action research project was a very pragmatic one: does the inclusion of an activities-in-text instructional design strategy for learning texts improve the quality of the dialogue between the educators and learners in a distance education environment?

A case study description is part of the action research project and provides the basis for explaining the "organisational milieu". This approach is recommended for course development descriptions. The action research study for the course Mathematics Subject Didactics included a case study description which portrays the context of the course.

The basic assumption for the case study was that course development does not occur in a neutral, consensus "vacuum", devoid of actors. On the contrary, it occurs in a complex organisational setting with its culture and a history, both of which have a crucial influence on the course development and production process (Altrichter et al., 1991: 23).

We were influenced by the project of Altrichter et al. (1991) who used a case study of a course production in distance education in order to describe and understand the process of developing and producing a new course in a specific context. Altricher et al. focus on informing policy and practice in distance education, but they also look at the theory behind this. Our research perspective was also influenced by Meek (1983: 3) and Giddens (1976: 161) where the focus on the "duality of structure", which seeks to explain how, within the case study description, structures are constituted through action and, reciprocally, how action is constituted structurally. It is imperative to maintain the historical perspective in order to inform the analysis of the complex interplay between human action and the social structure in which this takes place. No situation where there is an interplay of people, is static or fixed at any time, so explaining the particular historical circumstances provides structure and describes the forces responsible for conflict and change.

Following Stake (1995:23) this case was an instrumental case study with a research question and a need for general understanding of a particular case. An example is studying a particular instance of how a lecturer would undertake curriculum development, asking questions such as "What learning opportunities are incorporated in this particular distance education text?". During the research researchers should refrain from interesting curiosities and pursue only the critical issues involved in the case. This case study does not study the lecturer but through questioning and repeated action altered the variables in order to described the transformative outcomes (in contrast to Stake's instrumental case). If possible further research may be carried out to learn about a particular student, or evaluate a given programme. This evaluation process takes place without choice because we are interested to learn about that particular case, not to learn about any other cases, or some general problem. Alternatively, as soon as a number of case studies are studied where there is coordinating between the individual cases and where the focus is to learn more about some effect a collective case study may provide more answers.

In the present study, the researcher looked for a case to investigate. Three possibilities came up. However, only the Mathematics Subject Didactics course materialised because of the time-frame, the urgency of the course development, the commitment of the lecturer, and the shared philosophy, a belief in the active learning strategy as a solution to the perceived problems and the value that new knowledge from this case can influence further course design at Unisa.

Case study questions allow this researcher the luxury of a holistic understanding of the realities during the development of a course (the history, culture and politics behind it). Secondly, they give the researcher time to explore things and describe experiences during the process of improving the quality of the course - and improve the "efficiency" of the process. Thirdly, they establish factors that affect changes in practice and the content and pedagogy of course development. This results in a critical, reflective perspective on the course development process, in an approach known as qualitative-eliminative (also see Parlett and Hamilton, 1976; Evans and Nation, 1989a; Carr and Kemmis, 1986). McNiff (1993) in her teacher-user guide to action research as praxis and self-development, reviews a number of case studies of school-based action research. She bases the use of case studies on the premises that the nature of knowledge and how it can be generated from educational enquiry has an influence on action research.

4.5.2 Methodology for enquiry

Action research projects are focussed, planned and deliberate critical investigation by a group of people. They define them with a collaboratively agreed-upon outcome. Action learning programmes are focussed areas of investigation by a group of people for a particular period; they undertake them to improve understanding. A number of projects constitute a programme. It follows naturally

that a participatory action research methodology was appropriate as a method of enquiry, reflection and action for use in a case study.

Action research design is appropriate for researching instructional design in the development of printed distance education materials. Our research allows for descriptions of our experiences during our course design and development project. Another action researcher who explored case studies in the context of higher education in Australia was Zuber-Skerritt (1996a). The focus here was to link learning to learners' need to have "learning skills" (the ability to know the process of learning, or meta-learning skills) in order to produce more effective learners. Nevertheless, the research was about more than just study skill techniques. Zuber-Skerritt argued that to produce reflective educators they should be involved in the process of identifying, analysing and solving their problems *themselves*, rather than simply reading research done by others.

For this, we needed to consider our enquiry skills as part of our co-operative enquiry (suggested by Heron, 1996 in Reason, 2001:20). The team kept the following things in mind when making notes, and during interviews:

- *Being present and open*: This skill is about empathy, resonance and attainment - being open to the meaning we give to, and find in, the situation.
- *Bracketing and reframing*: We need to focus on the classification and constructs we impose on our perceiving, but we need creatively to try out alternative constructs. This means we need to be open to reframing the defining assumptions of any context.
- *Radical practice and congruence*: As a team becoming aware of the relationship between our purposes is important during our action, the frames, norms and theories we bring with us, our bodily practice, and the outside contextual influences. It means also being aware of the interaction between these different facets and constantly adjusting them.
- *Non-attachment and meta-intentionality*: Individuals in the team should not investigate their identity and emotional (in)security while in action. This means that one should be fully focussed and committed to one's identity and emotional security so as to be able to avoid confronting these issues while doing research.
- *Emotional competence*: This skill refers to identifying and managing emotional states in various ways - including keeping current action free from distortion resulting from unresolved distress and behaviour conditioning from one's past.

4.5.3 Methodology of interviewing

Bratton (1981:21) indicates that interviewing is a technique which many experienced instructional designers use. This type of interviewing has a specific focus, uses specific questioning strategies, and often offers analogies and presents tentative conclusions to establish common understanding. This interviewing technique is similar to the interviews conducted by ethnographers. Bratton goes

further to indicate a number of factors to take into account with instructional design systems such as discipline and experience; the ability to retain information, understand and relate to abstract concepts and principles; having an overview of different fields' values; understanding interviewing techniques; being able to work in unfamiliar contexts; being able critically to provide feedback; and seeking opportunities to improve one's skills.

The technique which this researcher used to conduct the interviews with the lecturer followed the suggestions by Bratton (1081:21-22). The researcher deliberately established a participative relationship with the lecturer following through from their working relationship over the years. She elicited information from a lecturer during two interviews, one conducted by the researcher and another by another interviewer for investigator triangulation. She planned a questioning strategy to create a calm and non-threatening environment in order to elicit more information as follows:

- The open ended questions aimed to discover unexpected or not anticipated information. Question 10 asked "What factors in the learning environment influenced learners' action and understanding of study material?" which gave rise to further clarifying questions on the use of activities in the text, a change in doing things, and on the mind-bending process of the new approach.
- The descriptive open ended questions was meant to discover other relevant questions. For example Question 11: How would you describe the ability of your course to promote dialogue between participants?
- Structural questions in order to gather detailed information. Question 18 asked "How did particular course assessment strategies contribute to getting student actively involved in the learning process? Question 19 followed on by asking "How did you as the lecturer manage the particular course assessment strategies?"
- Contrast questions are still more specific as they tend to discover the meaning of discrete facts and concepts and the relationship between them. In the interviews we asked the MMAT lecturer "What course design factors had a positive effect on the learning and understanding of the students (Q14) and what had a negative effect (Q15)?"

From the above relationships and questioning, the researcher captured the interview on video cassette tape, which, with the other data, had to be validated.

4.6 The data collection

Different sets of data had to be collected in order to describe the case.

4.6.1 Sets of data collated in the process

The data was collected according to the two research questions stated, namely:

- Question 1:** Will the development of learning materials with activities-in-texts as an instructional design strategy, produce a significant improvement in the competencies of the learners, in terms of their abilities to become active learners, critically to reflect, and to apply and evaluate various stated skills, knowledge and attitudes?
- Question 2:** Will the process of reflective praxis assist the members of the team to appreciate the complexities of events during distance education course design, critically reflect on changes that take place in their context regarding actions, dialogue and structure, understand the success or failures of their praxis in the design of activities-in-text, formulate criteria for good practice when including activities-in-text to improve action, dialogue and structure in self-study packages, add to the knowledge in the field through critical reflection about the processes during a typical distance education course design (preplanning, design, development, management and evaluation).

The following data was collected:

- Information from the literature (Chapter 1-4).
- The MMAT course study packages, to illustrate the initial development in 1996, the materials used in the pilot in 1997, and the 1998 materials used for the maintenance phase (see Addenda A-C).
- Extracts from students' reflections in letters which were required as part of the completed portfolio, a required assignment. The directions were explained in the tutorial letter (see selected extracts in Addendum D). Selected parts of the letters demonstrated the histories of the students, and their experiences of the course.
- Examples of students' mind-maps drawn of each chapter of the textbook - which was required for the portfolio assignment (see Addendum D).
- Transcripts of the two videotaped interviews with the lecturer (see Addendum E).
- A list of the students which handed in their assignments, wrote the examination - and their marks (see summary of aspects of this in Addendum F).
- Notes made by the core team (referred to in the text).
- Personal diary entries of the instructional designer dealing with matters arising during the course design and development period (extracts from these are presented in the text).
- Letters from the lecturer to the instructional designer (extracts from these are presented in the text).

In qualitative research there is a need for validation of the data by means of discipline, accuracy, and alternative views to minimise misrepresentation and misunderstanding. This is called triangulation. It is difficult because of the view that there is not one best view but that there are multiple perspectives, as is seen from a constructivist epistemology.

4.6.2 Analysis of the data

The data were analysed as follows:

- **Literature regarding the key issues (Chapters 1-4):** The literature was analysed and summarised. Evidence and trends were sought so that these could assist the core team in its planning, inform its actions, suggest key issues to observe, and allow informed decision-making during the process.
- **The MMAT course study packages (Addenda A-C):** Key ID issues were integrated into the course and a critical analysis after three years (undertaken to increase objectivity) along with peer discussions revealed examples of activity types, their relationships to various ID tools and strategies, the CCD and learning strategy, and other textually embedded issues, according to the categories suggested by the key questions.
- **Extracts from students' reflections in letters (selected extracts in Addendum D):** Parts of the dialogue were selected to demonstrate the background and histories of the students and their experiences of the course according to the categories suggested by the key questions.
- **Examples of students' mind-maps (Addendum D):** The mind-map examples illustrates how learners approached doing these. The categories were: the use of colour and graphics to create a mental map; the use of linear versus holistic layout; incomplete versus complete conceptual understanding; written versus printed drawing; and the use of key terms versus the use of full sentences.
- **Transcripts of the two videotaped interviews with the lecturer (Addendum E):** The interview schedule addressed the key questions. The lecturer answered seven questions in Interview 1 (Interviewer A) and 12 in interview 2 (Interviewer B). Some of the questions were repeated and the results were similar - which increased the reliability of the data. The issues under discussion were the aim of the project (Question 1, repeated 6, 9); the environment and DE students (Questions 3, 4, repeated 8, 10, 17); course development (Question 2); active learning and understanding with activities in texts (Question 7, repeated 9, 11, 12, 13, 14, 15, 20); dialogue (Question 11, repeated 16); assessment (Questions 13, 14, 18, 19); and team approach in course design and professional development (Questions 5, 21). The interviews were analysed by clustering.
- **Student's assessment statistics:** The pass-rate, fall-out and drop-out rates were calculated. The enrollment numbers over the years were noted, as well as the distribution of learners over the three courses (with the same course material for certificate, diploma and degree students).
- **Notes made collaboratively by the core team:** During the daily (later weekly) meetings, the team discussed issues, and notes were kept for frequent reference.

- **Instructional designer-as-lecturer diary entries:** Regular freewriting and notes indicated the emotions, the historical development, the problems, the solutions, the highlights and the development of issues in the “voice” of the designer. The issues were reflected upon individually either, or, where necessary, collaboratively.
- **Letters from the lecturer to the instructional designer:** Relevant aspects were identified and treated as the lecturer’s “voice” in the process.

These data sets allowed the lecturer critically to focus on moments in the research from a number of angles.

4.7 Validity of the data

Validation seeks to measure things and logically interpret the meaning of any measurements. The research methodology makes it more likely that misrepresentation and misunderstanding may be present, therefore, triangulation deliberately seeks to validate any observed data. In the process of assuming the meaning of an observation, additional observations provide us with a means to change our initial interpretation.

Triangulation is needed for each descriptive and interpretive statement. Triangulation uses (1) resources and (2) time to triangulate the important data and claims. The importance of data depends on (1) what the intention is for understanding, (2) the degree to which these statements help to clarify the case, or (3) the degree to which statements differentiate between conflicting meanings.

The following situations determine the extent one use triangulation (Stake, 1995:112):

- Undisputable description need not be confirmed;
- Ambiguous and debatable description needs confirmation;
- Data essential to a statement need confirmation;
- Key interpretations need to be confirmed;
- The author’s persuasions, as identified, do not need to be confirmed.

In contrast Flick (1992 in Denzin, 1995:15) considers a search for additional interpretations as a search for deeper meaning, not a confirmation of a single meaning. The reader might already be aware of this information. Nevertheless, we look for information to assure the reader that we see and think straight, or we show what type of slant there is on an issue. This allows readers to triangulate for themselves (Norman Denzin, 1984 in Stake, 1995:112; Duffy 1993:143 in De Vos 1998:359).

4.7.1 Types of triangulation

To triangulate data it includes understanding through means of data sources, consequential, Investigator triangulation, Methodological triangulation

Data source triangulation means that a variety of sampling strategies ensures that the theory is tested repeatedly, and the data, therefore, remains the same at all times in all circumstances. The data source triangulation required the data to be retested in other circumstances. Here is an example: In this study we used lecturer observations during the development of the course, and confirmed our observations with an interview after the development. The manner in which the lecturer drew upon the authority of professional experience during the development period might be the same as the willingness to participate and be motivated in academic development seminars. This, in turn, might be the same as sharing these experiences with other colleagues in the same subject field.

For the MMAT case, data sources were provided to the researcher by her experiences as a participant in the team, by a historical reflection by the lecturer during the interviews, by the researcher and lecturer notes, as well as by the study materials covering the period 1995 - 2002. The researcher-as-member of the course team observed the lecturer. Both she and an impartial interviewer held two interviews with the lecturer to confirm the data. The questions the learners were required to answer in their portfolio letters were closely linked to the questions asked for this study. In analysing a letter, the writer's own words describe his or her feelings. In participatory action research this exposition of the "I" is important. Readers experience the feelings and opinions expressed by the learners themselves, and are allowed to draw their own conclusions. The data sources were varied, providing additional data for suggesting the validity of the case study.

Both the researcher and the lecturer were subjectively involved, so bias is probable. However, the many years of observations and reflection and experience would eliminate some of the factors that cause bias. The collaboration in the team was planned, with regular critical discussions, interpretations by both the lecturer and the researcher, with the theory and experience informing their practice in all the aspects of the course development. Much more could have been done to plan activities and evaluations in focus areas: minor issues often distracted the researcher as it was often only in hindsight that it became clear during the development whether or not a particular issue was a key issue. In an environment where research potentially has such a huge impact and can cause change in all aspects of the participants' praxis, it is often very difficult to follow a clear static instructional plan. The researcher was unable to get statistical evidence on the learners' background information from the University. The researcher is of the opinion that qualitative

studies in course design and development provide such a rich source of data that the change of trivial triangulation should not be a problem (Stake, 1994:113).

Investigator triangulation focusses on other people's observations of the data. This researcher and a second interviewer interviewed the lecturer on two occasions a few weeks apart in order to validate the results. The course materials were presented to an external researcher who was, to some extent, unbiased but knowledgeable on the subject in question. The researcher could have requested more external researchers to discuss alternative interpretations.

Theoretical triangulation (according to Denzin 1989 in Stake, 1994:113) involves co-observers and reviewers from alternative theoretical viewpoints (such as a behaviorist and a holistic viewpoints) to view different frames of reference or perspectives in the analysis of the same set of data. It is difficult because of the notion that there is no "best" view but *multiple* perspectives, as is clear from a constructivist epistemology. A researcher may use indirectly relevant literature to test the relevance of findings (supported Duffy in Stake).

Consequential validity is where the consequences are unwarranted to prevent readers viewing the descriptive data as inconsequential, in low esteem and not fully valid. Although there are complex aspects and issues with no consensus of reality, research was added by Duffy (1993:143) to Stake's (1995:112-113) validity types.

Methodological triangulation is where two or more methods are used to collect data - such as direct observation to review old protocols. Old study guides and evaluation methods, for example, shed light on changes in the views and experiences that influence a lecturer. So too does a historical overview of the changes in the lecturer's own epistemology - as described in staff development seminars, old publications, or changes in approach to teaching (such as the change in the choice of a textbook for a course).

4.7.2 Validity procedures

An action research team has to focus on particular validity procedures to prevent any distortion that might arise as the result of uncritical subjectivity. Reason (2001:21) is of the view that these procedures are appropriate to co-operative enquiry (Stake, 1995:99). The validation procedures Reason (2001:60-68) mentions are:

- Research cycling: this is when the team goes through the four phases of enquiry several times. This process fosters critical reflection, which becomes progressively more objective. In this cyclical process there is a move between action and reflection, a swing between reflecting upon experience and practice, developing different ideas, trying different ways of

behaving. Describing the different “moments” in a unique case could guard against over-generalisation.

- Authentic collaboration increases the understanding of an event. Planned action, a critical discourse, participatory interpretation and theory-informed practice (or praxis) all guard against ego involvement.
- Reflection and action is based on a thorough literature review of the areas of research to explore the complexities of the topic. This may prevent premature closure of an enquiry into an event.
- Chaos and order may give rise to inaccurate observations. Planned activities and evaluations are necessary in order to focus on the key areas of concern. However, evidence of side effects is important: “Side effects are those outcomes that were not intended or not even considered when planning the course” (Posner and Rudnitsky 1997:199). Gathering evidence to indicate side effects is difficult as there are no indicators to serve as guides for the evaluation. However, it is important to identify likely or probable side effects to guide the evaluation, to change or abandon the course, and to sensitise presenters towards possible side effects. Side effects can be negative or positive. In view of resources very often being limited, efforts should be directed towards negative side effects. Side effects are identified by examining the instructional plan where the instructional plan includes planned interactions between learner and course presenter, instructional foci, and the organisation of course units in the context of different institutional factors.
- Challenging consensus collusion where selective observations may follow on too few specific data collection techniques which are appropriate to the research design.
- Divergent and convergent thinking allows the researcher to argue “from both sides” to find support for the argument.
- Distress management: in analysing external and internal difficulties and problems that may have lead to the breakdown of the quality of our research we concluded that since the research was not funded, there were no pressures from funding organisations. Such influences often affect how data is to be used, what “truth” is, what limitations are exposed, or how the data is interpreted. Academic freedom provided an open and free environment to conduct research (Dockrell 1980:12-14). It is possible that, despite the care the researchers took, internal obstacles to quality educational research did influence the research. The correct phrasing of questions provide acceptable definitions and set of criteria with high correlations that may already exists between concepts so that the same general conclusions were likely to be drawn no matter which measures were used.

The above validity procedures are supported by Rubin & Babbie (1997), Mark (1996) and Neuman (1997).

4.8 The research project: an overview

In real terms most projects are "messy": this research process was no different. The researcher, along with the course team, carefully planned, observed and monitored the events, documented the data, and reflected on the process and its outcomes. The course team considered self-development and course development at Unisa as the team members wanted the project to succeed and have reliable results. The core team set thematic research questions and identified areas of concern; these became progressively more focussed. Each person in the full course team had been employed by Unisa for at least six years, and therefore understood the Unisa context very well. Each team member was able to describe the context of this case: in this regard there were few misunderstandings and uninformed notions. They were all well aware of Unisa-specific organisational structures, politics, ethics, philosophies, practices, restraints, and the change that had to take place. The core team's actions and focus was cooperatively enquiry into the result of their different actions - a course of action which would enable each member of the team better to understand the course design and development of a mathematics teaching course.

The overview to the project illustrates (in Fig 4.2) the cyclical phases within the scope of this action research project. The phases depict the: (1) personal growth through professional development (1994/5); (2) course design and development of the Unisa MMAT course (1995); (3) the piloting of the course(1996/97); and (4) the presentation of the course over five years (1998-2002). Within each period the reader will notice the cyclical action learning and/or action research.

In cycle 1 (1994-5) the professional and personal development was action learning with research publications as an output by the subject specialist and the learning developer (Wilson, 1994a, 1994b, 1994c, Wessels, 1996:2000). Other DE practitioners also learned different strategies and experimented with processes - such as the editor, who, from the start, challenged current practice by getting involved in the team from early on in the process. It is through these growth periods and interactions that a team is initiated. This period is described in Chapter 5.

Cycle 2 (1995) illustrates the case design and development phase. The reader will notice in Chapter 6 the focus areas in Course Design namely analysis, development, design, production, implementation, maintenance and evaluation (described in 3.3.2).

Cycle 3 (1996/7) illustrates the pilot phase of the course development. This period is described in Chapter 7.

Cycle 4 illustrates the years of providing learners with a refined course (see Chapter 8).

Within each cycle the role players often change, with people moving in and out as needed (see the discussion of team roles in Chapter 2). Individuals may at any time negotiate or renegotiate roles

and responsibilities. This constant dialogue is in response to the tasks or activities required within a working structure. As indicated in Chapter 2, if any of these three elements - dialogue, structure, activities - are not present or are "out of balance", the team will not be successful. The processes and phases described in Fig 4.5 did therefore not take place exactly as they were meant to in terms of the diagram.

4.9 Conclusion

In distance education the focus should be on providing a quality learning environment. Educators and administrators both have a responsibility not to let learners down. Action research is a qualitative research method which is suitable for changing educational environments and, where necessary, critically examining and exposing processes and products of distance learning courses. It can be applied for project research, for post-graduate guidance, for professional development, and for curriculum and course design. Emancipatory action research projects are appropriate in both academic and administrative situations where different people are included in a process of enquiry which requires participation.

Any process of enquiry needs an enabling environment where critique fosters reflection-in-action. It is in this fast-changing educational setting where action learning, action research and programs in this field have the potential to provide a solid basis for change.

The world of education "morphs" - the focus increasingly is on change management and learning-on-the-go. These have become important survival strategies. This chapter provided a methodology to consider issues and concerns at a changing Unisa. Action research is appropriate to develop new resources, better institutional systems and structures, improve courses, and assist in the professional development of people. The action research methodology has the potential to enable Unisa researchers and distance educators (Unisa Research Policy, 1996: 5) to increase their knowledge - to self-reflect, engage in a critical dialogue, actively learn from the processes and outcomes of complex situations, and share their experiences. It follows that they can improve the rationality and justice of their practices, and better understand how this can influence their situations.

This chapter describes the methodology which is reported on in the following chapters. To summarise, action research is recognised by three key aspects: that people work on a particular project; team members are involved; and the focus is on the experiences. Therefore, in an organisation such as Unisa it is important to develop a culture within which people can share knowledge and skills that will have a domino effect through the organisation. One of the most important aspects of action research projects is the team's deliberate and thoughtful approach, following approved and recommended methodologies to maximise the chances of success and minimise errors. The difficulty is that the team is involved in a collaborative learning exercise

within a unique situation. Lessons learnt should be creatively applied and customised by one of the team members so that they may be generalised into other contexts, as the later chapters in this study demonstrate. However, from a particular case such as MMAT00-8 we cannot generalise. It is through 'thick description' that the reader is allowed to construct their own interpretation. The researchers' view of knowledge and reality would influence their decisions on their roles in situations and how to contribute to the experience of readers. All views are not equally important in case study research and the experiences are relative (Stake, 1995: 102). The aim of the research was to improve the learning, wished to improve their understanding of practice, and involve all participants in the learning process. This research enabled the developers better to realise developmental qualities in their practice. The development team actively invited learners to engage in the process as co-researchers. This process was extremely educational for all parties involved, as the various research results showed. Each time that there was some intervention, change took place; some to the better and some detrimental.

Lastly, this chapter provides an overview of the project phases. In the following section, Chapters 5 to 8, these processes are described. The first chapter in this section starts with a discussion of the professional development period and the team.

III: Chapter 5

Professional development of the core DE design team

5.1 Introduction

This is the first chapter in Part III that discusses four cycles namely 1) the professional development of the team members, in Chapter 5; 2) the design and development of the course, in Chapter 6; 3) the piloting of the course, in Chapter 7; and 4) the presentation to learners of the course and its management, in Chapter 8. (Refer to Figure 1.3 for an overview of the events-line of the course development project. This indicates Cycle 1, the professional development, as a researchable focus area.) Each chapter deals with an action research cycle in which we describe the plan, the action for change, the observed results, and our reflections.

This chapter reports the professional development of the course team members. This phase preceded the course development phase. It also followed a typical action learning cycle: planning, acting, observing and reflecting in order to describe the process of personal development and team approach strategies - a development that underlay the personal and teaching-learning changes described in this study.

A core course team was formed. This team initiated a collaborative enquiry to change the *status quo* of course development at Unisa. The team was referred to as a core team when the lecturer and learning designer was involved. The team was referred to as a full course team when more DE practitioners were involved (see 1.7). The successes and failures of the team and its professional development are described here.

The researcher wants to make it clear to the reader that the style of writing in Part III will become more informal, as required by the research methodology. The reader will therefore hear more from the point of view of "we" and "I" in the discussion. This change of tone indicates the participatory role of the researcher as part of the team. As participant developer she now describes her roles as instructional designer, staff developer and course team chair at Unisa.

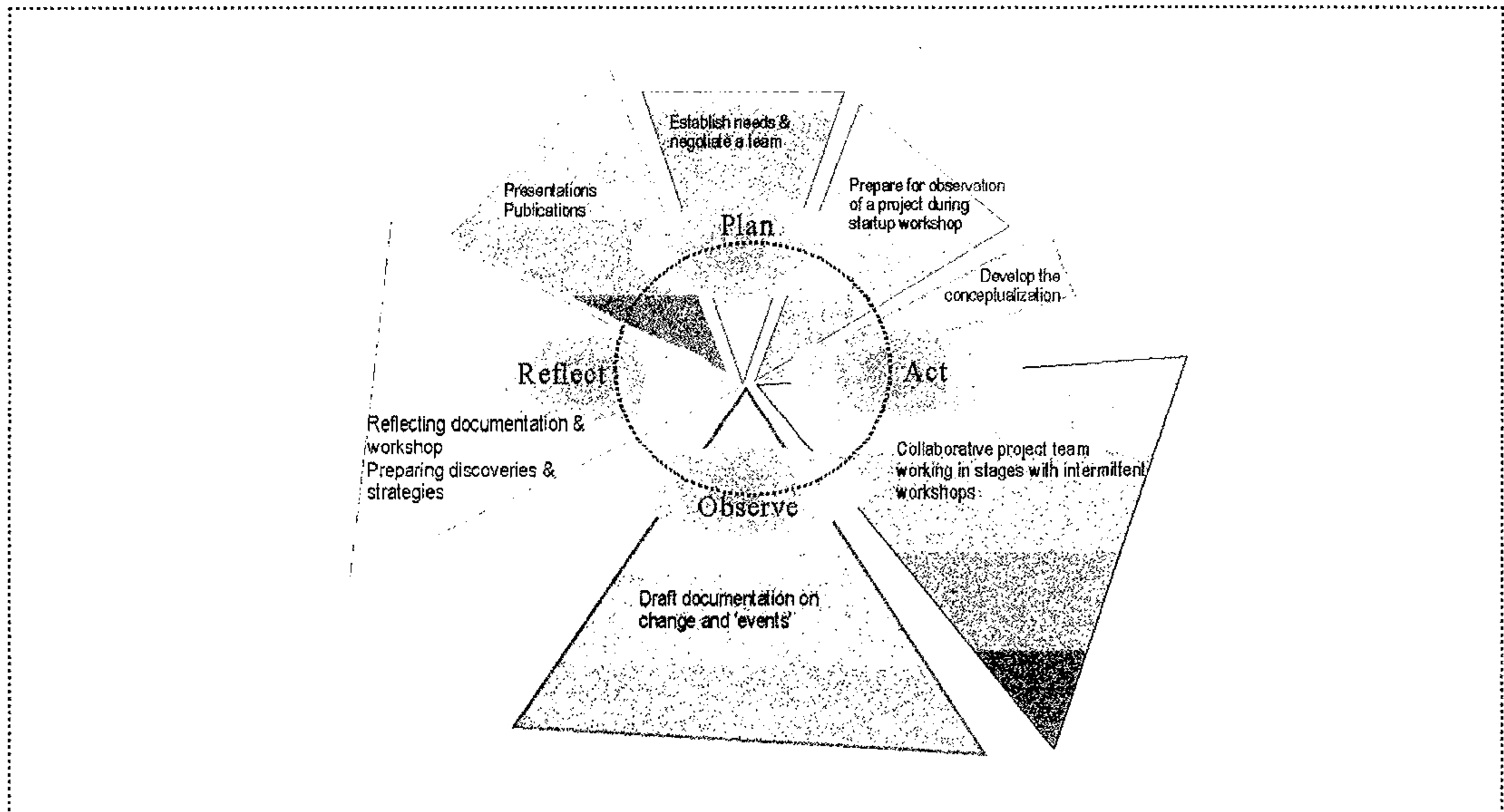
5.2 Planning for changed practice

Since the purpose of education is to help people make positive changes in their quality of life and work, the course material has to prepare learners for practice: DE practitioners are responsible for preparing quality learning materials. Unisa had to be re-engineered and transformed, to respond to social needs, and be a centre of quality and excellence (Macintosh, 1997: 3). (See Chapter 2.) The staff developer identifies and nurtures the practitioners involved in this preparation process, especially those who show an interest in changing their teaching and making a difference to the studies of their learners. For me as an instructional designer, this was one of my tasks: to initiate professional development of staff during open work-sessions or during *ad hoc* discussions in course design and development workshops run by the Bureau for Learning Development (BLD, during the development called Bureau for University Teaching (BUT)). An instructional designer had to identify the current "most limiting factor" - factors that were holding up progress toward the goal of the University as a distance education provider. I had to identify and support a few innovators, such as the lecturer, as well as show potential early adopters what the innovators were doing. Staff development strategies also needed to support the early adopters and, hopefully, draw in some of the late adopters. The support included course design and development training and instructional design tools.

There were congratulations and severe criticisms of Unisa in the Wedemeyer report (Wedemeyer, 1974) and the SAIDE report (SAIDE, 1994). The criticisms included Unisa's inability to address international best practices in pedagogy or use multi-disciplinary development teams to address the needs of learners in South Africa (Macintosh, 1997: 3). The resulting staff development plan therefore focussed on correcting these limitations (Heese, 1994). The next important strategy to support professional development was staff development workshops; these were planned to take place during 1994-1997.

Academics need to constantly ask questions, make assumptions, state preliminary hypotheses, or outcomes, and focus on relevant issues for learning. Distance learning through self-study is never an easy path; nor is the design thereof. Learners and academics at Unisa find it difficult to plan a well designed, quality self-study package that will provide learners with appropriate and efficient guidance, knowledge, and skills. The process of course design received much attention to stimulate discussion and challenge the *status quo*. Academic staff training and development, as a portfolio of the Bureau for University Teaching (now the Bureau for Learning Development), was an important platform to provide opportunities to address these issues, and give space and time to focus and reflect.

Figure 5.1: A professional development model integrating action learning in staff development workshops with action research.



The instructional designers were reminded by Goldfried (1980:6) in their planning and presentation of the course design workshops that they should “de-emphasise the unique or idiosyncratic characteristics of each theory and, instead, focus on ways by which practitioners can derive practically useful ideas from various (ever ‘competing’) theories”.

The team approach was one of the new strategies suggested during the staff development workshops of 1994-1996 (Heese, 1994) and provided the impetus for an institutional approach and this course development. The core team for this project included an instructional designer-as-staff developer and the academic subject specialist-as-lecturer (both in double roles).

Numerous barriers stood in the way of improving communication in course teams: persistent time pressures, and physical separation of departments, to name but two of these. There were many misconceptions about ODL theory and teaching systems. Within this segregation, academic staff develop disciplinary specialisations, such as in Mathematics, also that learning developers become specialised in academic development and course design (Macintosh, 1998). At Unisa the specialisation supports the industrialised character of the DE institute.

The Bureau for University Teaching (BUT) used staff development platforms to nurture institutional change and to foster actions towards a new culture that values and supports accountability (perhaps through new structures and roles), innovation through creative environments, and collegial conversation (Austin, 1998:12) where the use of terms and conceptual understanding changes. The staff development platform was meant to raise awareness about national education

policy shifts, changes in the subject matter, changes in the institution's student body, and changes required from the lecturing staff. These factors could directly feed back into institutional policy, organisational structures, staff development strategies and requirements, focussed financial spending, and most importantly, sound distance education learning materials. The policy change was demonstrated through the Unisa Tuition Policy drafted in 1996, the same year this course was piloted (it was formalised in 1998, but still not implemented in the University structures).

Firstly, learning designers studied the literature on course design, change theory, staff development and teams, and then published a series of presentations informing the Unisa community about all of this. Many Unisa practitioners took part in a series of presentations to foster collaboration, trust, and a shared vision (Wilson, 1993; Wilson, 1994; Heese, 1994; Wilson and Heese, 1995; Wilson & Heese, 1996). The researcher focussed on activities-in-text and their role in ODL in presentations during these workshops.

Walking back to the university after one such workshop the subject specialist-lecturer discussed the construction of a team with one of the presenters (who was simultaneously an instructional designer and academic staff developer). After our first discussion we formed a team to design the MMAT course. These teams were "informally" formed. The learning designer agreed to support and inform the course development. She suggested focussed research into the process. A mutually agreed upon collaboration and participation in a team followed, and we placed much value on applying our knowledge and experiences to a project of value to us, our learners, and the organisation. The roles naturally developed with the learning developer as the team leader who directed the team and the development of the course. The final responsibility for the course lay with the lecturer and the relevant department, in this case Department of Didactics in the Faculty of Education. The project plan (Wilson, 1995) identified the various role players and their input on a time-line (Smith, 1998: 251; Silber in Bratton, 1981:21; Wilson, 1996: Addendum A).

Various team members were co-opted at various stages during the total development process from 1995 to 2002. A full course team designed the course in 1996, moving to a core subject-specialist team during its revision into modules in 1997. The full institutional team was used (refer to section 1.7.5).

This core team included a learning designer, (also in the role of researcher, staff developer, manager and chair). The other main member was the academic subject specialist who was the lecturer. It is therefore clear that the team members had multiple roles. The role of the researcher was as a participant-in-team. This role of the learning designer as researcher was as a participant-as-member and I, as the researcher, was a full collaborator and participant in the central activities and processes taking place during the instructional design of the course.

Thirdly, we had to establish what our problems were. Our problem was to question the process of reflective praxis as a strategy to assist course teams during the process of including text activities in DE course design. We also had to decide on the manner in which the team would provide data on the process.

Research projects are especially relevant in bringing about change. After much deliberation and experience I concluded that the participatory action research methodology would be appropriate for this project. Participatory action research would allow investigation into the course development processes during its development, it would allow a description of processes and outcomes, and it would enable the participants to take ownership of the research and its outcomes (see chapter 4).

Goldfried (1980:6) suggests that academics in course teams need an outline of the various agreed-upon intervention principles, specifications of varying techniques for implementing each principle, and an indication of the relative effectiveness of each of these techniques. During our interactions in the team we were, indeed, presented with problems and individual differences. We were called upon to provide useful ideas. We documented these difficulties and differences.

5.3 Actions during professional development

It is always awkward for any one staff member who wants to start a discussion with a colleague about teaching to start with "Let's discuss the design of your course to ensure active learning". As part of our staff development in 1993-1996 the Bureau for University Teaching created a vibrant, enriching environment of institutionalised opportunities, and time, where distance practitioners could reflect on improving themselves as educators and researchers. It was easier for staff to explore new roles within a non-threatening environment of discussion, or to talk about and try out alternative behaviours and strategies while they rethought their practice and development as professionals. In this project the team had to be the supportive and motivational environment which enabled the group to take risks in changing their teaching practice and engaging in innovative work.

Considering the range of staff development sessions suggested by Raelin (1997:21-34), and Mashile (2001:135-136) and Steyn (1999:12-14) our development was clearly similar. We added to the staff development process the action learning process that we as team members were involved with. The suggestions of the above writers are graphically illustrated in Figure 2.5 and we add our own experiences to this model (see Figure 5.1).

The fourth stage in the professional development model (see Figure 5.1) developed the conceptualisation. The team members collaboratively assisted one another in making sense of their

experiences and outcomes with arguments grounded in the experiences of other teams and of theory, as far as published materials allowed (Cangelosi, 1996; Chapter 2; Chapter 3; Chapter 4). The discussions during the weekly meetings mainly during the period from July 1995 to February 1996 were not recorded. However, the later interviews refer to the interaction and collaboration to investigate relevant concepts including novel course design practices, the use of mind-maps, the problem-solving and problem-based learning approaches, and the use of portfolios as an authentic assessment strategy.

The main data collection methods included (1) the notes of the learning developer during the course development, (2) the course material with its changes, and (3) video recorded interviews. The focus of this professional development section is to plan the sources of information on the development of learning opportunities as an instructional design strategy to produce improvement in learners' competencies (see Section 1.4; Addenda A, B, C, D, E, F) namely the (1) learners' assignments, (2) their feedback to the lecturer, and (3) the course materials (described in Chapters 6-8).

In the fifth place, the team operated by participation and collaboration. We applied our prior and new knowledge to a real project of value to us, our learners, and the organisation. Together the core team members made mind-maps of each chapter of the prescribed book to correlate their understanding of the subject matter. These maps were consolidated or agreed upon and were used in the 1996, 1997 and 1998 study materials (Addenda A, B, C).

Our small-group work methodology enabled us to give feedback and reflective comments. As team members we constantly discussed the draft documents of the course materials by means of daily meetings from July 1995 to January 1996 (when the course was published and sent to the learners). Thereafter there were monthly meetings to follow the progress of the learning (up to the five year maintenance cycle of the course, which is reflected in Fig 1.1). Through effective team management and a good match in personalities, we, with other DE practitioners such as the editor and producer, developed a suitable team culture that the instructional designer-researcher and the lecturer found to be a supporting and successful relationship.

In the sixth place, there were opportunities to suggest new lines of enquiry for the research and/or the teaching strategies, which gave rise to additional influences and issues, called "side cycles" in action research. We sought new discoveries and alternative or creative strategies for new situations or problems such as the lack of colour layout, the time restrictions that effected the production print process (Addendum E during the interview with Wessels, 1999; Newey, 1975: 48), as well as the Unisa Editorial Department policy that limits the editor's role in the team (Boucher, 1996).

5.4 Observing change through professional development

The team decided to follow the suggestion of Altrichter et al. (1991:23) to use a case study of course production in distance education as this allowed us to describe and understand the process of developing and producing a new course in a specific context. We would thus be able to establish how our actions informed policy and practice in distance education. However, course development takes place over many years, so the action research methodology was the only to track the events in the process, as well as the development of the product. The complexities in the course design made observation difficult - it felt like a sensory overload. It was difficult to keep the issues of team work and course design separate, and so the data collected was a mixture of both. We know that we would have to carefully separate the issues. During this process professional development became more important.

We questioned the process of reflective praxis and how it would assist members of a team. What to reflect on the complexities of events, reflect on changes, on successes and failures of the process and products, provide suggestions for best practice and add knowledge to the field.

As an instructional designer the regular and numerous staff development presentations required provided frequent opportunities for development of both the participants and myself (see 5.2). The learning developer became more aware of her practices and came to understand the team and its functions better - this influenced her practices and experience in other teams. The lecturer also became more interested in mathematics teaching and published articles on the subject (Wessels, 1996) as "die benadering en die strategie en wyse waarop mense 'n studiegids skryf en daardeur kommunikeer is nuut. Maar ek het daardie kursusse baie sinvol gevind.". He requested that other projects follow the team approach with the same instructional designer, as the team have a much clearer understanding of the roles, actions and conceptual knowledge in the subject areas.

DE professionals such as production and graphic artists share, to a large extent, innovators. The Editorial Department, however, moved out of the team process (Boucher, 1997); this indicates pockets of resistance in the institution.

The learning designer and lecturer took samples that included noted experiences of defining moments, project plan notes, notes that become part of the course materials, correspondence, and their experiences with the learners and with other DE practitioners. The selection of the data was based on the categories of important events that the researcher identified and presented in this study. The data was collected over the full project period of eight years. (We discuss the first two years as staff development as we spent most of our professional development during this period. The rest of the period was devoted to course design (Section 3.3.2).

5.5 Reflecting on professional development

The team reflected on its ability to identify and deal with change by looking at historical evidence of what it had done. The researcher analysed the data and reflects on it here, following her identified categories.

5.5.1 The context as reference

As learning designers involved in course design we were reminded to take the context of the day in mind as well as the actors in the project. This involved planning, in the descriptions and in our evaluation of the project (Alrichter 1991:23). The Unisa context, the distance education learners, and team requirements are described in Chapter 2.

"Die omgewing was relatief nuut ... en die pakket waarin ek dit moes verpak het op die ou end ... asook die benadering en strategie en die bepaalde Studiegids. Dit was die maklikste oplossing omdat 'n ou maklik en vinnig daarin kon insink. (Wessels, 2001a)

5.5.2 Staff development as initiator

The staff development workshops were successful to a large degree as a large number of people from the University attended. The focus was on practical application, particularly in the use of activities in DE self-study packages (Heese, 1994; Goodwin-Davey et al., 1996). The enabling moment for course changes was the staff development courses presented by the Bureau for Learning Development (then the Bureau for University Teaching). The lecturer said:

"En toe begin die projek in 1995 waar julle ook die kursus aangebied het en ek deel aan gehad het en dit het uitgeloop op die eerste studiebriefe" (Wessels, 2001a).

5.5.3 Our reality shaped by our perceptions and our actions

We argued from the literature (section 4.2.1) that we each perceive our own reality and we make our own meaning; we are captured within this reality, however, and therefore our social reality is inherently meaningful because of our interactions within our situations. Here is an apposite extract from my personal diary:

"I [as a DE learning designer] found that I went through a very steep development curve: I was relatively inexperienced in teams. However, none of them had such a tremendous impact on me and the organisation as did this team. This one was supported by the general 'agreement' that teams transform organisations and, in retrospect, it made us transform with it" (Wilson, 2001: personal diary).

The lecturer noted during the interview (Wessels, 2001b):

"Ek het self 'n oriëntasie in my lewe ingegaan, saam met die Nederlande oor die

waarde van die ding voor jou. Ek het ook 'n kursus van die BUO bygewoon ... dit het die regte tyd gekom."

The three data sets support the fact that staff development was an initiator of the development of perceptions and actions.

5.5.4 Professional development initiates change

Initially, the personal development of each team member took part separately. The focus in each case was on learning theories, philosophical thought about knowledge and reality and discourse in design and production of DE materials. The learning developer changed through individual research and publication: Wilson (1989), for example, did work in didactical approaches; and then there is Wilson (1990a) and (1990b) in the role as a lecturer; and Wilson (1993) and (1994) developing staff development seminars about activities in DE texts; Wilson (1998) is work in strategic planning towards implementation with changed practices; Wilson, Schenck and Grobler (2002) is work into changed dialogue as a result of teaching practices; and Wilson, Spencer and Batley (2002) deals with change and collaboration.

The lecturer studied and published in the field of teaching strategies in mathematics (Wessels, 1996b) and constructivism (Wessels, 2000). In the lecturer's view the first phase was the professional development of the team members:

"Ja, die fases van die projek hang af van 'n persoonlike ontwikkeling en dis hoekom ek in 1994 en in 1998 studieverlof gehad het en het ook my Ph.D voltooi" (Wessels, 2001a).

The professional development as the first phase was in part, planned. Staff development workshops in activities in text provided a more simultaneous development (Wilson, 1993; 1994; Heese, 1994; Wilson & Heese, 1995 and 1996) . Later the team planned personal development in unison where needed and integrated it in the course materials (Addenda A, B, C). The literature study (see 2.6.2) supports the different "voices".

5.5.5 Failure often drives change

The impetus for the enquiry started with the failure of a strategy. The lecturer noted a change in his attitude concerning the teaching of mathematics.

"Ek dink dit [konstruktiewe onderwys] was die finale soort van oriëntering om te besef dat die vorige benadering tot die studiemateriaal wat ons gevolg het min effek gehad het op die studente." (Wessels, 2001a)

The lecturer reflects on his personal growth by describing how he started at Unisa in 1984 and became responsible for the course. He indicates that his development took place in phases (Wessels, 2001a) which correlate with the phases identified in this research (see 2.6.2). He says:

"die fases van die projek hag af van 'n persoonlike ontwikkeling en dis hoekom ek in 1994 en in 1998 studieverlof gehad het ... en toe begin die projek in 1995 waar julle ook die kursus aangebied het ... dit het uitgeloop op die eerste studiebriefe."
(Wessels, 2001a).

He also admitted that

"Ek sou dit [die uitkomst] nie ander kon behaal het as deur die leerteorieë nie. Ek dink dat die groter openheid in my eie erkenning bydra tot sukses in die gids omdat dat ek nie die antwoorde op alles het nie." (Wessels, 2001a).

The learning developer reflected on her period as Unisa lecturer from 1987. During her contact sessions the students often expressed an "aha" exclamation of sudden insight. However, designing such experiences in text was very difficult and her inabilities initiated a period of intense readings about activities as a "tool" for active learning or attended seminars presenting international practices in course design.

The international concerns illuminated the shortcomings of the Unisa course materials (see 1.1 and 2.3). This evidence supports our concern in this section.

5.5.6 The importance of experience

Experience in distance education was important as this process of change required commitment, persistence, an ability to reflect on change and see new ways of doing things, and an openness towards new idea. The lecturer said;

Ek was bevoorreg om in afstandsonderrig te wees vanaf 1984 tot 1994 toe ek hiermee [die projek] begin het. (Wessels 1997:interview).

The experience of the learning developer in presenting a distance education course supported her role in the team as a reflective practitioner. Her knowledge of the teaching strategies made it possible to give more input than usual in mathematics course.

5.5.7 Freedom, isolation and responsibility

We found that at Unisa there existed a strange irony affecting the dialogue between DE practitioners. On the one hand, academics can freely explore and exchange ideas, considered as part of the distinctive notion of academic freedom. Added to this freedom in DE is that lecturers

are separated from regular direct interaction with their learners (see section 1.7 and Chapter 2). This leads to many academic staff experiencing isolation, loneliness and segregation. In contrast, the academics are responsible for the learning experience. The team addressed created a supported "togetherness", a shared feeling of responsibility, within a belief that the system can accommodate new changes .

Often the lecturer is the only person responsible for the subject, and therefore he/she works in isolation in the institute. Sometimes there is an additional need for a fellow subject specialist in the team to enable people to learn from one another. For example a lecturer might need another subject specialist. In the words of the lecturer during an interview:

"Ek was bevoorreg om in 'n span te kon werk maar die span was vir my relatief baie klein. Jy het as ontwerper opgetree en wat daardie insette betref was, maar in terme van die wiskunde onderrig se kant het ek ook 'n klankbord gesoek. Dit was eintlik vir my 'n beperking [dat ek alleen as vakspecialis ... betrokke was. Ek sou dink dit sou baie sinvol wees [om] meer vakspecialiste betrokke [te] hê" (Wessels, 2001a).

5.5.8 Multi-skilled team

The full team type supported the development of the course as each person added an important skill; these additions were allowed and people were expected to do their share. The roles were clear: "Jy [Ms Wilson] het as onderrig ontwikkelaar gewerk and wie se insae, in terme van die Wiskunde Onderwys kant ek gebruik het as 'n weerklank" (Wessels 1997: interview).

Earlier we argued that each team member had multiple roles (see 2.6.4) with many other researchers supporting our experiences during this development.

5.5.9 Investment takes time

Personal development takes time and much reflection. In our case the reflection included the product, namely the improvement of DE course materials, and the process of many people working together in a team environment.

The team found that it took a lot of time to inquire into a new direction. However, the results were promising, in the opinion of the learning designer and the lecturer, as the design did foster learning and reflection.

5.5.10 Constant reaching for perfection

We found that we could always do better and we were driven by this realisation: "Daar is nog baie ander dinge wat moet bykom en uitgewerk word in 1996 in hierdie kursus" (Wessels 1995: letter).

5.5.11 Hard work

In this case each person gave more than was ever required through sheer hard work! In the words of the lecturer: "Ja, noudat ek weer 'n slag intensief met die projek besig was, besef ek andermaal hoe 'n groot taak dit was" (Wessels, 1995). Also "as gevolg van die werklading en departementele verskuiwing beteken dat jy nie so vinnig kon voortbou op die nuwe ontwikkeling soos 'n mens wou wou nie. (Wessels, 2001a).

The learning developer started with the activity-based research in 1989 while testing the concepts with around 500 students per year for at least three years. The staff development workshops were planned to incorporate all the faculties and staff at the university. The experiences were however, valuable on the long run.

5.5.12 Changed roles, actions and language

The team became acutely aware during the process of how important it was to foster dialogue between all the roleplayers in the institution who had an input in the course development process: academics, administrators, external subject-specific partners, and learners. The mechanisms for change, and the results of change were neither clear, nor documented in the Unisa context. Figure 2.5 illustrates the process of implementing change with the necessary components of dialogue, action, and structure: these relationships can also be seen within a team. This project was an attempt to be a change initiator though the strong collaboration in the project-based action learning and action research processes. In hindsight the language, actions, and roles in the teams did have an effect on change in our professional development.

We did not always have answers to our problems and had to use an open mind to address issues that came our way - we had to actively learn from our experiences. As a successful team, we addressed the reasons (Eison, Janzow, and Bonwell, 1990:82) why faculty members did not use active learning strategies. We found that as people we tended to stick to the easiest, most accepted, or safest thing to do and that it took courage to "push" the system and other people to "go along" with us. We reflected on our actions and planned the writing of articles to follow the first sharing of insights. The promise of accreditation in the institution as professionals was an added impetus.

We became more aware of our language use, the activities it promoted, and the social relationships it developed. Our professional development in course design meant that we became more aware of our shared understanding through the language we used. We constantly renegotiated our actions and activities in the team and the institution. We started to build strong personal relationships (Wessels, 1995). Through the periods of disagreement on how we perceived a concept, or on what strategy to employ, growth took place, provided we kept the relationships going. Reflection after the fact was an important equaliser: “debriefing” sessions and time apart gave us perspective.

As with the team, the institution was also affected by the finely tuned dynamics between the accepted discourse, the social relationships (as manifested in the organisational structures), and good practices. During the staff development the discourse was altered, the relationships and team roles were required to change, along with a change in the way things were done and what was done. With changes in how things were done, or who did them, the discussions had to focus on these altered environmental forces. This change was dealt with in the team.

5.5.13 Focussed project leads to managerial and team competencies

The use of this action learning/action research project led to an increasingly focussed investigation and an understanding of our practice and change. It had a further advantage that this strategy developed managerial competencies and our workgroup-specific competencies because of our involvement in such projects. We could argue that these personal support capabilities developed and that we were a supportive force in the development of Unisa as a learning organisation (adapted from Mashile, 2001:133 and Kemmis, 1991: 58). Rich descriptions of our experiences allowed us to share our experiences with you, the reader.

5.5.14 Changed pedagogy

We found that we had to change the pedagogy of the mathematics course from a subject-based viewpoint to an outcomes skills-based learning approach in order to cover the same amount of material in the study time available. We adapted to this change because we were supported by an excellent textbook. However, other teams might have to rely on internal motivation and understanding to change to a skills-based learning approach.

During our professional development we changed as individuals and we believe we grew in our understanding of course design. Professional development also meant experience and growth in our course project management skills. The lecturer commented on the additional, new knowledge which changed the context and expectations of quality materials.

Die omgewing was relatief nuut ... en die pakket waarin ek dit moes verpak het op

die ou end, asook die benadering en strategie en die bepaalde Studiegids. Dit was die maklikste oplossing omdat 'n ou maklik en so vinnig daarin kon insink. (Wessels, 2001a).

The learning designer researched the activities in text, and together with her colleagues in the department presented the new approaches in staff development seminars. We argue that the experiences of the lecturer, learning developer and the literature (see section 3.5.4) provides evidence that new approaches were the impetus for change in this course.

5.5.15 Co-responsibility

The team members each had to take co-responsibility for the outcomes of the project. The lecturer verbalised this relationship as follows:

"Jy het my eintlik gewys wat dit beteken om medeverantwoordelikheid en mede-eienaarskap in 'n saak te aanvaar. Danksy dit sal dié projek seker bepaalde hoogtes bereik. Baie dankie vir jou vennootskap en meelewendheid in hierdie taak van ons" (Wessels, 1995: letter). The learning designer writes "[the lecturer] het gevra dat ek ook mindmaps doen van Cangelosi se boek sodat ek volledig deel kan wees van wat gebeur in die kursus." The literature study supports our experiences (see 2.6.4) where the learning developer becomes a participant-in-team member.

5.5.16 Successful and unsuccessful teams

Compromises in the team have to be made all the way, especially in a stressed situation such as when a course is created in a very short time. This course was developed in only eight months. Even though we were working "in the dark" a lot of the time, one reason for the project providing course materials as product and insights into the functions of a team was our use of "deviance co-operation" in the Freirian sense in the organisation (see Chapter 3). The lecturer (Wessels, 2001a) said: "Die aspek van spanontwikkeling was op sigself 'n baie goeie idee. Die feit dat jy ook nie gehuiwer het om te vra nie. ... jy [leerontwikkeling] nie gehuiwer het om te vra dat ek dit moes regverdig nie of dan verandering aanpas of dan verandering aanpas." And "die vermoë van die span, dit is belangrik. Ek weet van die probleme min." As learning developer I feel that this team was very successful as we had an honest open approach with the team developing a relationship of trust.

This project fostered more projects that this instructional designer took part in. All the projects were aligned towards a shared vision in an emerging culture of quality course materials, although some deviated or had little impact (see Chapter 9).

5.5.17 Practitioner rewards

The reward structure of possible collaborative publications kept the team alive with a lasting cohesiveness. We have not lost contact with each other yet which is an excellent sign.

5.6 Concluding the professional development phase

In this section I write more for illustration of ideas than for understanding of the issues, remembering that our reality and situations change, that the situation had problems, that it had patterns and phases, and that it was unique.

The experience of the team members was positive, although there is no denying how much work it is to design and develop a distance education course. This chapter discussed aspects of professional development of team members in an attempt to change course development praxis.

A case study methodology allowed the team to observe personal change and environmental changes. For change to occur and project teams to collaborate, there are three essential components: a shared language, defined roles and relationships, and participation in activities.

The action learning process involves planning, action, observation and reflection. This correlates with staff development programmes such as initiating a team, starting actions for a project, establishing a focus, collaborating in a range of workshops, observing changes and "events" with supportive documentation, and reflecting on the discoveries and strategies and follow these experiences up with appropriate publications.

Following the evidence we were, and are, convinced that the action research project approach (Zuber-Skerrit 2001: Section 8 p.3) was the right approach to improve professional development of team members. From our professional development as a team, we went on to develop the Unisa self-study course for mathematics subject didactics (discussed in the next chapter).

III: Chapter 6

Course design and development

6.1 Introduction

This chapter reports the results of the course design and development of the Unisa Mathematics Subject Didactics (MMAT) course. The researcher uses rich descriptions and empirical evidence to support the concepts elicited in the literature study and explained in Part I. These concepts include self-study, open distance learning, constructivism, problem-solving, the distance learner, action learning, action theory, curriculum and course design theory, and action research.

The chapter is based on action research methodology, and is divided into the four parts in the action research cycle: planning, acting, observing and reflecting, in order to describe the process of designing a self-study course with activities in the text.

As designers and researchers, the team asked a number of specific questions. We attempted to influence the outcomes of the learning in a particular way. The case study describes the curriculum development process of the Mathematics Subject Didactics (MMAT) course. The MMAT course had a particular type of design, a unique institutional development processes, Unisa-specific production processes, structured assessment of learners, and integrated evaluation of the course. The explicit purpose of the development was to understand relevant but complex educational curriculum theory and practice, how this impacts on distance learning, and how to manage the integration of theory and practice in educational curriculum development. The focus was to reflect on the processes within the learning environment, understand the complexities of theory and practice embedded in the instructional design of text-based learning materials, and manage the integration of theory and practice in a Unisa-specific DE course. The course design of Mathematics Subject Didactics explicitly addressed the need to increase dialogue, to provide structure to learning, and to add skills development learning opportunities.

6.2 Plan the MMAT course design and development

The study takes place in a context where the course team's experiences provided suggestions

towards a focussed question: How can we use activities in text to change the dialogue, structure, and actions to improve quality of distance education learning texts? Will the development of learning materials with activities-in-texts as an instructional design strategy produce a significant improvement in distance learning texts that will improve the competencies of the learners in terms of their abilities to reflect critically? This course development would have to change the dialogue, structure, meta-cognitive ability, study strategies, problem-solving abilities, ability to reflect on praxis, the outcomes of learning, and motivate the completion of activities.

The profile of the students in the course indicated the issues mentioned in Chapters 1 and 2 (see Addendum D). The course development tried to focus on the individual mathematics educator as a member of a particular social group. This teacher has to become an efficient educator who does not know the future as it is affected by globalisation, rapid and constant change. It was difficult to focus on the individual learner because of the large student numbers at Unisa - and the diversity of students (see Chapter 2). The course was context-specific and students were required to apply their newly acquired knowledge in their work environments as mathematics educators. The course focussed on how best to integrate theory and practice in distance learning resource development according to instructional design principles (see Chapter 3). The research cycles described here were explained in Chapter 4.

The following questions all arise in this study. Will the process of reflective praxis assist us as a course team to design better Unisa learning packages? Will this reflective praxis allow us to reflect on personal change and the changed DE context? Will this reflect on successes and failures of praxis, and are we able to demonstrate our compliance for applying activities-in-text strategies, and best practice policies? Thirdly, how did we experience the process of the action research methodology in course design and development?

6.2.1 Plan the MMAT course design and development: the course

The focus of this study (as explained in Chapter 1) was to address the above problems by analysing the role that learning opportunities in texts can play in improving educational dialogue, structure, and actions. The specific aim was to develop a new course, a quality DE course (materials and methodology), employing an instructional design strategy of activities in the text in order to change the actions, dialogue, and structures which affect the learning and practices of mathematics teachers. From the beginning the investigation focussed on how activities in a text should be designed to create a sustained change in the learner's views, on how activities could impact on how students learn, and on the nature of effective learning (supported by Kelly, 1990; Moore, 1987). As the lecturer put it: "Ek dink dat die ontwikkeling wat plaasgevind het in die studie tot by die gids veral daarop gerig was op die aard van die werkopdragte en die aard van die kontak te

probeer verbeter" (Wessels, 2001b)

This course development started as many typical Unisa courses which then followed the course design and development process. The first stage was the exploration where the situational needs were analysed by the new course team. The planning and design stage involved setting goals and outcomes for the course and the curriculum. The development stage included development of resources and establishing an instructional strategy. The teaching materials were then produced and all the components implemented into the Unisa DE learning environment. The learning was then managed by the lecturer in all its facets - including assessment of the learners. The evaluation phase included an evaluation of the process, a description of the project, the design and evaluation of the study materials, and the development of the curricula and course. Unisa's study packages should include structured learning events focussing on, for example, skills development, assessment, progress, contact, support and pacing of study (BUT, 1997: Chapter 6, 129).

A Unisa study package includes a variety of objects, each with a specific predefined role. This course would be based around a prescribed book (Cangelosi, 1996) with a supporting study guide, tutorial letters, and examination papers. The team decided to structure the course following the topics in the textbook, including planned learning events, while the explanations in the guide complemented concepts in the textbook. This was a wrap-around guide (Rowntree, 1994: 119) and the lecturer commented "Dit [the guide] is beskou as 'n 'wrap around guide' - dit was met genoeg geskrewe teks om die lyn die handhaaf. Maar vir die aktiwiteite gaan hulle na die handboeke toe en wat hulle verder moet lees. En aktiwiteite in die handboeke bestaan ook wat hulle noem die 'vingette'" (Wessels, 2001a).

The course expected deep learning with a thorough and holistic understanding of mathematics education principles and processes; it needed to be verified in a teaching environment and new strategies had to be constantly explored. Reflections and insights were the motivation for changes in students' teaching practices and new collaborative innovative connections often followed. These requirements did make their studies both important and exciting, but also strenuous and stressful. The strategies for dialogue to enhance active learning embedded in learning opportunities in text were related to the definition for active learning (provided in the Introduction). Active learning is viewed as a multifaceted ability which involves components of reading skills, study skills, critical reflection skills, writing skills, meta-cognition ability, contextualising ability, and practical relationship building skills. The nature of these constructs is examined in Chapters Two and Three.

The MMAT distance students are not resident at the University; they study independently through Unisa without regular contact. Unisa does make use of synchronous contact during telephone calls, student visits to lecturers, seminars, and group discussion classes such as the day seminar of the

MMAT course.

The course development had to follow the well-established administrative systems and specified procedures of the institution - a large percentage of this knowledge is inarticulate or tacit knowledge often only available from within a department. For example, the potential number of course enrollments did influence production decisions such as whether or not to print material in colour. Hidden costs included the time and effort the course development would involve.

The course team was aware of the new developments in national curriculum revision. The OBE infused curriculum (discussed in Chapter 2) was on its way, but there was very little information available that could be taken into account during the course development apart from our own knowledge about the OBE approach. In the words of the lecturer:

"in terme van die sogenaamde OBE, dink ek dat ons in S. A. nog worstel om uit te vind wat is wiskunde onderrig in terme van die OBE. ... my besluit in terme van OBE is dat die klem sal bly val op 'n behoorlike onderrig metodiek. OBE is dan die raamwerk waarin die onderrig uitgeoefen behoort te word" (Wessels, 2001a).

The MMAT course is based on a problem-solving approach. The outcomes in the course require a set of skills and knowledge as identified by Cangelosi (1996). Demonstrating outcomes may indicate that a learner has accomplished the needed skills. UNISA (1996: (UNISA MMAT00-8/101, 1996a: Addendum A, page 4-5) indicates that the course stresses "mathematical thinking", based on the "Standards" set by the National Council for the Teachers of Mathematics (NCTM) in the USA. The prescribed book corresponds to recent South African mathematics syllabi." These directives foster the critical engagement with the existing temporary school curriculum (provided in an additional tutorial letter in 1996, UNISA MMAT00-8/104, 1996d.).

6.2.2 Plan the MMAT course design and development: the course team

The aim for this study was, secondly, to change the course design and development practices of distance educators. The process of designing a course following a team approach was also a concern. The learning design and development techniques were novel for the period 1995 to 1998 (see Addendum A, B, and C).

In contrast to other institutions (Brinkley, Pavlenchko and Thompson, 1991: 51 at Ball State University, Indiana, USA; OU UK; OU Hong Kong) the lecturer was not required to, but made a choice to be part of a course team approach and contacted an instructional designer. The lecturer informally requested support for a team approach. In 1996 the university had no policy structure, just a number of critical reviews of the university by renowned scholars. Unisa course development traditionally included editorial support and department-dependent author-dependent course design and development. The plan was to change to course teams. This team wanted to set an example and follow best course design and development practices following some examples presented

during staff training and development workshops. This would include working within the institutional systems, but also changing the systems to accept the course team. The team set out to manage the project, develop the course, and focus on documenting its experiences in appropriate research publications. Such a discourse promotes a reflective and participatory environment. The learning designer (who at Unisa also has the role of instructional designer) was also the course manager. The actions in each phase roughly followed the course design stages known to the team which were later described as "managing stages" (in Heese 1998:154-161).

The course team placed emphasis on a full integration of action and reflection with co-operative, collaborative and participative enquiry between all those involved in the project with the aim of producing really useful knowledge, or theorising. (Winter, 1998: 58). At Unisa different professionals would work in a course team addressing these elements in order to harmonise the various components in the course design process. The team realised that the planned change would impact on the institution and possibly create resistance.

The course team agreed on the confidentiality issues of the research data, the participants, and other sources of evaluation. These were included in the introductions of all the data sources and of the publications that followed. The discussions between the instructional designer and faculty member is critically important; there must be trust and rapport between them as it can be uncomfortable for the lecturer to answer questions never thought about before.

The course team immediately discussed the stakeholders that would be involved in the process. It was decided that for this MMAT course participation and roles would be limited to the following: a faculty member would be the lecturer and subject-specialist; the instructional designer would advise on course design and active learning issues and monitor and drive the research; an editor would edit the course materials during, and at the end of the development, although this agreement later proved to be a problem; unisa was to be the publisher with full copyright as is required - and this was to include the copyright section, the press department and production department; national subject specialists in the department and in other South African universities; international subject specialists such as the author of the book, Cangelosi; the learners enrolled in the course; and other members as required.

Team dynamics, personality, power perceptions, temperament, commitment, workload and able communication are key elements to successful course design (Crick, 1980; Newey, 1975: 50). Many team members has to visualise a process it knows little about and must therefore trust the guidance it receives from some more experienced or knowledgeable members. All the members within their functional roles should be treated with respect as professionals. This promotes favourable interaction. The members of the course team should be cognizant of, and respect, each

faculty member's personal characteristics and teaching style (Brinkley, Pavlenchko and Thompson, 1991: 51). All team members should understand that the questions asked are not intended to challenge, question expertise, interrogate or intimidate, but to enquire about things and clarify issues concerning the course or learners.

The course team defined their working strategy. The actions in the course action plan will include a time line, an outline of the interventions, different types of activities, their relative effectiveness, principles, techniques to implement the principles, interaction of techniques with principles, and unique problems and potential differences. The working arrangement had to include frank and regular discussions to share perceptions. We agreed to follow a research paradigm that was in agreement with our constructivist view of educational knowledge. The research design would have to allow changes during the process, as well as the potential for publication of the process - this action research methodology could provide.

6.3 Actions during the MMAT course design and development

The actions of the course team focussed on the development of the MMAT course materials and on the process that accompanied the development.

6.3.1 Actions during the MMAT course design and development: the course

The team decided to structure the course around a prescribed book (Cangelosi, 1996) with a supporting study guide, tutorial letters, and examination papers (UNISA MMAT00-8/101, 1996a;). All the sections of the textbook should be dealt with and the guide should provide simplified descriptions, examples, and short assessment exercises. The learners had to study examples provided as vignettes and then had to apply these to their classroom practice. The assessment includes activity-in-text opportunities, assignments, and examinations. During these contact opportunities the lecturers take great care to provide guidance and interact with the learners' study environment.

The focus of this study was to identify potential Unisa mathematics graduates who would become mathematics teachers - and their problems, such as isolation, lack of direction, dependence on guides, and the tendency to learn without insight. During this stage the demographics of the learners were not clear. The course team did have a good perception of the learners-to-be as the entry requirements were a prior degree or diploma with experience which included mathematics.

Following the course map and a team discussion, the process followed the curriculum and course design processes. (Refer to Chapter 3 for the literature study that indicated a number of important

issues and directions for the development of this course.)


The textbook was written by an American author, Cangelosi. He is a master at implementing problem-solving. The textbook includes a great number of vignettes to demonstrate real-life problems. However, the guide contextualised these vignettes in the South African situation and required learners to implement concepts in their classroom situation. The guide was also essential as an entry point into the complexities of the textbook. Tutorial letters provided guidance, structured the course and the assessment, and provided guidance and guidelines for the assessment (such as on the portfolio and criteria for self-assessment.) Learner support included a winter school" group discussion (optional), library support, guidance counsellor expertise, tutor support (additional fees), and an administrative support structure.

The strategy was to include knowledge and skills activities within the teaching texts. The focus was to follow the textbook as a main directive. The teaching approach embodied the philosophies, teaching approaches, and strategies described in Chapter 3. Adults are able to demonstrate their knowledge, abilities and skills: the portfolio results of the learners should demonstrate the principle that what is required for assessment via a portfolio (Addendum A contains the course materials for the 1996 course.) The learners needed to be actively involved so they were required to complete the activities and include 80% of the total number of activities in the portfolio section of their assignments. (UNISA MMATOO-8/101. 1996a.)

The course team followed the curriculum and course design processes as an initial plan of action (refer to 3.2.2). The content was divided into lesson units and the team structured the materials by mapping the course. The lecturer began the writing of the first learning unit. The self-study guide was divided into study units (see 3.4.1). The unit structures were planned to provide references, explanations, learning opportunities, and self-test questions - as well as introductions and summaries to study units. These sections were meant to motivate learners, and make concepts meaningful and relevant, tying the unit together and linking the study unit with the textbook.

The course developers believed that a problem-solving postmodernist approach to the course would address the need for skilled mathematics teachings in the South African school system. The outcomes formed the basis of all the in-text activities, the curriculum development, the learning design and the assessment structure. Learners start the learning process departing from stated outcomes. Outcomes are organised in a hierarchical sequence, from simple to complex levels of competence (see mathematics outcomes in 2.3.3) Throughout the learning process, progress towards achievement of outcomes is assessed.

Figure 6.1: Example activity demonstrating the study skills technique in the 1996 guide.



Activity 1-1: Overview and exploration

How could you use the 1S2S3S method to explore this chapter? We shall explain the method. Read our explanation and then draw your own mind map on a loose page in order to get an overview of the contents of the chapter. You may later find it useful to put the nine loose summaries together and in this way form a general view of the contents of Cangelosi's book. **REMEMBER:** After this chapter we shall no longer set out the six steps in detail; you will merely be asked to do S1S2S3 with regard to the relevant chapter.

Draw a mind map of chapter 1 which gives an overview of the contents of the chapter:

THE "READING-WITH-INSIGHT" METHOD

1. *Page through, explore. Read the chapter quickly (1S), forming a rough idea of the contents. Concentrate on headings and subheadings, bold and italic type, boxes, tables and illustrations, summaries and introductions. The objectives set for the chapter are important.*
2. *Make a cursory survey. Ask yourself this while you read: What key terms occur in this chapter? Stop when you identify a key term and read carefully what is said about it. Mark it in the book. What you are trying to ascertain is: "Where is it?"*
3. *Scan the chapter (2S).*
4. *Start a mind map (for the whole or for parts of it, as in starting a summary.) You are looking for items and concepts while reading the information in the chapter in a more evaluative way. Reflect on interrelationships between concepts. The question now is: What is it? What is the meaning and the purpose? Visualisation is important and you are certainly going to start writing down key concepts. You can omit parts of the text.*
5. *Deeper reflection. Start building a structure in your mind map, work towards an entirety. As you work through the prescribed activities of the chapter, keep returning to the mind map to fill in the detail. Reflect on the value and meaning of categories, concepts, motivations, variables and key terms.*
6. *Study-read (3S). This follows directly from stages 2, 4 and 5 and is done carefully, thoroughly and thoughtfully. The key terms and concepts you pinpointed have to be linked up, and in this the mind map and/or diagrammatic summaries are important. Pause while reading, consolidate what you remember and consider how new information fits in with what you already have.*

2

learner to draw up an overview and exploration of the chapter in the form of a mind-map, following 1S2S3S (Figure 6.2 and Addendum 1: 22). (See 3.6.3 (5)). An example of an activity addressing study skills using a table (UNISA, 1996: 15) is in Figure 6.2.

Figure 6.2: An example of an activity addressing study skills using a table (UNISA, 1996b:20)

Activity 0-12: Demystifying mathematics: perceptions

Draw up a table of two columns headed "Easy" and "Difficult". Turn to p 12 and scan the next few pages up to p 18. Look for indications of what makes mathematics easy or difficult, and note such factors down in the relevant column. Amplify this from your own experience. How can the difficult ones be made easy?

Figure 6.3: An example of an activity addressing study skills using a mind-map (UNISA, 1996b:20)

Activity 1-1: Overview and exploration

How could you use the 1S2S3S method to explore this chapter? We shall explain the method. Read our explanation and then draw your own mind-map on a loose page in order to get an overview of the contents of the chapter. You may later find it useful to put the nine loose summaries together and in this way form a general view of the contents of Cangelosi's book. **REMEMBER:** After this chapter we shall no longer set out the six steps in detail; you will merely be asked to do S1S2S3 with regard to the relevant chapter.

Information about the course, its assessment structure, administrative services, contact details, and support sessions like the day seminar offered were included in the first tutorial letter to the students and in the introduction to the module (UNISA MMAT00-8/101, 1996a). We urgently needed to complete the course design for implementation at the end of October 1996 for the November enrolments, and it was already June!

The course team planned the holistic learning strategies, such as mind-mapping and tables, to foster critical analysis and synthesis, and provide alternative options to students' habitual study-skills repertoire. Critical reflection activities regarding study strategies included directions to use a particular study process namely skimming, scanning and study reading (the 1S2S3S method). Each chapter starts with Activity 1-1 which requires the

The activities also address social integration (UNISA, 1996b:27). The course development focussed on the individual mathematics educator as a member of a particular social group (see section 2.2 and 3.2.6)). This was difficult because of the industrialised nature of Unisa as a mega distance education university (where mega" means more than 100,000 enrolled students) (see 2.1). The course was to be presented for the first time as a year course in 1996 (UNISA, 1996a) as part of a qualification (see section 2 for a description of the qualification).

Figure 6.4: An example of an activity addressing social integration and guided didactic conversation (UNISA, 1996b: 27)

Activity 1-1: Overview and exploration

1. Have you noticed how many different facets of the teaching of mathematics have emerged? Share your perceptions of the scope of mathematical instruction with a friend, colleague or fellow student.
2. Does the same apply to other school subjects? Talk to colleagues or fellow students in other disciplines and share your perceptions. What real differences are there between your experiences and theirs?

I suspect that the teaching of mathematics is larger in scope and complexity than that of other subjects. Do your conversations confirm this?

The activities to develop skills such a meta-cognition and study skills, follow in a thread-like fashion from one unit to the other, throughout the guide. Weaving a cohesive argument in a progressive, developmental manner (overcoming the Zone of Proximal Development, see 3.2.12), or in a diminishing scaffolding manner, is the researcher's view the "art" of writing an active learning course where activities are used in texts (see 3.2.4). "Daar was ontwikkeling in die materiaal en voortdurende kontrolering en deur niks uit te vee nie kan 'n ontwikkeling waargeneem word indien na drie hoofstukke weer daarna verwys word." (Wessels, 2001b). For example in UNISA MMATOO-8/102. 1996b, Activities 1.1, 1.2,2.1,2.2,2.10, 3.1, 3.2, 3.6, 4.1, 4.2 illustrate the use of mind-maps.

A number of activities required learners to form a dialogue with themselves, a colleague, the classroom children, or a group. The lecturer supports the idea that the focus should be on the building of "*interaktiwiteit tussen my en die student, maar veral dan ook die leerstof ... en 'n Unisa student net kan baat by 'n ander student as iemand wat met hom oor die vak kan kommunikeer.*" (Wesels, 1997: interview).

Figure 6.5: Example activities which foster dialogue from the MMAT study guide (Add. A:12)

- Act 6-17: ... compare your answer with that of a colleague.
- Act 6-18: ... could be discussed in a group context.
- Act 5-18: ... plan two scenarios to tell student and pupils the rules so that all can follow.

Activities included prompts to make a topical outline such as, the partially filled in mind-map (UNISA, 1996b: Act 2-2), the table (UNISAb, 1996: Act 3-20 and 4-6), sometimes writing a reflection paragraph, a letter, or a report. These are simplistic examples of image perceptual-conceptual structures such as image-schemata or conceptual metaphors and its embodiment and situatedness (Núñez et al., 1999:51-53).

The course would be published by Unisa. A number of media would carry the marketing of the course - such as an advertising brochure, a website, and the University prospectus. All our production choices had financial implications for the faculty as contract workers had to be paid by faculty, though using professionals from within the University support departments is currently free. Obviously it had financial implications for the University as a whole, but this course team did not have to consider this factor.

At Unisa typographical design influences the production requirements and the course was printed only for the first 80 enrolled students. The desktop layout provided us with flexibility to change aspects on-the-run and to get the guide printed via a photocopy process. The course team decided to use the first two course years as pilot years. This would allow the team to make radical changes to the course, if necessary. The production choices are dependent on aspects such as the time available, the print-run size (student numbers enrolled in the course, the number of years the course stays the same), the course content requirements (such as the learning components in the text, maps, tables of data, figures, or photos), printing ability and capacity, limitations in space and ability at the Dispatch Department. At Unisa a few good examples have been decided upon for suggestions, called the "fast-track layout". They are used for low print-runs. In some cases, the department may even do its own layout, called a camera-ready" layout. For the MMAT00-9 course the layout was camera-ready" for the first year, then the decision was that a fast-track layout" replace it. (See Addendum A). The mindmaps were deliberately hand-drawn to model the process and function of the map (figure 6.4)- following the direction of the instructional designer. A maximum of about 200 students were expected to enrol over a three-year period and the printing strategy for the cover page, therefore, was to design and print in one colour on gloss standard cover paper. No additional media were planned. Printing for about 80 students changes the printing process.

6.3.2 Actions during the MMAT course design and development: the course team

Academic departments had the freedom to elect professionals to the course team either from within the University support structures or from outside. The team decided to use an author-instructional designer-editor team (later formalised in the Unisa Tuition Policy, 1998).

In a mega distance education institution it is, in general, easy to allocate resources and functions to people because of the nature of the industrialised institution. The core course team dealt with the phases in the design and with all the teaching-learning issues. This team established teaching methods and pedagogy. Together they designed the environment. The delineation of the roles provided each member with appropriate territories, and there was little conflict. They also clearly defined the roles of the various course team members. During this stage course team members were identified and their expectations were discussed. The case study was written later in the process as expectations were expressed and issues came up. The drafts of the study unit were shared and critically discussed. During this study more specific discussion notes should have been shared as these notes are crucial in the data analysis phase.

The normal course development processes were used to develop the materials. The action research methodology cycles provided a constructivist approach, a non-linear cyclical structure for rich description. No standardised procedures at Unisa in the teams were used to the action research methodology proved to be a solution. As a course team we decided to each keep as much information as possible, so we made notes, kept letters from learners, kept some example portfolios (with approval from the learners), stored the course material from each year, and the assessment instruments, with results and summaries. We planned to do some interviews on video or any other appropriate media.

One of the major aspects of the research was to require learners to experiment with a holistic approach to learning. We expected the mathematics background of the learners, as linear thinkers, to influence their ability and openness towards using the mind-maps. So we ourselves made mind-maps and through this exercise got to know one another very well. We thought differently, and the first chapter was especially difficult. The end result of this first chapter was the view of the lecturer; some compromises had to be considered. This was a good experience for us both (as the editor was not involved in this stage, though we wished him to be). The structure of the course followed the textbook closely, but did evolve on its own.

We requested (in the MMAT00-8 tutorial 101 of 1996) that the learners provide us with feedback and give input in the course development as part of the course evaluation. (See 3.5.5 (16)).

A teaching advisor's role (refer to Bratton, 1981:21) is to design course materials. Silber (in Bratton, 1981: 21) goes further and identifies some "thinking processes" which developers use and this course team had to:

- identify a problem related to learning and/or performance;
- gather information about the problem, analyse it, synthesise it into a statement, and evaluate the statement in terms of its reality;
- understand the body of knowledge;

- analyse the content, and restructure it according to the integrity of the content and the learning and instructional principles to be applied to it;
- evaluate the accuracy and adequacy of this restructuring, and redo it if necessary;
- translate verbal messages into text for distance education print, or visual or audio format.

The instructional designer may be known as the course developer, teaching advisor, facilitator of the course team, or instructional development specialist. This person engages in several intellectual tasks in the design of a course of which he or she may have very little personal knowledge; he or she might interview experts, read texts and journals, or employ techniques to gain an understanding of unfamiliar content, the nature and characteristics of the particular discipline or field of knowledge. As a researcher the instructional designer may collaborate to conduct research either openly or covertly.

During the first few meetings with the subject expert, the researcher as teaching advisor:

- tried to understand the nature of the educational situation presented by the client as it manifested, with its advantages and limitations;
- established and maintained a professional consultation-type relationship with the client;
- made an effort to understand the subject matter, especially because the mathematics curriculum content is unfamiliar, though the teaching methodologies were very familiar.

In the beginning there were many problems that affected course design for the MMAT course. The team observed the course design developments in the visual design, the linguistic design, the content design and the learning design. A course map would aid the process. A course map is an outline representing the content of the course. This content consists of the course description(s), general aim(s), instructional goals, units and lessons/modules to drive the content. The map allows the instructional designer to look at the overall organization of the blocks of information to see if the order of information is logical in its progression and developed enough for the students. The key point to be made is the relationship between the course map components. The overall picture of the course and the integration of the course map components provide a complex yet thorough depiction of what contents the instructor wishes to convey to his/her students and it lends itself well to a flexible "non-cookbook" approach (Brinkley, Pavlenchko and Thompson, 1991: 51).

The course map for the MMAT00-9 course was very important in the course development. Apart from stating the focus of the course (outcomes), the details of the target group, and how it links in with the learning programme (SAQA requirements for registration of the learning programme), it provided the course team with specialist overviews for each unit - which were later incorporated into the course activities in the form of half-filled-in mind-maps which learners used these to check their understanding and study the chapter.

The product had to be visualised. The course team (instructional designer, graphic artist, editor, faculty member) discussed how the printed version should look and the result was that the layout (as Tutorial Letter 102) was characterised by a "tentative", open, and friendly feel. In some cases individuals had personal preferences. Often the team agreed on which examples to add to stimulate ideas. The choices are dependent on aspects dictated by the institution but the team suggested alternatives in most instances.

The team decided to not use boxes, but soft lines to demarcate areas on the page, especially the activities(see figure 6.2). The feedback would be softly" added directly below the activity or follows in the subsequent discussion. The typeface for the three levels of heading was a flowing script with sans-serif used for the rest of the text. The mind-maps were hand-drawn, not computer graphics, to model how a learner would do these. The front cover was a single colour, pink. Other printed material was not typographically prepared in the same way.

6.4 Observations during the MMAT course design and development

The Unisa course team addressed course design aspects in order to improve the quality of the printed course. During the design the team processes played a significant role.

6.4.1 Observations during the MMAT course design and development: the course

The team members' personal notes, letters and e-mail correspondence during their many discussions provided a paper trail through the first 18 months of planning, developing and producing the course. (See for example Sonntag,1996; Boucher, 1997; Wessels, 1995.)

At this stage the action plan was revisited. Time was short and some aspects had to be altered; the website was put forward till the course was tested thoroughly, and a specially designed page layout was not possible so the layout was designed on a normal wordprocessor by the instructional designer.

The instructional designer advised faculty of the most appropriate way to write for the layout. The language style was often addressed during the writing of the guide: the style was meant to foster dialogue. Students of mathematics think and write differently because of the subject. The writing style of the lecturer is a determining factor and this was addressed a number of times with compromises made.

Our historical perspective on Unisa informed our analysis of the complex interplay between our actions and our social structure in the organisation. No situational structure, where there is an interplay of people, is static or "given". The forces for conflict and change were ever present in this case (see 2.6.1). For example, in the pilot course during 1996, the mind-map required in Activity 1.1 and 2.2 was a compromise, as the learning developer saw things differently from the subject specialist - whose view was accepted after a team negotiation. Another disparity was the form of the text layout - which was seen as crucial as this either "draws" a learner into the text, or hinders engagement (Addendum A). It also affects ease of reading. Here is the learning developer's note about this:

"I am making a special desk-top publishing layout partly because the materials are late and cannot be printed by the University printers. Given this opportunity I want to experiment with a different layout which the system otherwise would not allow me. We [the core team] accepted the layout principles in August 1995" (Journal note of learning developer, November 1995).

The note continues:

"November 1996: The layout was changed without consultation. The elements that are the same are the sans-serif font, the areas of focus at the beginning of each chapter. The element that has been changed is the 'informal' scroll-type script to a more formal sans-serif script, in bold. And the activities are now boxed, although my experiences with students are that boxes tend to be 'psychologically excluding'. Oh no here is a regression!" (Journal note of learning developer, December 1997).

The thread continues:

"The relationship between me and [the lecturer] is becoming more distant and the product was changed out of the team context. Perhaps it is because the team is no longer necessary, or perhaps we are just too busy, or may it be another reason?" (Journal note by learning designer, March 1996).

As the extracts of the diary notes shows, the team members observed and reflected on events of course development as it was our required reality.

The outcomes formed the basis of all the in-text activities, the curriculum development, the learning design and the assessment structure. Learners start the learning process departing from stated outcomes. Outcomes are organised in a hierarchical sequence, from simple to complex levels of competence. Throughout the learning process, progress towards achievement of outcomes is assessed. Assessment used the stated assessment criteria which had been derived from the stated outcomes. Assessment criteria were clearly stated to students and the assessors before the assessment took place. Marks and symbols were awarded, although this is not necessarily needed to attain the outcomes. The structure of the guide closely followed the textbook topics.

Course development subjectively selects and uses instructional theories and learning theories but their application should be with conviction (Reigeluth, 1983: 452). The learning design of the MMAT course was based on constructivist and problem-solving theories and approaches. The inquiry needed to address the focus questions stated in section 1.4.2. The major activities that are involved in curriculum development are stating of objectives, determining content, organising learning experiences, and evaluation of learning.

The layout of the course was a desk-top format because of the limited time needed by the Production Department to print the 100 copies quickly and because we were running late with the course. The second reason was that we experimented with a layout principle that was unique in the institution and used "deviance" techniques to keep the team and the process alive within the bureaucracy of the institution.

6.4.2 Observations during the MMAT course design and development: the course team

A typical Unisa course developing team dealt with the course. This case included the action research component to document the process - this is often a neglected. This research design is appropriate for with the practice of research in instructional design and course design process (section 4.2). The research data were collected through qualitative methodologies with interviews, course material samples, a description of the case, student letters, and portfolio assessment results. There were quantitative data from the examination results, and drop-out rates. The action research methodology was both a useful and an enabling research method for the development team and researcher who wished to improve their understanding of the discourse within distance education practice and mathematics education as informed by educational theory. The course team wrote an invitation to the learners to engage in the text and to take part in the process as co-researchers.

During the development there were times when some course team members worked together, while the editor and graphic designer were co-opted later on. Production specialists were included in the planning and during the production stage. The course team was founded on a research relationship in which those involved were participants in the change process (according to the view of Hart and Bond, 1995).

The research executed by the course team was founded on a research relationship in which those involved in the curriculum and course development and management were participants in the discourse of a change process (according to the view of Hart and Bond, 1995). The aim of the course team was to improve and involve all participants in the learning process. This process was extremely educational for all parties involved, as the various research results showed. Each time

there was some intervention, change took place; on reflection some of these changes were for the better and some were detrimental. The whole process of curriculum and course development (about two years) and the piloting of the course (over three years) was developmental and involved reflective enquiry. This enabled the course designers to better realise developmental qualities in their practice (see Chapter 2).

During the first meeting in July 1995 the instructional designer discussed the instructional design process with the lecturer, they exchanged needs and expectations, and they discussed roles in the course team. The instructional designer was introduced to the course structure, the components and the instructional strategies the lecturer normally used. In the MMAT00-9 course, the curriculum, the existing tutorial letters, the textbooks, and the proposed changes to the course with the new textbook were put forward for discussion.

The instructional designer proposed a draft course map during the next meeting, and described the functions and role of the course map. At the end of meeting the lecturer took the course map to develop it further for the course team.

The role of an instructional design consultant in a course team differs when compared to the instructional designer as action researcher. There is reflection in both cases, but the action research process forces the course team to be reflective on only a few important issues. In instructional design course teams all the issues involved in the curriculum development of the specific distance education course team tend to be equally important. During this programme this distinction was initially unclear - which created confusion, difficulty and a blurred focus on the important aspects of the improvement of dialogue in the distance education setting.

The researcher's role was as a participant-as-member in the team. As a specialist in learning design I focussed on keeping my attention free to recognise problem-related events and to attune the course team to the researcher-subject interaction and its interpretation. As a team, our actions were intentional and empathic, with a value commitment.

It is vital to select, compile and plan materials very well, especially when using the problem-solving approach. The educator has to be experienced in planning course materials. One has to repeatedly revise the document. "jy moet maar die paragrawe 'n bietjie goed skommel en skud voordat jy 'n ding verander." [Wessels, 2001a).

A formal period of professional training into the design of course materials is necessary "[na] 14 dae se intensiewe onderrig nodig en al hierdie middels [tegnieke en strategiee vir aktiewe leer] voordat jy dink jy 'n verandering gaan doen." [Wessels, 2001a). In the experience of the learning designer, this period cannot happen in two weeks because of emotional and psychological overload (based on

results from staff development experiences by Heese, 1994) but needs to be spread over a 6 weeks period, as was the initiation period for this project.

The subject expert and lecturer had a number of important experiences. "The curriculum design process was known as he is a very experienced Unisa lecturer. However, the philosophical changes that the course team strove towards impacted heavily in the development phase. There were regular periods where both the instructional designer and the subject expert fell back into the familiar comfort zone. It took constant reflection to move out of the known ways of doing, into the unfamiliar - the theoretically advised - areas: The interview with the lecturer confirmed my own experience working with him in the team. I often think about our experiences - what we wanted, what we thought was feasible and what we wanted to try out in our case" (Instructional designer, 2001: notes).

The course team discussed problems and unknown aspects which popped up in the form of questions; the team members made assumptions, stated preliminary hypotheses, and raised issues that might have been of relevance.

At this point we were subjective and passionate about the course:

"It is indeed difficult to be dispassionately objective when events are seen from the inside and without the perspective which time alone can lend them. However, if approbation is the keystone of the story of this university since 1946, it can at least be said that the view is widely shared, particularly among the many students who have, over the years, enrolled for its courses" (Boucher, 1973a: Foreword).

In the University resistance to a new approach became evident (mirroring the research Fox and Clark did, see 3.3.1). As individuals (see chapter 5) we searched for answers, and as we started with the course team we came to share our proposals on how to design a course based on a problem-solving approach within the constructivist paradigm with staff being part of the full course team in order to break down resistance.

6.5 Reflections on the MMAT course design and development

Both the product, the course materials, and the process of team work is now visible. The Bureau for University Teaching (BUT) extensively used staff development workshops to inform academics of new developments and best practices in course design and instructional design. It was after the course design and development workshops for the six faculties at Unisa that the subject specialist requested BUT to support in such a course team approach to the course design for Mathematics Subject Didactics. Course teams often foster the collaborative and participatory development of

study materials. This strategy sparked the initial contact and the collaborative planning, development and evaluation of this course's materials.

6.5.1 Reflections on the MMAT course design and development: the course

The development of the MMAT00-8 course took in the region of 520 hours - from initial planning, to writing, to editing, printing, packaging and distribution to students. The textual design elements (see figure 3.2 in 3.4.3) are interwoven, but will be discussed separately. Costing was not the purpose of this research.

(a) Reflecting on the linguistic design

The subject expert had to regularly refocus on the changed discourse. The new focus on the dialogue with the student was difficult, not in the conceptual and planning phases, but in the writing of the study materials phase: the tone and register of the language had to be different to the impersonal and third-person style based on the lecturer's personality, subject specialisation and writing habits. The mathematics lecturer also has a distinct writing style linked to his personality and habits (See Addendum A) with the editor and the learning developer having to make him constantly aware of the influences of the constructivist approach to writing for learners. The language style was seen as a function of fostering dialogue (section 3.4.3). (Wilson, 2001). The "invitation" to the learners to write in different formats was a motivational device (3.5.5 (8)) .

(b) Reflecting on the content design

This was a new course development. The course materials were produced according to the University guidelines and requirements for tutorial letters, assignment structure and presentation, and the materials' distribution. The study guide design followed the following structure:

- the learning outcomes for the learning unit or its focus;
- the learning resources such as prescribed and recommended reading;
- the assessment of the learning (in-text activities and following assignments) and the format of the assessment (portfolio, essays, multiple-choice questions);
- the integration of resources to provide students with an exciting learning experience;
- the integration of a variety of learning strategies;
- the learner support strategies;
- the sequence for teaching the knowledge and skill components for each outcome;
- the descriptions of visuals to enhance learning.

This was a wrap-around guide (Rowntree, 1994b: 119) in which the tone addressed the learners and "die handboek opsigself sou nie iets beteken het sonder dat hy 'n taak moes voltooi om die konsepte te ontsluit nie." (Wessels, 2001b). The guide was structured following the topical outline in the textbook. The explanations in the guide complemented concepts in the textbook. Topic 1 and 2 was

interesting but difficult to conceptualise. The instructional designer and the lecturer did not agree with one another's mindmaps - it was decided to choose the lecturer as specialist.

The lecturer felt uncomfortable from the beginning about the absence of mathematics content and syllabi for schools as the learners have little knowledge or resources to support the problem-solving approach. As a solution he decided to include additional references to content and provide syllabi in the 1996 course (Addendum A) because "Die [skool] sillabus was nie beskikbaar nie. Ons is eintlik in hierdie handboeke [gidse] ver voor [die Suid Afrikaanse beweging]" (Wessels, 2001a).

(c) Reflecting on the visual design

Visual design and appearance (e.g. general appearance, presentation, user-friendliness, relation between guide and textbook, availability of package and textbook, and readability of the textbook) presented an integrated study package; the instructional designer believed the "open" and "tentative" nature of the guide with icons and a one-colour cover to be important in making the guide interesting.

The key issue at this stage was the course materials that had to be ready for the new enrolments. It was decided that final documents would be presented as a guide-as-tutorial letter because "dit meer veranderbaar is." (Wessels, 2001a).

(d) Reflecting on the learning design

The written materials reflected the use of activities as one of the a textually-based learning devices (see 3.4.3). The course team incorporated theories in the course design and development of the course resources (as described in Chapter 3). The 1996 course materials included various arguments based from the literature (see 3.2.1), that the knowledge premises of the design team will influence their team roles and the learning design of the course materials. A number of activities were included in the text and proves that it is possible to foster an enabling pedagogy through a particular course structure and roles, the design of particular activities and actions, and by using particular language and planned dialogue.

The team did not meet their production deadlines. A new course development at Unisa of six months is unrealistic. The academic year also includes many other responsibilities with stressful periods such as examination marking. The MMAT materials was three months late - still on time for the closing date for registration.

1) Reflection on embedded premises:

In contrast to rote learning this material's development stimulate learners to reflect on borderline cases and complex practical issues as educators should promote a student-centred approach to learning, allowing learners to construct their own meanings (section 3.2.6). In UNISA 1996b, the

MMAT guide, activities that supported learners premises include Activities 1-6; 1.14; 2-8 and 3-10. It is therefore possible to include activities that address learners' embedded premises. "As gevolg van leer kan studente daadwerklik 'n onderrigstyl en gedragspatrone verander." (Wessels, 2001a).

2) *Reflection on independence and autonomy:*

The activities included the strategies to overcome dependence and dependency suggested by DE scholars and this researcher (section 3.2.2).

- A self-study programme with actions per study unit to pace themselves, with deadlines for the four assignments (section 3.2.2; UNISA MMATOO-8/101, 1996a; UNISA MMATOO-8/102, 1996b; UNISA MMATOO-8/102, 1996c).
- Individualisation to choose examples and applications from their own environment to responsibly follow an own course of study through for example contract learning or authentic learning through compiling a portfolio. (BUT, 1997, Chapter 6; section 3.2.2; UNISA MMATOO-8/101, 1996a; UNISA MMATOO-8/107, 1996g)
- freedom to select own direction through setting own goals, choice of activities and self-evaluation and a feeling of "space" (section 3.2.2; UNISA MMATOO-8/101, 1996a; UNISA MMATOO-8/107, 1996g). The lecturer said "*ek dink dit het hom toue gegee om te waag en vryheid gegee om sy eie skills te artikuleer.*" (Wessels, 2001b).
- planned actions to sustain interest and motivation based on the premise that alienation creates boredom, passivity, submissiveness and anxiety. Therefore the learning actions should foster conscious and creative alienation (section 3.2.2; UNISA MMATOO-8/101, 1996a; UNISA MMATOO-8/102, 1996b; UNISA MMATOO-8/102, 1996c; UNISA MMATOO-8/107, 1996g)
- supportive actions in a project-oriented program as a framework to actively engage in tasks and topics in studying the texts which may reduce drop-out (section 3.2.2; UNISA MMATOO-8/102, 1996b; UNISA MMATOO-8/102, 1996c; UNISA MMATOO-8/107, 1996g)
- a design that enables understanding of the structure of the subject (section 3.2.2; UNISA MMATOO-8/101, 1996a; UNISA MMATOO-8/102, 1996b feedback to activity 3.-5; UNISA MMATOO-8/103, 1996c; UNISA MMATOO-8/107, 1996g)
- assessment structure for authentic learning (section 3.2.2; UNISA MMATOO-8/101, 1996a)
- course assessment (section 3.2.2; UNISA MMATOO-8/101, 1996a).

3) *Reflection on dialogue and communication:*

The strategies for dialogue to enhance active learning embedded in learning opportunities in text were related to the definition for active learning (section 1.7; 3.2.3). Active learning is viewed as a multifaceted ability. There are many examples in the study guide of which we list a few. Some involves:

- components of reading skills (UNISA MMATOO-8/102, 1996b activity 0-3 feedback)and "*taal, hulle verstaan nie wat hulle lees nie*" (Wessels, 2001a)
- study skills (scaffolding in activities UNISA MMATOO-8/102, 1996b activity 1-1 and 1-2; 2.1 and 2.2; 3.1 and 3.2; 4.1 and 4.2) ,

- critical reflection skills (UNISA MMATOO-8/102, 1996b activity 1-10),
- writing skills (UNISA MMATOO-8/102, 1996b activity 1-7). Vir 'n tweede of derde taal gebruiker is dit moeilik... daar was swak formulering en min geskryf" (Wessels, 2001b).
- meta-cognition ability (UNISA MMATOO-8/102, 1996b activity 1-6 and mindmaps 1-1),
- contextualising ability (UNISA MMATOO-8/102, 1996b activity 2-3 based on the curriculum or 3-14 and 3-15),
- praxis relationship building skills (UNISA MMATOO-8/102, 1996b activity 3-16 and 3-20). (The nature of these constructs are examined in Chapters Two and Three.)

Conceptually, the guide and textbook had a good flow of dialogue although it is possible that through study there might be logical gaps, deviations from the topic ("red herrings") and dead-ends to arguments - all of which may create confusion.

The lecturer should include more examples from the South African situation (UNISA MMATOO-8/102, 1996b; UNISA MMATOO-8/103, 1996c) to illustrate concepts and to discuss borderline cases relevant to the industry environment. "Ons het aan hulle vier voorgeskrewe boeke gebring waar die ander studente net een kry." (Wessels, 2001a). The text builds continuously on the prior knowledge of the target group in the guide, but more variety was needed to cater for diverse learners. (Instructional designer, 1997: notes).

The study process of the whole course was very detailed with many activities required (UNISA MMATOO-8/102, 1996b; UNISA MMATOO-8/103, 1996c) and the activities were frequent to help the learners that required it. On the question how the course assisted the DE students to learn independently the lecturer answered "'n volledige pakket wat hulle ontvang het met geweldig baie riglyne." (Wessels, 2001b).

4) Reflection on an integrated synergy

This is probably the most difficult aspect to provide evidence for because of the integrated nature of the experiences with concept forming (see 3.2.6). From the learning developer "the activities are completely integrated in an artful unity which is so exiting. Perhaps making the mindmaps makes one aware of the "integratedness" in the textbook and the interrelationship with the guide." (Instructional designer, 1996: notes). Also, the lecturer refers to the integration of mathematical language and knowledge "in die boek word ... die kennis en taal geïntegreer . Die integrasie van verskillende afdelings van wiskunde ... terminologie en taal." (Wessels, 2001a).

5) Reflection on feelings and motivation:

Following the argument in 3.2.5, UNISA MMATOO-8/102, 1996b Activities 1-12 reflects on side effects during a lesson and 3-14. These activities demonstrate the imbeddedness of feelings and motivation in text. In most cases in the guide the feelings and motivation was placed in the feedback text. The textual design actively prompted emotional involvement. Students need to

focus on "objects" which becomes important when feelings and motivation is added.

6) Reflection on historical and social relatedness:

The course development focussed on the individual mathematics educator as a member of a particular social group where he is able to integrate new information through meaningful learning and relationships among concepts, as tools to understand his world (see 3.2.6). The team found this difficult because of the many diverse learners in the course and the industrialised nature of Unisa with its standardisation and mass of learning provision. However, the problem-solving approach provides a platform enable learners to foster relationships between concepts and context.

"Activiteite waar hulle 'n ding self uitprobeer en dan in die klaskamer daaroor rapporteer."

(Wessels, 2001a).

7) Reflection on structure and support:

The main teaching technology at Unisa, also for this course, was a pre-prepared, printed learning resource that included study guides and tutorial letters (see 3.2.6), however the structure of the course was not the same teaching-focussed element such as it was in the early 1980s. Structure is perceived differently today.

Unisa learners studied at the time and place of their own choosing, therefore as independent adults they need a sustained and structured dialogue and active environment. The "independent study" model (see 2.4) was augmented in the Mathematics Subject Didactics course with a study school for support where the learners met the lecturer face-to-face (UNISA MMATOO-8/101. 1996a).

Structure includes teaching, learning and subject structure. Semantic models are imbedded in the learning structure. The teaching structure include an alphabetical index or a functional glossary - both useful tools for reference purposes which the textbook possessed. The structure of content in the guide was good, providing references, explanations, learning pathways, learning opportunities, and self-test questions. Introductions and summaries to study units received particular attention (see 3.2.7). These sections were designed to motivated the learners and made concepts meaningful and relevant, tying the unit together and linking the study unit with the textbook. References to the textbook were sometimes bothersome to add, but doing this was essential for a wrap-around guide. (For example Activities 1-12 and 4-24). The textbook on its own would be not enough "Die handboek opsigself sou nie iets beteken het nie as ek nie vir hom 'n opdrag gegee het op 'n werkopdrag te voltooi nie. 'n Gids is nodig om die ding te ontsluit." (Wessels, 2001b).

8) Reflection on mental growth and schema development:

Overviews and schema structures were an important underlying learning theory principle that the course team wanted to introduce. The course team planned holistic learning strategies, such as mind-mapping, to foster critical analysis and synthesis, and to provide alternatives to students' habitual study skills repertoire (see 3.2.8). For example, in UNISA MMATOO-8/102. 1996b, Activity

4-20: "... draw your own mind-map on a loose page in order to get an overview of the contents of the chapter. You may later find it useful ...".

The team wondered whether the mathematics learners would be able to manage with the "strange" concept of a mind-map. (See activities 1-1, 1-2 etc) The mind-maps of different students should show the extent of their schema - their understanding of the concepts.

9) Reflection on active involvement:

Various techniques were employed in the course to foster active involvement such as concept mapping, metaphors, rehearsing, imagery, chunking and others (see section 3.2.9).

"interaktiewiteit tussen my en die student, maar ook tussen die student en die leerstof en hulle omgewing." (Wessels, 2001a). Active involvement is never easy and learners may shy away from taking a course because it is taxing. Although it was difficult, the team did not want to change the approach "ek wil dit gladnie verander nie. Dit is 'n baie kragtige proses wat ek wil beoog." (Wessels, 2001a).

10) Reflection on critical consciousness and reflexivity:

Students were able to become more conscious about their own views and some were able to challenge and change the world, not merely uncritically adapting to an environment (section 3.2.10). Within their emerging praxis, the expression of a critical consciousness empowers. Often this empowerment happens according to mutually agreed upon goals.

11) Reflection on liberation and empowerment:

The course requires learners to investigate their reality in class, challenge their practices, and to suggest changes. They are expected to be critical in their search for knowledge. They development a collective responsibility that seek dialogue, political and personal empowerment. Free expression and the development of skills and competencies becomes possible. (See 3.2.11). "as ons met groter perspektief na die goed kyk. Ek wou eerstens wiskunde onderrig oordra maar in die proses was ek bewus van die tatele tradisionele persepsie van wat wiskunde is en ek wou positiewe verandering bewerkstellig gerig op probleemoplossing." (Wessels, 2001b).

12) Reflection on context-focussed change:

Students were confronted with new ideas which they applied in their own context with a critical awareness. This should make the students consciously acquire skills and change:

"[W]at ons wil bereik het saam met die verandering is die ontwikkeling van vaardighede wat hulle nog nooit gehad het nie.... die studente skryf hulle het goed teëgekome wat hulle nog nooit gedoen het nie, of wat ooit van hulle verwag was nie" (Wessels, 2001b)

This change requires a social embodiment (as argued in 3.2.12)

"Ek het hulle keer op keer gevat om hulle praktyk met die Amerikaanse boek te vergelyk; ook omdat die boek [Cangelosi] 'n weergawe is van die ou bedeling ... om dit dan ook in terme van ons eie situasie te interpreteer. Dit sal natuurlik weer 'n nuwe evaluering wees want ons land gaan baie sterk in op hierdie komplekse tegniese raamwerke wat onderrig vir die onderwyser moeilik te maak. (Wessels, 2001b).

13) Reflection on occupational relevance:

Adults are able to demonstrate their knowledge, abilities and skills. The vignettes or case descriptions in the textbook model situations and described experiences that the students had to engage as teachers. "Evaluasie dan ook in die klaskamer situasie, maar ook die materiaal waarmee hulle werk asook die kurrikulum" (Wessels, 2001a). The use of an "other" before the "me" is an important principle to enable critical evaluation in the classroom. The portfolio results of the learners should demonstrate that the inclusion of personal experiences should be chosen with the aim of evaluating occupational relevance (see section 3.2.13).

14) Reflection on measured progress:

DE learners have a weakness to measure their progress (see 3.2.14), therefore in this course they were required to reflect on their learning process in portfolio letters and in the activities (for example UNISA MMATOO-8/102. 1996b: 1-16). The assignment dates provide time-defined indicators, as do the date for the day seminar. "Refleksie en evaluering is een van die belangrike elemente in die kursus." (Wessels, 2001).

Progress can be stifled by a too heavy workload as learners become demotivated. (See 3.2.14 and 3.2.18.) The drop-out rate of the learners was a concern "wat problematies was was die omvang van die kursus. Die studente het in groot getalle gesê." (This was a big issue but later not investigated in this study).

15) Reflection on directed open outcomes:

The portfolio provided evidence of the purpose and the degree to which the learner established and maintained a clear sense of purpose. Looking at the 1996 guide (UNISA MMATOO-8/102 and 3, 1996b-c) the aims of the learning were stated explicitly at the beginning of the guide and in the textbook focussing on knowledge, skills and values. The outcomes were made measurable in tasks embodied in the learning opportunities (activities). The tasks were closely linked to the formative assignments and summative examination strategies (SAQA, 2000, see 2.2). The chapters end with a chapter review which takes the learner back to the aims or goals and relates the information to the other chapters as none of the chapters stands alone but is part of the whole process.

The instructional design in 1996 excluded upfront outcomes and students had to be guided to discover the topics and unit outcomes themselves by way of enquiries, mind-mapping of chapters in

the textbook, and working through the questions. The text guided learners towards an overview of the course and of each chapter and the team expected that the learners would succeed in doing this. The learners were not bound to content, but to outcomes (see 3.5.15) as "ek het elke keer die keuse gelaat in terme van die totale tema. Die student weet hy moet die keuse maak van sy eie strategieë." (Wessels, 2001a).

16) Reflection on assessment:

Assessment used the stated assessment criteria which had been derived from the stated outcomes (see 2.5.4). Assessment criteria were clearly stated to students and the assessors before the assessment took place. A mark structure linked to Unisa's credit system (UNISA MMAT00-8/101, 1996a), although examination entrance could be negotiated with the lecturer. The learning design was focussed on fostering problem-based learning bound to unique learner contexts. The Mathematics Subject Didactics course has an assessment structure that includes paragraph and multiple-choice formative assignments, a portfolio, and a summative examination. In order to triangulate the data further the researcher, in collaboration with the lecturer (Wessels, 2001b), planned to analyse the marks of the assignments, portfolio and examination.

The portfolio directions that were designed by the team indicated clearly that it is not a neatly typed document with the same look" from the first to last pages lecturer (UNISA MMAT00-8/101, 1996a-k). Therefore the completed portfolios included (UNISA, 1996d) a contents page; activities completed, improvements" to work; collaborative work with another student - with details; changes and motivational aspects, with notes; the selection of items for the portfolio; a self-evaluation of the portfolio according to suggested criteria; a letter from the student describing how his or her insight and understanding towards problem-solving changed, how his or her attitude changed, which one of the activities and measuring instruments was most enjoyable, and which one the worst and most difficult to do.

Formative self-assessment (see 3.5.5 (15)) criteria may be designed according to different strategies: cumulative schema, analytical schema, or a focussed-holistic approach. A *cumulative schema* evaluates the different parts separately and then the marks are counted together (Randall, Lester, & O'Daffer, 1987: 6). In contrast, when using the *analytical schema*, separate ratings are used for each outcome and achievement (such as to communicate effectively, to do procedures correctly, to demonstrate the understanding of concepts and insight, and to apply the concepts in a real-life situation). The marks for each area will depend on overall ability throughout all the parts of the portfolio. This approach works well when one activity should be evaluated for evidence of more than one outcome and achievement. A scoring rubric may make the evaluation more explicit to students and to evaluators. The marks for a particular skill will be based on various sections of the portfolio. Also, one section of the portfolio may be used to evaluate a variety of outcomes

(Randall, Lester, & O'Daffer, 1987: 6). The *focussed-holistic approach* is used where the portfolio is used as a method to evaluate purpose - the purpose being the achievement of one particular learning area. A selected, limited section within the portfolio is chosen and a single mark is given which represents the student's abilities. These abilities are considered to be representative of the portfolio as a whole.

The team included a scoring rubric (Figure 6.1) to assist in both the learner and course presenter finding the use of portfolios more enjoyable and to assist in their self-evaluation. These strategies were described to the students in their study material (Unisa, 1996d: 6).

Figure 6.6: Scoring rubric used in the MMAT course.

EVALUATION INSTRUMENT FOR YOUR PORTFOLIO

NAME *W. P. K. Riddings* STUDENT NUMBER *6467571*

LEVEL 4			YES	NO	
4.1	more or less consistently accurate interpretation of problem situations or statements		<input checked="" type="checkbox"/>		
4.2	proper use of the given data		<input checked="" type="checkbox"/>		
4.3	appropriate strategies and approaches that are logically compatible with the stated problems		<input checked="" type="checkbox"/>		
4.4	few errors or none in mathematical procedures		<input checked="" type="checkbox"/>		
4.5	evidence that answers have been reconsidered and evaluated		<input checked="" type="checkbox"/>		
SELECT (a) and/or (b) and/or (c)					
(a)	evidence of approaches (to problems) that show creativity and insight but are atypical	(b)	the use of technology either in preparing or in solving the problem	(c)	deceptive handling of complexity, vagueness and ambiguity in mathematical (teaching) problems
(a)	<input checked="" type="checkbox"/>	(b)	<input checked="" type="checkbox"/>	(c)	<input checked="" type="checkbox"/>
LEVEL 4 (Mark)		75% - 79%	80% - 89%	90% - 100%	

LEVEL 3			YES	NO
3.1	virtually consistent accurate interpretation of problem situations or statements			
3.2	proper use of the given data			
3.3	appropriate strategies and approaches that are logically compatible with the stated problems			
3.4	few mathematical or procedural errors			
3.5	evidence that answers have generally been reconsidered and evaluated in the context of the relevant problems			
LEVEL 3 (Mark)		60% - 64%	65% - 69%	70% - 74%

Students were required to compile a portfolio, in combination with a typical Unisa written or multiple-choice assignment. The portfolio accounted for 50% of the credits towards examination entrance, while the other two essay-type assignments contributed 25% each. (UNISA MMAT00-8/107, 1996g). The guide provided help with completing the assignment questions and portfolio. "Ek het mettertyd 150 aktiwiteite gehad en almal vereis van die student, toe afgeskaal na 80% en daarna na 70%." (Wessels, 2001a).

With the other assessment formats, self-assessed authentic assessment strategies provided a solution - portfolios could encapsulate certain experiences and provide a qualitative view of learning (see 3.5.5 (15)). The assessment criteria specified did indicate the different aspects to be assessed

and scored. It was simple to use, easy to understand, reliable, and a faithful representation of the work done. The learners who sent in their assignments and portfolios sent in this evaluation instrument. None of the learners commented on the assessment criteria.

This strategy address and evaluates various dimensions of a process and the student's achievement in a particular dimension. Various abilities and outcomes are focussed in and represented within one value. The student's abilities may be to: interpret a problem, the method and choice in using a

particular strategy, the way to evaluate a problem, and the way of providing feedback concerning the problem within a particular situation. For example, in the MMAT00-8 course, various communication abilities were evaluated - such as the ability to correctly communicate mathematical ideas, correctly follow procedures, demonstrate understanding of ideas, apply mathematics in problem-solving situations (Randall, Lester, & O'Daffer, 1987: 6).

Students who meet or exceed the envisaged outcomes in the beginning of the course should be able to get credit by way of recognition of their prior learning. In 1996 this was an informal recognition, as the University only later initiated the recognition of prior learning. The learners are required to self-evaluate and relate their understanding to an evaluation instrument. This strategy addresses and evaluates various dimensions of a process and the student's achievement in a particular dimension. Various abilities and outcomes are focussed in and represented within one value. The student's abilities may be to: interpret a problem, the method and choice in using a particular strategy, the way to evaluate a problem, and the way of providing feedback concerning the problem within a particular situation. For example, in the MMAT00-8 course, various communication abilities were evaluated - such as the ability to correctly communicate mathematical ideas, correctly follow procedures, demonstrate understanding of ideas, apply mathematics in problem-solving situations (Randall, Lester, & O'Daffer, 1987: 6). The self-evaluation guidelines for assignments we as a course team felt were important (Tut MMAT00-8/101/97:11). The evaluation instrument for the portfolios was critical and the guidelines and criteria documents provided (refer to Addendum C: Tut MMAT00-8/103/1999:7-11) were good as "die riglyne vir die portfeulje is baie goed opgestel, die aktiwiteite is duidelik" (Wessels, 2001a). The criteria to assess learning effectiveness included the purpose, achievement, application, and reflection on learners' learning development (as suggested by Posner and Rudnitsky, 1997: 198-99 and UNISA, 1997a: Addendum B) but the MMAT portfolio "moet dieper en intensief plaasvind." (Wessels, 2001a). Students were required to compile a portfolio, in combination with a typical Unisa written or multiple-choice assignment. The portfolio accounted for 50% of the credits towards examination entrance, while the other two essay-type assignments contributed 25% each (UNISA MMAT00-8/101, 1996a.).

(17) Reflection on problem-solving and skills development:

The assessment tests the student's ability to address real-life problems through problem solving and not domain specific. The development of schemata, advance organisers, imagery and social learning seems to play an important role so each unit included a mindmap that integrated closely with the context-dependent activities (see 3.2.17). Examples of activities are UNISA MMAT00-8/102. 1996b activity 1-13; 3-8 to 3-12).

(18) Reflection on personal change:

Adults reflect on their own practices and change processes and attempt difficult work and new

experiences often and with trepidation (see 2.5) but find it stimulating if they complete these. Generative learning (3.2.18) linked to feelings and motivation play an important role. The tasks in the activities were constantly focussed on the completion of small incremental steps in the whole guide UNISA MMAT00-8/102. 1996b.

(19) Reflection on structured action to develop different kinds of knowledge

In the 1996 guide, Activity 4-20 is a good example of including declarative (factual), procedural, and conditional knowledge in an activity (see 3.2.19). It requires the student to identify particular activities, number the stages that indicate solving strategies for word problems, provide a reason why this strategy would be appropriate, as well as their views on the problem. Although mathematics have well structured knowledge domains, the teaching of mathematics has not - "messy" (UNISA MMAT00-8/102. 1996b: activity 1-5).

(20) Reflection on integrated media experience:

No additional media were used in the course. However the lecturer felt that the importance of technology in mathematics was a limitation addressed with "artikels wat ek ingesluit het om meer klem te plaas op 'n tegnologies ryker kursus." (Wessels, 2001a).

6.5.2 Reflections on the MMAT course design and development: the course team

The case study describes the curriculum development process of the Unisa Mathematics Subject Didactics course. The case study description followed Stake's (1995: 52-53) suggestions. This action research process included the course's piloting phase which was considered to be a very useful strategy (next chapter). The whole process of development (over two years) and piloting of the course (over five years) was developmental and involved reflective inquiry.

Stake (1995) identifies a typical case as either people or programs (less likely events and processes) which are an integrated system. The parts may not be working well and their purpose may be irrational, but it is still a system. Sometimes there is no choice at all, and the researcher is obliged to take on the object of study: the case is therefore a given". The mathematics case was available, but there were other reasons why it was chosen namely, as researchers we could maximize what we could learn; the course was easy to get to; the prospective informant could be identified; actors were willing to comment on materials; the case's balance and variety, was either typical or unusual - which helped to illustrate matters (Stake, 1995: 4).

The action in this case was in the form of constant change and adaptations to the course over a number of years, following more than one cycle in order to adjust and refine the course to better facilitate learning. Understanding the mathematics educators was difficult because of the distance

between the Unisa lecturer and student, and that between the lecturer and the mega university's organisational form. The course philosophy of Mathematics Subject Didactics was to prepare individual mathematics educators as members of a particular social group to be efficient educators in an unknown future linked to globalisation, rapid and constant change, and to change the thinking about mathematics education (Figure 6.1).

(a) Reflection on the organisational structures and team roles

The Unisa organisational form supports its open distance learning (ODL) character (Macintosh, 2001:5). Within the organisational structure that supports academics in their distance teaching, there are a number of separate departments, processes and policies in a traditional industrialised setting. These structures and processes supported the development of this course. There was also a wait-and-see view with many of the support people in the university. A positive effect was that the reflective and participatory environment was sometimes mirrored in other course teams within Unisa during this period.

If one analyses the processes that students go through in their quest for an accredited qualification, one can see this mirrored in the way various departments work together: individually they focus on a detailed aspect of the student's needs, but together they form the picturesque puzzle that is an image of the ODL institutional structure and processes. Each of these structures or departments at Unisa operate within processes that enable our students in their distance education studies. Limited co-operation involves the establishment of an overall pattern of co-operation which is, regularly, but almost imperceptibly, punctuated by opposing norms, and dominant values and systems. The success the course team had limited co-operation as a form of engagement depended on the frequency with which team members attempted to answer boundary-violating questions within the DE system. Staff in the system allowed "deviation with co-operation" up to a point. The course team attacked traditions and dominant systems. Team members worked as a group or course team during the development of the guides for example the materials included bulky portfolios as assessment strategy with the easy-to-handle postage items paragraph or essay type items. The team got the agreement from the direct section heads to go ahead as planned.

Students are generally guided through the processes to become aware and guided to make informed choices for study, enroll and pay for their studies, get developed course material delivered, get support during their study period, hand in their assignments, and write their examinations - after which, if they are successful, they are rewarded with a qualification. Policies, procedural guidelines and expectations for good practice guard the quality of teaching in the ODL organisation.

As it is, the course design and development process addressed many issues but we tried to stay

focussed on the questions of facilitating an active learning process, therefore within the case's boundaries. We have to conclude that no course design process is easy; it is often messy" and problematic because of "die tempo, die soort van verstaan van die projek, die lyn wat opgetel moet word uit die projek en die vermoë van die span". The team approach was "deurslaggewend" (Wessels, 2001a).

(b) Reflection on the team discourse

The researchers described the course team-based design and production of the course. This is typical (to a greater or lesser degree) of Unisa courses. This discussion included the instructional design steps that the course team completed - namely, the construction of the team and provisional planning.

In a course team, existing power players may affect course team members' role development and can disrupt the cohesion in a course team to the point of making the course team ineffective. This course team identified the power positions, and decided not to use such power in the team. In fact, support from team members was the only position of power possible. The core team members experienced the thrill of being co-responsible and co-owners of a project where all the members participated equally.

"Jy het my eintlik gewys wat dit beteken om medeverantwoordelikheid en mede-eienaarskap in 'n saak te aanvaar. Baie dankie vir jou vennootskap en meelewendheid in hierdie taak van ons" (Wessels, 1995). A participatory project where the team was successful provides each member of a feeling of satisfaction and completion: "Die proses van verandering was vir my nogal baie goed en positief. [Wessels, 2001a).

The researcher's experiences was that the success the course team with limited co-operation as a form of engagement depended on the frequency with which they attempted to answer boundary-violating questions within the DE system. Staff in the system allowed deviation with co-operation" up to a point. During this "attach" on the traditions and systems the group included bulky portfolios together with easy-to-handle postage items paragraph-type or essay-type items.

(c) Reflection on the team actions

The researcher's experience in the team was that there are variations regarding the amount of input that is necessary as time, expertise, and budgets do not always allow individuals to work in each element. The lecturer stated how much work such a course development project was, how much work it took to put everything together and to finalise the documentation:

"Ja, noudat ek weer 'n slag intensief met die projek besig was, besef ek andermaal hoe 'n groot taak dit was en hoeveel jy ingesit het om alles aanmekaar te heg and af te rond. Daarvoor sê ek aan jou baie dankie en spreek ek my hoogste waardering uit" (Wessels, 1995).

6.6 Reliability and validity

We sought an appropriate research paradigm to empower us to plan our enquiry, use appropriate strategies to implement our planned development of the course, collate information and evidence regarding the questions, and critically reflect on the outcomes in the particular situation and present the findings in an appropriate presentation. Following this research approach the postmodern instructional systems design (ISD) model of Tennyson (see Fig 3.1) provided us with a model for our course design (refer to Chapter 3). The mental structures of knowledge and learning (Chapter 3) were consistent with the approach we decided to follow. Our focus was to foster action, dialogue and role definitions in the social context of the learner.

It is important that as researchers we raised questions of validity, justification and rigour against questions of scientific and educational knowledge. As researchers we strove to triangulate our enquiries and we used self and peer evaluations. We described how we guarded against enquiry errors. During the enquiry, the researchers considered the integration of course design and development techniques, instructional design theory, conceptual frameworks in education, and open distance learning theory and practice. The researcher reviewed literature concerning the methodology and examples of various research methodologies, and decided upon a qualitative research strategy. Participatory action research would allow investigation into the processes *while* they happened, and it would allow a description of processes and outcomes - and enable the participants to take ownership of the research and its outcomes (see 4.2.4). This participatory enquiry approach followed the cyclic processes during the curriculum and course development of this particular course (refer to Figure 1.3 depicting a model of the events-line of this research describing the typical full DE course development).

The sequential and repeated cycles of this project fostered critical reflection and made it easier, as a subjective participant, to become more objective. The validity procedures needed to be taken into account in the process (see 4.7). The course team members collaborated, reflected in action, and were involved in a known process of course development, but the process was still messy.

The researcher focussed, during the literature research, not on one theory, following the suggestions by Goldfried (1980: 21) that instructional design practitioners should de-emphasise the unique or idiosyncratic characteristics of each theory and, instead, focus on ways by which practitioners can derive practically useful ideas from various (ever competing) theories". We also took Goldfield's advice that instructional designers should be provided with an outline of the various agreed-upon intervention principles, a specification of varying techniques for implementing each principle, and an indication of the relative effectiveness of each of these techniques together

with their interaction with varying presenting problems and individual differences" (Goldfried, 1980: 2).

The course that had to undergo instructional design was chosen as a case study. The literature provided some models to follow. The case had to be delineated and treated as a bounded system. This case was a convenient choice as the course had to be developed for a particular degree and target group of students - which is typical of study material development at Unisa. Therefore, the complete course design and development process was attended to as much as possible (see 3.3 and 3.4).

The course materials were evaluated informally and formally by external people (according to the lecturer) and he saw them as valuable exercises to support our feelings about going into the next pilot cycle. The voices of the learners, the voice of the lecturer, the literature, the voiced experiences of the learning developer, and the repeated process provide evidence that the results in this phase were reliable and valid.

The researcher decided to interpret or analyse the data under key elements, but also to gathered and presented it in such a way that the subjects' experiences speak for themselves (also refer Strauss and Corbin, 1990: 21 in De Vos). It is not possible to compare this case with many others at this stage, although our prior experiences at Unisa as researchers did not seem to be different where the distance education processes were concerned. The course team work was an experience we had not had before and we admit that it was difficult at times to stick to our roles, and understand and accommodate one another. However, we felt comfortable to go into another cycle of enquiry together as a more cohesive course team.

Theory was triangulated using indirectly relevant literatures. As a researcher I rely on the history of case studies to support my quest in consequential validity, but I need to be critical of this protocol. To assist us in our methodological triangulation, I, as the researcher, was a participant-as-member (as defined in Chapter 4), subjective, and part of the process. The learners were not part of the development so we relied on them to provide us with additional data. The historical unfolding of the course development (as seen in Addendum A, B, C) assisted us. Reflection on our process during the personal growth and staff development workshops also provided us with more information to validate our research methodology. This process contributes to the theory of the instructional design of curricula and courses within the Unisa distance education environment.

We drew tentative conclusions, organized according to the key issues. We used intuition, but supported them, as far as possible, with cross-comparisons. We exposed disagreements and we noted these findings for the reader to interpret. We collated as far as possible, uncontaminated texts supported by our experiences as we went along. Our notes during discussions came in very handy, especially when there was disagreement. This often indicated differences in power and knowledge between the researchers and the subjects. We tried to keep all the different ways of showing how change happened during this initial phase - the e-mails, diagrams we drew during our meetings, students' letters to the lecturer, anecdotes recited during phone discussions, and the assessment results.

In a course team there always seem to be challenges arising out of differences of opinion and different thinking patterns. To have a successful course team (see 2.6.3-5), management of the similarities and differences is vital.

6.7 Concluding the course design and development phase

To conclude, the action research methodology was a useful research method to trace the design and development of this DE mathematics didactics course. This methodology also allowed the researcher to follow the processes and analyse the product of the development to improve understanding of our praxis. The team members' discourse within distance education practice and mathematics education was informed by educational and mathematical learning theory.

The study takes place in a context where the course team's experiences provided suggestions towards focus questions (as stated in Chapter 1). The evidence showed that there were many changes that took place based on reflection of the situation. The course team reflected upon the processes that took place during the course development.

The course team came to realise how very complex the process of events in course design and development is. Instructional design (as described in Chapter 3) is often based on non-researched theory and is very dependent on change during the process. However, this process did make the course team members reflect on their personal growth and change, and the changes that the team made on the structures within the organisation.

The process of designing a particular course package (See Addendum A) required the team to demonstrate its compliance to applying activity-in-text strategies to learning. However, the learning designer and the lecturer agreed that many improvements are still necessary: "Daar is nog baie ander dinge wat moet bykom en uitgewerk word in 1996 in hierdie kursus" (Wessels 1995: letter). The learners' perceptions of their learning environment are discussed in the pilot phase in the next chapter, Chapter 7.

III: Chapter 7

Piloting the MMAT course

7.1 Introduction

Following the first cycle of personal development, the course design and development in the second cycle was subjected to a pilot run.

The instructional designer-advisor and the subject specialist-lecturer still formed the nucleus of the team. The implementation phase, as the course design model described in Chapter 3 indicates, is typical of Unisa course design. During this stage of the development the implementation and maintenance of the MMAT course was used as a pilot phase.

7.2 Plan the MMAT course pilot

The team discussed problems and unforeseen possibilities. We questioned the use of activities to foster particular skills, and we questioned the practicality of the team approach at Unisa. We assumed that the institution would be able to adapt its systems sufficiently to deliver the course and that the team would be successful in developing a course. It was not clear whether or not the course would be relevant to the students who teach mathematics in the South African situation. (See 6.2)

7.2.1 Plan the MMAT course pilot: the course

The course materials described earlier were now ready for piloting. The literature provided some models to follow. The focus of this part of the project was to test the course development (refer to Addendum A (1996) and B (1997)). (See 6.2.1).

7.2.2 Plan the MMAT course pilot: the course team

The MMAT course team was still founded on a research relationship within an industrialised institution with a new focus on course teams. (Refer to 6.2.2).

7.3 Actions during the MMAT course pilot

The team's actions focussed on the process, its own micro-environment, and the products or outcomes of its labours.

7.3.1 Actions during the MMAT course pilot: the course

The course design was completed during the latter part of 1995 (as described in Chapter 6). The adapted Tennyson model was followed (see Chapter 3). At this stage the action plan was revisited. (See 6.3.1).

Time was short and some things had to be altered - such as the website whose launch was delayed until the course had been tested thoroughly. Also, a specially designed page layout was not possible, so the layout was designed by the instructional designer, using a wordprocessor, and Production printed this in limited copies, with the proviso that for the second year the layout would be changed using a professionally designed "fast-track" layout. The 1996 course was not written for the Unisa production layout. (See 6.3.1).

The course included activities that the MMAT students should do as part of their assignments. The wrap-around guide was distributed and learners had to purchase the textbook. The guide was essential as it afforded learners an entrance into the complexities of the book. Information about the course and other services such as contacts and support sessions offered (in this case a winter school and the in-text activities, the assignment structure and required textbooks) were included in the first tutorial letter to the student and in the introduction to the module. (See 2.4.5 and 6.3.1).

Because the team decided to use the first two course years as pilot years, team members could make radical changes to the course, if necessary. At Unisa this influences the production process and the course was printed only for the first 80 enrolled students. The desktop layout provided us with flexibility to change aspects on-the-run and to get the guide printed via a photocopy process. (See 6.3.1).

The data collection instruments included the portfolio information, the assessment scores of the students, informal discussions, interviews, and notes from experience. The procedures of interviewing were used. However, other procedures were difficult because of the nature of action research methodology. The team also had to learn what participants knew and why they wanted to understand the issues. (See 4.6).

7.3.2 Actions during the MMAT course pilot: the course team

The same course team was involved in the pilot phase. The team discussed a working methodology during the first consultations in July 1995 (see 4.2-7) for the development phase. Members came to early agreement and only a few meetings were needed in the pilot phase. These meetings were planned on-the-run, when needed.

The data for this pilot phase were collected from students' notes, feedback, assignments, portfolios, and the course materials. It was decided that the final results of the course

development and the team approach would be presented as papers, articles, and that this postgraduate study would follow. Initial but limited reports were provided to instructional designers and the department involved. The case study was written later in the process as expectations were expressed and issues came up over time. Drafts of the notes taken during this period were to be distributed to validate descriptions and observations. This had to be done as often as possible throughout the process.

The course marketing would include a comprehensive "look and feel" for publication in an advertising brochure, a website, and information about it in the University prospectus.

The team agreed to keep the learners' bibliographical details confidential including the research data, the participants, and other sources of evaluation. Students were requested to support the evaluation of the course: "Ek het hulle ook gevra hulle moet elke jaar hierdie pakkette evalueer en veral in 'n oopbrief skryf wat is hulle invloed daarvan op hulle lewe as onderwysers" (Wessels, 2001a). (see 4.7).

In a mega distance education institutions it is in general easy to allocate resources and functions to people because of the industrialised nature of such institutions. The core team dealt with the phases in the design and with all the teaching-learning issues. They established teaching methods and pedagogy. Together they designed the learning environment. The delineation of the roles outlined each member's appropriate territory: little conflict took place. (Refer to 6.5.2.)

The team constantly revised priorities to address problems and new occurrences. However, the learner characteristics was not made available from the central statistics office with the result that the reasons for the drop-out rates could not be investigated. (See 2.5.13).

The team started to pay more attention to members' different views and conceptualisations. To this end, we discussed our individual terminologies - and our language usage started to change. We all tried to consciously change our way of acting and we were constantly aware of the team culture and its development. The roles we played were interesting and we constantly tried to establish working patterns and areas of overlap. When there was overlap, such as when we analysed content together to design activities, there was conflict. We had different mental maps of the subject material and we had to come to some agreement.

7.4 Observations during the MMAT course pilot

Both the course and the team "events" are described in this section.

7.4.1 Observations during the MMAT course pilot: the course

This pilot project preceded the implementation of the course. The focus was to evaluate the course before a final review and maintenance took place. The weekly observations by the lecturer and the instructional designer were constantly related to the curriculum and course design in terms of planning and design, development, and the production of the course. The lecturer and learning designer discussed the effectiveness of the material following informal discussions with learners and colleagues from the contents of the portfolios and our notes informed the research. Assignments and examination results also provided data. The layout of the guide had to change for the production process.

The students' verbal remarks (over the phone, in person or in letters) gave the team valuable input. They testified to their experiences and told the lecturer their "stories". In distance education and in mathematics, it is important for learners to be able to read and write English or Afrikaans (Wessels, 2001a).

The nature of the learners enrolled for the course (used towards different qualifications) was diverse. (See 2.5). The lecturer explains the three target groups and their diversity in *preknowledge and experience*:

"Ons het nou eintlik drie soorte studente. Die een is die HOD-groep en daar kry ons nou die gegradueerde mense. Hulle het almal tenminste hulle standerd 10. Jy kry van hulle wat ook Honneursgraad wiskunde het of dalk 'n M-graad in 'n ander rigting. So dit is werklik opgevoede mense en dit het 'n wye reeks van ervaring. Die tweede groep is die B-Sec-Ed, VDO-groep, en hulle is mense wat hoofsaaklik die Senior Teachers Diploma, die STD3, wat hulle kwalifikasie in swart onderwys kollege verkry het - van hulle is baie laag vaardig en [weet] minder as Wiskunde 1.... in terme van hulle ervaringe is hulle ... so laag as wat jy dit kan tel. Dit beteken dat jy dit duidelik verskil is tussen die studente met dié van die gegradueerde mense. Dit is die probleem met die VDO-groep wat hulle taal ... swakker as wat die ander is. Die derde groep is die B.Sec Ed, dis 'n graad maar dis 'n addisionele graad. Daar is ook hoofsaaklik swart studente en hulle kom nou as inisiële studente in en daar het ek nog nie kursusse gekry nie. Hulle hoef nie 'n graad te hê nie so hulle hoef nie hulle nie te vra nie - ons verwag dat hulle probleme sal hê" (Wessels, 2001a).

7.4.2 Observations during the MMAT course pilot: the course team

Following the fifth movement in qualitative research (De Vos, 1998: 245, 359) we gathered both qualitative and quantitative data for this case (chosen according to the criteria in 4.8.2) in the action research. The research techniques were qualitative, with interviews, an analysis of the course materials, and a description of the case, student letters and portfolio assessment results. There were quantitative analyses of the examination results and drop-out rates, and a descriptive

case study analysis. All the team members kept a record of arrangements and activities because of the planned research (this is not necessarily happening during regular course design projects). We kept selected e-mail discussions that included reflections by the team, the course materials in development and in final form, and the assessment results of the learners. The course team kept examples of students' work in the form of photocopies, depicting above average, average, and below average work. Our discussions during debriefing sessions were valuable as they allowed us to share our experiences and reflect on the data. The students' verbal remarks (over the phone or in person or by letter) gave the team valuable input. They testified to their experiences and told the lecturer their "stories". As the researcher, I gathered additional data through reflective interviews with the lecturer.

The interview technique during the semi-structured interviews that were videotaped followed the recommendations of Stake (section 4.8.5). The observations from all the sources were collated by the researcher. Although the technique was critically analysed keeping the key focus questions in mind, the rich descriptions and authentic "voices" were kept to illustrate concepts. The pilot period saw us demonstrate enquiry skills (as suggested by Heron, 1996 in Reason, 2001: 20-21, section 4.8.3). This data was triangulated for validity and reliability (section 4.7).

7.5 Reflections on the MMAT course pilot

We shared the outcomes of the pilot in August 1996. To see the plans come to life was a very worthwhile experience. Learners were requested to take part in the evaluation and redesign of the course. Few of them answered this invitation directly, although the many letters provided feedback. It was stated clearly in the beginning that the course was piloted and that the learners were part of this development. A learner felt "strongly that opportunities should be provided for students to assess the course and contribute to the final product". The tentative format of the layout during the pilot made the course material less formal in design, and a learner liked its "tentative form".

7.5.1 Reflections on the MMAT course pilot: the course

The students' experiences were diverse, as many were unemployed, in part-time employment or were employed as teachers: "I tried whenever possible to discuss some of my problems with fellow maths teachers" (Student, 1997); or "I felt that the questions and activities were aimed more at practising teachers, with several years of teaching experience; it was particularly difficult for me" (Student teaching for one year, 1996); or "[I] am not presently teaching, do not have colleagues with whom to discuss questions and am not part of a study group" (Unemployed student, 1997). Here is another response: "ek gee al vir 20 jaar ekstra lesse" (Student 1996); or "I have been attempting for 10 years to teach in the problem-solving way" (student 1996); or "As 'n

gegraduateerde, [graduate student] ons is nie meer voltydse studente nie, maar self ook nie in 'n professie" (Student, 1996); or "I didn't feel so much like the new (40 year old) kid on the block" (Student 1996); or "I have been teaching for the past 3 years - the problem solving approach was used by me from the beginning" (Student, 1997); or "Not having an extensive maths background is a disadvantage as I could not rely on my own knowledge of the subject to help me plan the correct steps" (Student, 1997).

(a) Reflecting on the linguistic design

The learners commented on the style of the dialogue. The tone should be more varied to create a personal character and to be more challenging. The sentence structure could improve as it tended to be too long and overloaded with subordinate clauses. Referring to acceptable typographical principles (Chapter 3), the layout of paragraphs could also improve. In general, the language used could improve to prevent logical gaps. (Instructional designer, 1996: notes; see 6.5.1 (c)(3)). The translation to Afrikaans could improve as "die Afrikaans en die Engels het verskil asook van die handboek." (Wessels, 2001b). The language style was pitched correctly for the target group: it was friendly and appropriate. The tone should be more varied to create a more personal character and to be more challenging. The sentence structure could improve as this tended to be too long and overloaded with subordinate clauses. In general, the language used could improve to prevent logical gaps and the lecturer thought

"om op 'n paslike wyse vir hulle te skryf omdat ek agtergekom het dat hulle dit moeilik vind met die nuwe veranderinge. Dit was vir my belangrik om te verseker dat ek by daardie komponent kom. Ek het ook die rol van taal in die onderrig van wiskunde sterk oorweeg" (Wessels, 2001a).

The guided didactic conversation should foster a dialogue in the text (3.6.3 (1)). Students found the style of the writing acceptable. For example: "Wat egter 'n groot sukses is, is u studiebriefe. Ek het u hoor praat en gesels" (student, 1996).

The students felt positive about a very good textbook:

"I would like to appreciate you [sic] for making such a good decision of choosing [sic] such an informative book as Cangelosi. The book is useful to a teacher with an aim of assisting students to understand mathematics. The language used in the book is simple and easy to understand. This book stresses the use of the problem solving approach"

and

"Cangelosi's book is an excellent choice. I do not remember any book that taught me so much in such a practical and accessible way. Actually the quality of the book was the main motivating factor that kept me working" (Student, 1996: letter).

The various quality criteria mentioned by SAQA (2000) were important to the classroom teachers. They indicated that the course enabled them to address the practical implementation of the newly required curriculum. The textbook was considered to be a quality reference work and the activities in the guides were considered key to the learning experience: "I have found Cangelosi an excellent book and enjoyed its creative approach" (student, 1996: letter), or "I am very impressed with our prescribed books. Cangelosi has a deep insight into the education system and the psychological aspects concerning the learners and their attitudes towards maths" (Student, 1996: letter). The lecturer also praised the textbook "in terme van probleemoplossing en lesplanne" (Wessels, 2001a).

Activities should be clearly stated. "Some of the activities were vague in their questions but I did indicate this at those questions." (Student, 1996.) This is in contrast to the lecturer's view that the activities are clearly formulated "duidelike formulering van aktiwiteite" (Wessels, 2001a).

(b) Reflecting on the visual design

The general appearance set new standards in the university at the time and the lecturer said "groot skommeling is gemaak van 'n ou benadering in terme van teksontwerp en materiaal voorsiening." (Wessels, 2001a). The layout were effective and interesting. Pages were balanced, with good typefaces and type sizes. Upper/lower-case headings enhanced reading. There was space in the margin. Pictures of the African context could be well worth putting in, as contextualisation is an issue. The presentation included icons and the activities were referenced 3.6.3 (7). The team decided to not leave space for notes (3.6.3 (12)), but to foster note-taking on separate paper, of which some should be assessed (UNISA MMAT00-8/102. 1996b.). The focus was on user-friendliness.

The length of activities (see was sometimes demotivating) - a noteworthy, frank comment from a student describes how

"Akt. 5-10 se voorkoms ... my dadelik laat besluit om dit uit te laat - dit is, volgens my, heeltemal te lank vir een aktiwiteit, daar is bloot nie tyd of energie vir sulke tipe aktiwiteite as mens eerder ander kan doen wat korter is nie". (Student, 1996: letter).

The experience of the course designer is that this comment is very pertinent.

The hand-drawn mind-maps and the layout of the course were specifically designed to give the impression of an "unfinished" product in development: "I do like the tentative form. I feel strongly that opportunities should be provided for students to assess the course and contribute to the final product" (Student, 1996: letter). This supports the use of hand-drawn mindmaps (6.3.1).

(c) Reflecting on the content design

Content design deals with the nature and structure of the subject of the MMAT course. The guide was still a wrap-around guide which referred to the textbook. Students have to read "die essensieele van die materiaal ... wat gaan oor die [studie eenheid]. Daarvan het ek baie positiewe

terugvoering gekry" (Wessels, 2001b).

A wrap-around guide is dependent on the textbook. Any changes to the textbook or in the availability thereof are critical to the success of the distance education course:

Wat natuurlik ook gebeur het is dat die 1992 uitgawe van [die handboek] ... waarmee ek in 1994 begin het, is toe vervang met 'n 1996 uitgawe en ek het eers in 1997 daarvan gehoor toe die studente sê hulle kry nie meer die uitgawe nie. Toe moes ek inderhaas met Unisa se goedkeuring van Unisa 'n Unisa-uitgawe publiseer. In die volgende jaar het ek met die nuwe gids begin. .. [en] Met die nuwe boek. Die verskil tussen die twee nuwe boeke was dat herordening plaasgevind in terme van die leerstof en stofindeling deur [die outeur] - hy het die basiese dieselfde goed gehad maar [die boek] het ook 120 bladsye bygehad. Sy uitbreiding was 'n fokus op tegnologie. Ek het deur veral artikels wat ek ingesluit het meer klem op tegnologie geplaas. Die nuwe boek was tegnologiese ryker as die vorige een." (Wessels, 2001a).

References to the textbook were sometimes incorrect in 1997, which is an aspect that should be specifically addressed in the course updates. This is one of the "problems" with a wrap-around guide. The references should be made clearer and be included in the layout as side comments. The explanations in the guide complemented concepts in the textbook. The new textbook in 1997 created havoc as the page numbers in the guide did not correspond to the textbook. The mismatch between the prescribed and new edition caused referencing problems - which were addressed, with some effect, in an additional tutorial letter: "It was very frustrating trying to work through the study guide, even after the errata were supplied in a subsequent tutorial letter" (Student, 1997). The student continues: "I could not correlate the directions in the study guide to the relevant content of the textbook ... very frustrating for me" (student, 1997). These words express the importance of guide-textbook integration and synchronisation.

Here is another observation:

- "I battled with the incorrect page references, until I received the errata in mid-March. There was much repetition with some of my education courses! This has been very difficult! I wanted to include everything and more!!! ... additional items I included are the classroom management assignment, notes I made on assessment from D. Clarke's book, and some item pool ideas. All the other stuff is peripheral.
- The most frustrating aspect of the portfolio was the incorrect references in the list of activities, which took a lot of detective work to try and identify what was actually required. Two examples are Activity 00-7, where Case 2.6, page 19b does not exist, and Activity 8-6, where Case 8.5, page 249 is not a lesson plan. I recognise the reasons for this, but nonetheless it created some significant frustration!
- "Chapter 9 was a disaster because I could not find the activities or the references because

these were to the 1992 edition. Were we supposed to buy that book or only the 1996 edition?" (Student, 1997: letter)

The course materials were not provided to learners on time in 1996, which created many problems. The new textbook editions and availability of textbooks needs to be carefully considered each year in DE, and at Unisa a comprehensive system is in place eight months before the time to ensure learners are able to get textbooks. However, this book was published without the course team's notice, which created a situation where a student "got the prescribed book at the end of July" (student, 1997: letter). This learner had to have it in a portfolio in early August. A further comment was this:

"While I understand fully the workload commitments of lecturers I also feel that the students are being unfairly penalized when they cannot start their studies until mid-February. Prof [...] has been helpful in providing 1996 tutorial material and textbooks (no longer in print) from which to work, however, this may differ somewhat from the 1997 course" (Student, 1996).

The design of multimedia course materials was not necessary for the pilot study. After the pilot study in 2000 the team members did decide to provide learners with Internet access to the completed course.

The authentic assessment strategy was successful but too much work for the portfolio. Managing authentic assessment materials in an industrialised institution means procedures and systems has to change, such as its strategies to accept bulky assignment folders, provide new assignment numbering options in the assignment system, re-post bulky items, and other administrative details.

The learning package was presented with style and was acceptable in all aspects:

"The instructional design in 1996 excluded upfront outcomes and students had to be guided to discover the topics and unit outcomes themselves by way of enquiry, mind-mapping of chapters in the textbook, and working through the questions. The text guided learners towards an overview of the course and of each chapter, and the learners succeeded in doing this" (Wessels, 2001a).

(d) Reflecting on the learning design

Introductions and summaries to study units should receive particular attention as "summaries and introductions, especially in the tutorial letters, motivate the learners and make concepts meaningful and relevant, tying units together and linking them more closely with the totally different, 'embedded' structure of the textbook" (Instructional designer notes, 1997). Students wrote that they "suggest you provide a more detailed motivation for your choice of ... contexts" (Student, 1996: letter.) And "state at the beginning of the maths course guide (102) the overarching

goal of enabling effective learning of mathematics by the pupil" (student, 1996: letter).

1) *Reflection on knowledge premises*

Some learners that completed the course did provide evidence that their knowledge premises (see 3.2.1 and 6.5.1d-1) changed. The activities were helpful but the approach, not necessarily individual activities in the textbook and the guide that was the biggest motivator "Ek het nou 'n heel ander siening oor wiskunde-onderrig. Ek voel die verandering is nodig." (Student, 1996: letter.) And "my approach to teaching mathematics have changed" (Student, 1996: letter.). I now realise the importance of the problem-solving approach, and I believe my attitude has changed (Student, 1996: letter.) Also "I feel that I now understand maths teaching in a totally different dimension".

2) *Reflection on independence and autonomy*

The course materials included directions to use a particular study process namely skimming, scanning and study reading (the 1S2S3S method). Each chapter starts with Activity 1-1 which requires the learners to draw up an overview and exploration of the chapter in the form of a mind-map, following the 1S2S3S method (Addendum 1: 22) while the following activity provides opportunity for feedback.

The investigation of a topic of interest could improve learners' ability to work independently and to structure enquiries:

Maths becomes exciting and students succeed when the teacher moves away from relying on the textbook and teaches creatively. So, after reading through the standards, I know that at the coalface of teaching, what I teach has a powerful philosophical underpinning, but unless I as the teacher take the initiative, the "standards" or the S.A. curriculum are not going get in the way of my ideal to be an effective teacher. In reality my experience has been that math teachers still rely on tests as their primary evaluation method. (Student, 1997: letter).

The learners were encouraged to work in groups in a collaborative environment. They provided evidence that the portfolio was "the product of my own work with the assistance of some of my colleagues". (Student, 1996: letter). Some students provided evidence of their autonomy and individual work but also in a group:

- "Ek het ... alleen gewerk en al my werk is individuele besinning". And "I find it easier to learn from my own summaries and have summarised most of the chapters." (Student, 1996:letter).
- "I covered over 80% of all the activities in each chapter. It was quite tiresome and difficult, because I worked individually, but nevertheless very enjoyable and motivating. The items that I selected, I found exciting and enjoyable as well as answerable.

- Some of the questions/activities I found rather difficult, and so I did not attempt them. I honestly found the "mind-maps" quite difficult. I could not relate the various concepts as wanted by the activity/tutorial letters. (Student, 1996: letter.)

The learners started being selective about activities, choosing those appropriate for their needs. They also displayed the identified adult characteristic of acquiring relevant information and ignoring the rest - for example: "I selected very few [activities] in the overview chapter as I found them irrelevant and confusing"; or "I had my doubts but I developed a method as to approach each section. I discovered a lot about myself. I can revise my teaching methods. Maybe more time should be spent on planning." (Student, 1996: letter.)

3) *Reflection on dialogue and communication*

As active involvement is difficult study guidance in mathematics "is altyd 'n baie baie belangrike ding. Dit [studieleiding] het 'n belangrike kenmerk van die gids en van die materiaal en ook 'n baie kragtige middel ...". (Wessels, 2001a).

There was sufficient guidance and feedback in the text and in tutorial letters:

"I felt this course is more easy for me than a full-time course because of your help and explanation of the items, and continuous details of the subject [sic]. I am very happy for your help and [you] also made the course so easy and comfortable. I learned a lot. Also the book of James S. Cangelosi was very helpful for me with simple and in details each topic [sic]. (Student, 1996: letter.)

A number of activities required learners to form a dialogue with themselves, a colleague, the classroom children, or a group (Addendum A: 1). Some had difficulty with these activities, some found them very helpful.

- An invaluable part of my learning was discovering another student who was doing the same course.
- I feel that I succeeded in keeping the approach open and non-rigid because I very often ask for your own interpretation and for feedback from conversations and discussions with fellow teachers and fellow students about the questions and tasks. Self-evaluation of a completed assignment is a very valuable part of the learning process. (Student, 1996: letter.)

The mind-map is a strategy that supports the building of schema which provide learners with a basis from which to engage in a focussed discussion (as with the guided didactic discussion of Holmberg, section 1.7):

- "Daarmee is ingesluit die saamstel van 'n 'mindmap' en ek kan net getuig van fantastiese berigte ook in terme van hulle [studente] se waardering om vir hulle die [studie] kennis 'te gee'". (Student, 1996: letter.)

Learners wrote in their letters that they, through the vignettes, could "see the background noise" of interaction between the students, and between the lecturer and learners. They experienced the inability of the group to work together, in contrast with the positive spontaneous interactions. They experienced such positive interactions as linked with the problem-solving strategy.

- Terwyl die vinjet voor die geestesoog afspeel kan jy as t'ware uit die agtergrond geraas "hoor" hoe die interaksie tussen dosent/student en studente onder mekaar plaasvind. BAIE keer vind jy groepsamewerking wil net nie realiseer nie, of slegs een of twee persone doen die dinkwerk alleen. Dit word dan 'n tipiese "boring", moeilike werkswinkel. Al die byvoeglike naamwoorde wat al negatief aan Wiskunde gekoppel is, geld dan. SOMS weer kry jy fantastiese, spontane interaksie; 'n regte spanpoging. En dan word gesê: "Dit was lekker, net soos in Wiskunde". 'n Groot deel van Cangelosi se strategie en dus ook die probleemoplossingstrategie hang ten nouste saam met hierdie interaksie. (Student, 1996: letter.)

The learners were strongly advised to attend one workshop, with the following results:

I enjoyed the discussion class. The contact with other students was very beneficial.

If this could be done more regularly, or over two days so that we might get to work in groups and perform the various stages of problem-solving approach together, with feedback, exchange of ideas. It would be most beneficial. (Student, 1996: letter.)

The learners indicated that they would like more contact learning opportunities (after- hours). Such learning would motivate, foster dialogue, deepen understanding, and lower feelings of isolation. Trusted support methods in distance education are visits, telephone calls, video conferencing and seminars (Wessels, 1996a). "Dit [studieskool] het ook die kwaliteit en die interaksie met die groep besoeke baie positief beïnvloed. Dit hang alles saam met die korrektheid van interaksie en van soort van vrae wat hulle vra was net anderste gewees" (Wessels, 2001a).

Some learners enjoyed the contact session and the seminar: "I enjoyed the day seminar in June and the interaction with course leaders and other students" (student, 1996: portfolio letter).

However, there were some learners who felt the day seminar did not support them in their quest to learn: "I would have liked the Day Seminar to have been dynamic and exciting, well-organised, well-structured and informative. I found it lacking in certain of these key elements. It did not inspire students to diligence and involvement with the course material" (student, 1996: letter).

4) *Reflection on Integrated synergy*

It was interesting to note that none of the respondents indicated that there was *no* direct correlation between the formative, assignment-type assessment and the summative assessment during examinations. Each chapter ends with a chapter review which takes the learner back to the chapter's aims or goals and relates the information to the other chapters: none of the chapters

stands alone, but is, discernibly, a part of the whole. Their own teaching also has to follow this suggested pattern.

In die eerste plek het ek besef hoe 'n groot rol beplanning in die onderrig speel, nie net beplanning van elke les nie maar ook die algehele beplanning van 'n kursus of vak. Om die kursus aan die einde 'n geheel te laat vorm en dan ook wiskunde 'n geheel te laat vorm. Die afdelings moet inmekaar vloei en nie net as enkel afdelings en eenhede behandel word nie. Die Algebra moet dus in verband gebring word met die ander afdelings soos Meetkunde en Trig.

5) *Reflection on feelings and motivation*

Here are some reactions from students about the affective elements of the course:

- Hierdie kursus was baie stimulerend
- On the positive side, most of the activities are such that they require a lot of enthusiasm and common sense to answer. I have been teaching for the past 3 years – the problem-solving approach was used by me from the beginning. Cangelosi's approach is bound to pay dividends.
- I found this course interesting, worthwhile, and very difficult. It has convinced me that I know how to teach in terms of the research-based approach. Turning theory into practice is the challenge.
- I covered over 80% of all the activities in each chapter. It was quite tiresome and difficult, because I worked individually, but nevertheless very enjoyable and motivating.
- inspires and motivates one to try it. My insight into problem solving has grown from nil to what I hope will be a view that can make a profound interest change in pupils.
- I have developed a passion for trying to teach maths better in our country.

From the comments it seems some learners enjoyed the course.

Some learners were not well motivated:

"I find assignment 3 [portfolio] very tedious and at some points unstimulating" but the same learner adds to the negative by pointing out the advantage of the portfolio, and by being

"thankful for this assignment in that I feel more prepared for the forthcoming exams"
(student, 1996: letter).

6) *Reflection on historical and social relations*

Following our argument in 3.2.6 and the activity design in 6.5.1 (c)(5), the learners indicated that they were socially involved as they applied their knowledge in the classroom. (See (3) and (13).) A learner was able to cultivate a positive attitude towards maths and to impart this attitude to the students, and to increase my awareness of my role as facilitator of knowledge and the ways of obtaining it in the maths classroom.

As a learner noted his/her relationship with his/her community changed.

"I was also able to contribute meaningfully [in my community] because of the work I have been doing in this course. ... Thank you" (student, 1996).

7) *Reflection on structure and support*

The study process was very detailed; it helped some learners but did not provide enough focus to others and became boring to experienced learners. Identification of core concepts, different pathways, or selected study support - as well as challenging scenarios - could provide a more exciting learning experience.

Overviews and schema structures were an important underlying learning theory or principle that the course team wanted to introduce (see Chapter 3). The learners were required during the course to make mental structures. We wondered whether the mathematics learners would be able to manage with the "strange" concept of a mind-map (see Chapter 7 for the results).

Here the learner's response provides a feeling of the lecturer being with her, "talking" to her, reducing her isolation and alienation:

Wat egter 'n groot sukses is, is u studiebriefe [gidse]. U slaag uitmuntend hierin. Ek het u hoor praat en gesels en het gesien hoe dirigeer u hierdie kursus. Selfs uit die baie aktiwiteite het ek u hoor loop en beweeg (student 1996).

The textbook followed a complex and very specific structure. This was difficult for both the instructional designer and for some of the learners. A learner formulated the difficulty as follows:

- The source of my material [for mathematics content] was a textbook from the Scotts Foresman series. The textbook is arranged in a specific order and has been organised according to the author's plan of goals and objectives. I found it difficult to take material and organise it around my own goals and objectives (based on Cangelosi) when it was already organised into a specific and logical pattern. I think this is one of the reasons that teachers hold so closely to the textbook. (Student, 1996: letter.)
- I thank you for choosing such a readable and enjoyable book which is filled with everyday life examples.

The course was topic-related and learners had to choose topics of their own choice.

Ek het elke keer net die keuse gelaat in terme van die totale tema. Die student moet weet wat hy moes kies, hy moes die keuse maak van sy eie strategieë (Wessels, 2001a).

The deliberate inclusion of activities in the text required that learners contact other learners and their colleagues - a strategy which was meant to reduce alienation and isolation, and increase communication and dialogue. (See 3.2.3). The strategy provided evidence that it is possible to have a meaningful "guided didactic conversation" (Holmberg, 1982:7):

Ek dink 'n baie kragtige element in die is die kommunikasie met ander studente en met ander kollegas en mense. Dat hulle gaan met hulle probleme en uit eie ervaring die probleme moet neerskryf en ook in terme van 'n gesprek, die antwoorde moet deurgee. (Wessels, 2001a).

Learners found communicating in distance learning difficult -

- "Communicating with fellow students - this area has been one of the hardest requirement. I felt quite isolated. I have thoroughly enjoyed this experience of 2 opposite teachers [in the textbook]! Thank you" (student, 1996).
- "The difficulties I encountered were mainly being alone and doing everything by myself. Again there is no colleague or friend with whom I could discuss some of the issues concerning this assignment" (student, 1997).

However, the team expected this outcome

- Daar is min seker studente in dieselfde kursus naby hulle. (Wessels, 2001a).

Isolation is found even in schools too: "There is not much communication among the different schools and therefore I could not visit any other classroom where maths is taught" (student, 1997).

Learners have a need to communicate and share in order to reduce the isolation they experience: "ek wil immers my eie ervaring met die toepassing van die teorie vergelyk met die ervaring van ander" (student, 1997: letter).

The concept of scaffolding and sequencing in texts provided students with examples and allowed them to grow into the use of this holistic learning strategy. (The usefulness of this study technique was not investigated.)

The course design with activities was considered to pace the learners through a well designed course:

- I found the course worthwhile in didactic preparation and the layout of Cangelosi's book led one systematically through the steps of lesson preparation. (student, 1997: letter).
- "Ek sou selfs voorstel dat as hierdie kursus nou klaar geskommel is en al die baie stof gaan lê het dat hierdie selfevalueringsoefeninge as kernaktiwiteit behoue bly" (student, 1996).

One learner was totally despondent and could not cope:

- "I am finding this course totally frustrating and confusing. I am finding the questions in the study guide totally confusing. I am also finding the mind-maps in the S.G. totally confusing. I find it very difficult having one's studying of a textbook so rigidly guided" (student, 1997: portfolio letter).

The large drop-out rate in the first year would be a result of this despondency, while the few enrolments thereafter may also support the perception of this course as "difficult". More research is

necessary in this regard (see Addendum F).

Student support in terms of the availability and response of staff seemed not to be a problem. In fact, the learners thanked the lecturer for his support and effort: "Thank you very much for your consideration and effort - so far I am finding this a most worthwhile and interesting course!" (Student, 1996: portfolio letter).

8) Reflection on mental growth and schema development

The course team decided to add activities to each study unit that were intended to build meta-cognition while at the same time addressing the need for study skills:

Die student het dan die geleentheid om 'n bepaalde hoofstuk te lees en die oorsig te kry voorheen was dit nie so omdat integrasie van die [studie]kennis maar 'n bietjie moeilik was (lecturer, 1997: interview).

Self-assessment activities at the end of each chapter were perceived as an opportunity to prepare for the examination. They also summarise the work in the study unit. A student said:

"Die selfevalueringsoefeninge na elke hoofstuk is 'n groot hulp. Dit is samevattend en 'n MOET ook met die oog op die eksamen. TOP". (Student, 1996: letter).

The mind-maps may showed mental growth over time to the learners and to the lecturer. In the case of the mind-maps there were mixed feelings from the learners. This confirmed our suspicions that mathematics students might find it difficult to relate to a holistic study strategy, however much we wanted it to work smoothly and provide a great opportunity to the learners. A number of learners attempted it. It was interesting to note that our observations were that the more mature and experienced learners were able to draw mind-maps. In other words, mind-maps that showed good relationships and concept-mapping were produced by the learners who did well. However, this should be proven as it is at present simply a shared observation. The holistic learning strategies such as mind-mapping fostered critical analysis and synthesis, and provided alternative options to students' habitual study skills repertoire:

At the beginning of each chapter in the Study Guide is a mind-map. I found that by completing the mind-maps I was able to identify some items that are included in the chapter. (Student, 1996: letter).

Some learners found the alternative study strategies improved meta-cognition. This could be attributed to the characteristics of the target group or to the learning style of the learners. One could argue that some mathematics students tend to be linear learners who are uncomfortable with study strategies that require mind-maps. One learner said she "found the 'mind-maps' quite difficult ... and could not relate the various concepts as wanted by the activity/tutorial letters" but also because "it was difficult to put in all the important points [in the mind-map] without

elaborating too much". However, it is interesting to note between the good comments that a learner finds "the mind-maps in the S.G. totally confusing" even though she considers herself not to be a novice with mind-maps, having used them and taught them to school children. Mind-maps are very personalised - the dialogue needs to consider this more, with more guidance and openness being provided in drawing mind-maps. (Student, 1996: letters).

Mind-maps were useful to some learners. The study activities promoted an integrated approach to understanding concepts and relationships. A learner noted that although mind-maps were "always difficult for me to construct and I often do not enjoy doing them" he always attempted doing them: The S.G. was very helpful [in drawing mind-maps] and in this way I wish to commend it.

The course team's plan was to use the mind-map as a strategy for learners to map their learning progress. A learner indicated that she

considered redoing the mind-map for Chapter 1, but left it as I felt it was part of a "learning-curve" that should be included for you to see.

The responses of the learners regarding the portfolios were both positive and negative, with many reasons given:

"The portfolio assignment was too strenuous, too long in itself, and time consuming.

The assignment needs a hundred percent concentration and a total commitment."

(Student letter.)

It took me some time to get used to creating mind-maps for this work. I found it difficult at first to condense the information (student in letter).

"I found it difficult at first to condense the information." (Student in letter.)

9) Reflection on activity for action

There appeared to be no problem or insensitivity to different cultures and prior knowledge of learners affected their needs and experiences. The activities and vignettes were stated in an "open question" fashion - which did not restrict learners in applying the concepts to their own situations. Aspects of active learning were identified as "doing" rather than explaining. This involved students and provided enough functional activities as well as formative and summative self-assessment.

Specific activities were included (Addendum 1:68, Activity 4-20). For example:

Activity 4-20: "Number the stages that indicate the solving strategies for word problems. Would this strategy apply to word problems of all kinds? What is your personal view of this?"

The current methodology tended to encourage rote learning and did little to stimulate learners to reflect on borderline cases and complex practical issues. Educators should promote a student-

centred approach to learning, allowing learners to construct their own meanings. The learners provided evidence that they could not use rote learning.

- "Initially I found the process to be very time consuming but with practice Goal 5 took a lot less time to break up into objectives than Goal 1. Before I would just follow the textbook because someone else had done the hard work for me, but then I would get frustrated (and so would my students) as the lessons were not addressing their needs." (Student, 1996: letter).
- "[the activities] tended to tax one's insight and required a lot of time to do." (student in letter). (Student, 1996: letter).
- leerders se ontwikkeling en die kweek van belangstelling in die vak, dat die probleme wat gebruik word toepaslik op hul eie lewens moet wees. Dit wat hulle leer moet dus vir hulle sin maak en dit moet vir hulle lekker wees om dit te leer. ... vir hulle gewys word waar hulle dit eendag kan gebruik en nie altyd eendag nie, somer al nou. (Student, 1996: letter).
- ons leerders sukkel met die probleemoplossings beginsel in die algemeen. Hulle kan nie die probleem self oplos en uitredeneer en bevraagteken nie, hulle kan nie verbande sien tussen beginsels en konsepte nie. Hulle is nog nooit toegelaat om Wiskunde te ontdek nie. (Student, 1996: letter).
- Die atmosfeer in die klaskamer is ook baie belangrik (Student, 1996: letter).
- Die manier hoe die leerders kommunikeer in Wiskunde is ook belangrik, hulle moet weet wat al die terme beteken voor dit gebruik kan word. Hul gedrag moet konsekwent benader en aangespreek word. (Student, 1996: letter).
- Active participation of students should take place in every learning situation. Teachers should help the students to realise that maths is not just a group of numbers and calculations, it is needed in everyday life situations. A number of techniques are used for assessing what students have learned from lessons. (Student, 1996: letter).
- "Some of the activities required real thinking. These activities can be applied in S.A. schools. Some of the activities were difficult to understand. In real life problems, students will be confronted with puzzling questions, where they have to apply insight and are require to make value judgements. (Student, 1996: letter).
- "The activities I thought I would least enjoy ended up being not so bad. Mind-maps are always difficult for me to construct and I often do not enjoy doing them - however, I decided to attempt them for this assignment." (Student, 1996: letter).

Some learners did not do activities. "Some of the questions/activities I found rather difficult, and so I did not attempt these." (Student, 1996: letter).

Learners are required to self-evaluate and relate their understanding of their understanding to an evaluation instrument . We as a course team felt that the self-evaluation guidelines for assignments

were important (Tut MMAT00-8/101/97:11). The evaluation instrument for the portfolios was critical, and the guidelines and documents with criteria were provided (refer to Addendum C: Tut MMAT00-8/103/1996:7-11).

The aims of the learning were stated explicitly at the beginning of the guide and in the textbook. Knowledge, skills and values were to be addressed. The outcomes were to be measurable and linked to the learning opportunities (activities) to promote the ultimate formative and summative assessment strategies (SAQA, 2000). In contrast, during the pilot stage the "instructional design in 1996 excluded upfront outcomes and students had to be guided to discover the topics and unit outcomes themselves by way of enquiries, mind-mapping of chapters in the textbook, and working through the questions. The text guided learners towards an overview." (Wessels, 2001a). Some learners worked throughout the year and some crammed as the examinations approached. The modules met the expectations of learners and they believed that these modules would be of practical value in the future.

A learner indicated that any previous understanding of teaching mathematics at secondary school level changed:

My attitude to the teaching of maths has definitely changed. I've been exposed to numerous ways of approaching a topic to be taught, the most exciting of which is the use of real-life situations in the application of problem-solving.

The learners were required to apply the theory in their practice. The course designers assumed that the learners had mathematics backgrounds; however, this was not always the case and the learners then had great difficulty:

Not having an extensive maths background is a disadvantage as I could not rely on my own knowledge of the subject to help me plan the correct steps.

The activities required the students of this course to create activities for their secondary school learners:

I had to resort to a text to provide me with the details and that is when I encountered the problem of not being able to follow Cangelosi's suggestions as the textbook structure was overwhelming.

The students lack many of the basic skills and if they are not familiar with simple knowledge they will never attempt the more challenging aspects of maths. The textbook obviously ignores the ability of the students, so goal setting is crucial in meeting their needs. In order to address this problem the lecturer decided to reduce the required number of activities for the portfolio:

dit wat van die studente verwag is in die projek, was nogal baie en ek het mettertyd van die 150 aktiwiteite gehad en almal vereis van die studente het ek dit afgeskaal

na 80% en daarna 70%.

10) Reflection on critical consciousness and reflexivity

Students were able to identify differences and reflect critically on issues:

"Finding real-life applications was virtually impossible. The textbook had none and the examples that my colleagues provided were merely contrived problems. Again, my lack of mathematical background proved to be the limiting factor" (Student, 1996: letter).

The learners reflected critically on their ability to deal with sections of the work, their strategies, successes and failures:

Chapters 5 to 8 were done more thoroughly for two reasons: firstly, I felt more confident with the work I was doing; and secondly, I had more time available. These activities have been included in my own handwriting. However, from Chapter 3 onwards I found it a bit easier - possibly because the whole concept of research-based learning was starting to come together for me. (Student, 1996: letter).

The course was designed to foster a critical reflective approach; it seems in this case to have been successful.

Adults reflect on their own practices and change. Adult learners attempt difficult work and new experiences often and with trepidation - but find it stimulating if they complete these things. An example of this is the work of one student who showed that she addressed and included aspects which she found difficult and enjoyable, that she used technology, and applied mathematics to an extra-curricular situation which required knowledge about geometry. Also, her ability in problem-solving is hinted at here:

The idea of "a hint is not always a help" seems to run through the course and forces one to employ more inductive thinking than some other courses.... (Student, 1996: letter).

- My approach to the teaching of mathematics underwent a dramatic change during the course year 1997. I have given importance to the real-life problem solutions and tried to make mathematics teaching more effective and understanding. I am more dedicated to my students now. (Student, 1996: letter).
- I have enjoyed all the chapters well especially chapter 4 and chapter 5. (Student, 1996: letter).
- I would like to practise as a real mathematics teacher, by integrating all the virtues that I have learnt from the course. May the Almighty help me in my career to make my ambition fruitful. Thanks to you. (Student, 1996: letter).
- Die lekkerste en interessanste aktiwiteite was beslis vir my dié van hoofstuk 5, terwyl ek

moet erken hoofstuk 2 was vir my die slegste en moeilikste — die ontwikkeling van jou eie kurrikulum bly vir my duister. (Student, 1996: letter).

- Lesson design appeared so comprehensive that I was tempted to use the short notes of a lesson which I was taught 10 years ago. (Student, 1996: letter).
- This is a logical development within... aims and objectives and will bring valuable information and data to the fore concerning how pupils and teachers think about proofs, and the problems they have with that. This research will be more directed towards a subject-oriented approach. On the basis of a model which distinguishes different functions of proof within mathematics, the researchers has over the last number of years been developing some materials for introducing pupils to proof within dynamic geometry. Since pupils do not exhibit a need for verification in such environments pupils are first introduced to proof as a means of EXPLANATION and further DISCOVERY. Only at a later stage are more sophisticated functions of proof introduced, namely, those of VERIFICATION and of SYSTEMATISATION. (Student, 1996: letter).
- Difficult assignments for me included those that required a school context/classroom situation as the majority of the activities were completed in the school holiday period. I do feel I applied maximum effort. (Student, 1996: letter).

The course material requires reflection; therefore the learners need time to think through the new knowledge and its implications for practice:

- Daar is tog een aspek waaraan ek sou verkies die handboek aandag moes gee: Is daar leerlinge wat nie Wiskunde behoort te neem nie? Wat van leerlinge met lae IKs wat in die Tegnieuse studierigting is en dit moet neem? Hoe hanteer jy hulle? Werk die probleemoplossingsmetode ook vir hulle of nie? (Student, 1996: letter).
- After a short time, I became used to Cangelosi's style and I found the case studies useful in bringing the theory to life and in being able to relate it to the classroom situation. The experience clarified my interpretation of Cangelosi's messages, and simplified his teaching approach, as I realised that effective teaching involves a few basic fundamentals. (Student, 1996: letter).

11) Reflection on liberation and empowerment

Students should be guided towards empowering themselves.

- My understanding of and insight into this problem-solving situation has definitely changed for the better! I enjoyed the exposure to creativity objectives in lesson planning. This I found fun and will be sure to use [sic] in the future. (Student, 1996: letter).
- "[The course] highlighted to me the limits of the current educational system in S.A. as most activities [in the current system] are aimed at the knowledge-level." (student in 1996 letter).

12) Reflection on contextually focussed change

One student showed that context-focussed change this was a pertinent aspect in learning from this course.

- "The portfolio assignment exposed me to new strategies of teaching and learning of maths in a classroom. I had to compare them with what I am practising in class and choose the best one." (Student, 1996: letter).
- *"It was an enriching experience and especially exciting because I could see how relevant the research-based approach is to where South Africa is going in education"* (student, 1996).
- "The education system in South Africa is at present facing severe problems - the biggest problem being a financial one. From this many other problems arise, e.g. class size, discipline, etc. Another major problem is trying to integrate educationally deprived students into a privileged school system. It would therefore be of great benefit if all these issues could be addressed in the mathematics methodology course" .(Student, 1997: letter).

Real-life problems contextualised experiences while requiring the student to change his/her approach:

At first the idea of a real-life problem confused me, but I feel confident that I now have an idea of what a real-life problem is and how useful it is for teaching maths. Cangelosi uses a lot of examples which I only did in first year university. (Student, 1996: letter).

A learner identified the vignettes as the aspect that taught her most about different life situations:

Die aanbieding van 'n les vanuit 'n probleemoplossingsoogpunt met sy gepaardgaande "messiness" en die beheersing of wanbestuur daarvan, word in elke vinjet treffend illustreer. Uit hierdie vinjette het ek die meeste geleer. Elke vinjet is 'n klein lessie op homself. TOP. (Student, 1996: letter).

The students on this Unisa course were of the opinion that they could see the value of structured learning environments for their own classroom situations:

A properly planned lesson in a proper learning situation will motivate the students to achieve the goals and specified objectives.

The practical applications in the textbook were more suitable to an American context:

- I also felt that the book is very Americanised. We do not have all the technology (graphing calculators, etc.) and so I found parts irrelevant for me at this point. There are questions I left out that I felt incompetent to deal with, but now I have finished going through the book I would like to revisit them. (Student, 1996: letter).
- One of the largest problems with the new book as I perceive it, lies in your situation of maths teaching within the context of the history of maths rather than within the context of teaching in S.A. Because of this difference of focus, I am concerned that the value of

Assignment 01 will be lost because it does not address the practical reality of having pupils in a class with a wide variety of ability, languages, age-ranges and motivation. (Student, 1996: letter).

- The use of vignettes was helpful but one wonders how closely the course content and examples would be relevant to the South African syllabus. (Student, 1996: letter).

However, the lecturer carefully evaluated at the Mathematics outcomes as stated by the NQF (see Chapter 2) when these became available. During the early teaching phases the lecturer analysed the course and, with slight adjustments, confirmed that the course was consistent with the OBE guidelines.

The course materials were contextualised and learners needed to be part of a school situation with access to the syllabus. Some learners found this a limitation, as they were not immersed in any such context:

- I have chosen to include the activities that I have in my portfolio as I believe that they are relevant to real-life problem solving. (Student, 1996: letter).
- There were many activities that I could only do half of or that I could not do due to the fact that I do not have a school textbook to refer to. (Student, 1996: letter).

13) Reflection on occupational relevance

Learners all felt the need to improve mathematics teaching:

- "My understanding and insight of mathematics teaching problem solving is that maths should be made more meaningful to the students. The maths should not be confined to solving book problems. But it should be taken outside to the real-world application (sic)" (Student, 1996: letter.)
- "It [the course] has been an eye-opener for me - in the 5 weeks that I have done my practice teaching, I have been able to use some of the types of lessons discussed by Cangelosi and have been amazed at the results". (Student, 1996: letter).
- "I have tried to apply a few things I have learnt in my classes and have found them to be successful 95% of the time". (Student, 1996: letter).
- "After writing the portfolio, I have applied the problem-solving approach in my class and found it worthwhile. Some of the activities were difficult to understand."

The topics in the course directly linked with the requirements of the mathematics teacher's occupation:

It contains a discussion about the reasons for teaching mathematics. The 4th section is a comparison of direct teaching methods and real-life application of mathematics. This is another crucial section to a mathematics teacher. The 5th section is the developing of mathematics curricula. I have included a discussion of the spiral-

approach curriculum design. This is an approach used locally in Swaziland. The 6th section is a discussion of maths learning level objectives. This is the central part of lesson design in maths (student, 1996: letter).

Students engaged in the real-life descriptions of the vignettes and where their learning was stimulated they engaged fully in the learning. They experienced it as a "real-life" situation that mirror situations they confront in their working environment:

Die vinjette in Cangelosi het ek die meeste geniet, wat bevestig dat die aanskoulike, beskrywende situasie tot 'n mens spreek. Dit is amper soos die lees van 'n storieboek, of die kyk van 'n film waar jy met die hoofrolspeler (die onderwyser) kan identifiseer. Dit is tog sulke situasies waarvoor ook EK as onderwyser te staan gaan kom (student, 1996: letter).

The problem-solving approach, although completely new to the target group, was accepted well and could be implemented in South African schools, especially rural schools:

- This course has given me an insight and motivation to change my methods completely to informal ways of problem-solving approach and motivating the students to learn from experience. It looks like a foreign system when we compare it with the South African black school environment, especially in the rural schools. (Student, 1996: letter)
- If we can apply all the strategies given to us we can be very good teachers. I wish such strategies you are giving us now had been here long in South African schools, especially black, as there are still a lot of problems [sic]. I now love mathematics more than I used to. It is so stimulating and very much exciting. (Student, 1996: letter).
- When I first encountered the NCTM I was rather sceptical about its use in our education system. However, talking with students soon revised my opinion. Students have the perception that mathematics is difficult, boring, only for the "clever" people. If mathematics is to be viewed differently, then this negative attitude to mathematics must be eliminated. (Student, 1996: letter).
- I would also like to suggest that you provide a more detailed motivation for your choice of an American or Dutch context, and some of the implications this has over, say, a Mexican or Australian perspective. I feel this is important because you discuss "contemporary emphases in the NCTM standards". It may be a good idea to emphasise right at the beginning of the maths course guide (102) the overarching goal of enabling effective learning of mathematics by the pupil. (Student, 1996: letter).

Learners had to have experience as teachers:

- At times I felt that the questions and activities were aimed more at practising teachers, with several years of teaching experience; it was particularly difficult for me to formulate

creative lessons that had, in addition, direct relevance to real-life, or that facilitated the process of solving real-life problems (student, 1997: letter).

Even though the tasks were difficult, the learners applied them after completing the assessment, especially the portfolio: Some of the activities required real thinking. These activities can be applied in South African schools. (Student, 1996: letter).

14) Reflection on measured progress

The time spent on learning in this course was considered to be a lot. An adult student has to balance this time spent with gains achieved:

"Designing lessons based on research-based principles requires a lot of thought and planning, and it is very time-consuming. However, when one considers the long-term benefits both for the student and the teacher using this approach, it is well worthwhile to spend the extra time preparing meaningful lessons." (Student, 1996: letter.)

In most cases the portfolio was just too much work. Learners usually underestimate the time it takes to complete the preparations:

- "I feel that the work load is unreasonable (especially if this is only 1 course out of a total 7 courses that 2nd year HED students are doing. Most Unisa HED students have full-time jobs)." (Student, 1996: letter.)
- [I] also battled to complete this portfolio and have had to rush through the work to complete it (student in letter). (Student, 1996: letter.)

15) Reflection on direct open outcomes

Holistic active learning strategies facilitated the achievement of set learning outcomes. In this course students were encouraged to become familiar with graphic representations (in the form of mind-maps) of the conceptual structure. The relationships were very complex.

The learner indicated that the "aktiwiteite was baie oop vrae". The lecturer felt uncomfortable from the beginning about the mathematics contents and he suggested the inclusion of more subject-related skills in the authentic evaluation strategies. He decided to include some in the 1996 course (see Addendum C):

The book is useful to a teacher who has the aim of assisting students to understand mathematics. The language used in the book is simple and easy to understand. This book stresses the use of the problem-solving approach. I had a problem before with my students, but since I obtained this book the problem has reduced. Some of my students really hated maths. They even asked me why this complicated subject was introduced. This book stresses the use of the problem-solving approach. My mathematics department teachers are all willing to read the book. The problem I

had was of answering the questions that appear in tutorial letters 102 and 103. It is very difficult to understand those questions. (Student, 1996: letter).

The usefulness of activities in the guide was not a problem because of their relationship with assignments and examinations. There were a few problems with a number of practical applications in the textbook:

It contains the discussion of the reasons for teaching mathematics. The 4th section is a comparison of direct teaching methods and real-life application of mathematics. This is another crucial section to a mathematics teacher. The 5th section is the developing of mathematics curricula. I have included a discussion of the spiral-approach curriculum design. This is an approach used locally in Swaziland. The 6th section is a discussion of maths learning level objectives. This is the central part of lesson design in maths. (Student, 1996: letter).

The aims and outcomes of the learning may have to be stated explicitly at the beginning of the course and in the study units.

'I also found that the approach used in this book is good in maths teaching because here are objectives you are achieving in a child.' (Student, 1996: letter).

However, no one objective was more important than any other.

"the prescribed textbook does not advocate the learning objective "discover a relationship at the expense of other learning objectives". It views all objectives as being important, e.g. knowledge, comprehension, algorithms, etc. (Student, 1996: letter).

Knowledge, skills, and values should be addressed. The outcomes should be measurable and linked to the learning opportunities (activities) so as to promote the ultimate formative and summative assessment strategies (SAQA, 2000):

- I feel that I have achieved the objectives of the course, namely to familiarise the prospective teacher with the problem-solving and problem-centered approaches to teaching; (Student, 1996: letter).
- I gained a better perspective of the course content and its aims from the day seminar. The course has broadened my outlook to teaching, and I am now able to approach the different objectives and teaching strategies with greater enthusiasm and confidence.

Students who exceeded the envisaged outcomes should be able to get credit because of recognition of their prior learning.

Learners demonstrated a definite awareness of the task, to the point that some were scared" of

what the work entailed. In most cases the learners showed effort and perseverance in attaining their goals. Extracts of what learners did are included in Addendum D in the form of mind-maps and extracts from their letters:

"The section I found the most difficult is designing learning activities in order to achieve the desired learning objectives at a specified learning level. I found that it was not always easy to think of appropriate learning activities, especially for intellectual-level objectives." (Student, 1996: letter.)

16) Reflection on assessment

In the MMAT00-8 course, as with all Unisa study packages, the assessment strategy included feedback on activities, and short assessment exercises. As with all Unisa's study packages, this course had to make provision for assessment opportunities, feedback about the learners' progress, contact, support and pacing opportunities. Also, evaluation had to be in place so as to evaluate "*ook die klaskamer situasie gedurig deur ... die materiaal waarmee hulle werk, asook die curriculum waarmee hulle werk*" (lecturer, 1997:interview) . The assessment included activity-in-text opportunities, assignments (including a portfolio and paragraph questions) and examinations. In the course in question the assessment included feedback on activities, and short assessment exercises. The lecturer felt that "die bepaalde tipering en afbakening van die portefeuljes was 'n belangrike toevoeging [tot die evaluering]" (Wessels, 2001a).

Learners were able to self-evaluate and score the work done for the portfolio (observation by the researcher from the portfolio results). The focussed-holistic score card (Kuhs, 1994: 334) as adapted for the case study (Unisa: MMAT00-8/107/1996) was successful. The four levels specified for each criterion (according to Posner and Rudnitsky, 1997: 198-99) were evident in the different portfolios. Each of these levels reflected the difference between the levels. The levels did indicate the competence in a insight or learning aspect. There was a balance between these levels and the weights attached could be carefully evaluated.

Students who exceeded the envisaged outcomes should be able to get credit by way of recognition of their prior learning (SAQA, 1998: 3). In 1996 prior learning was only informally recognised by the lecturer because the University only allowed for the recognition of prior learning after 1996.

"The portfolio approach requires students to develop and utilize maths in real life problem-solving. There are problems, however, encountered while compiling this; like those of trying to find clarity out of data; meaning of information and evaluation of the approach being chosen for a problem. Another problem is that of being used to the traditional methods of teaching and learning where students and teachers concentrate in the knowledge of executing algorithms and remembering them in examination situation of pen and paper." (Student, 1996: letter.)

Students also seemed to think that assignments and the examination guidelines were fairly useful in preparing for the examinations:

It [the portfolio] covers 80% of the work assigned to us. It is comprehensive in the sense that it covers my total approach to the work. (Student, 1996: letter.)

Overall, learners found the portfolio as authentic assessment strategy appropriate and applicable to their work situations:

- I really enjoyed assessing myself. I never had this opportunity before and I must say that this is quite creative on your part. I also enjoyed the section on creativity. It was something really different and against the norms. (Student, 1996: letter.)
- Most of the activities were applied in daily school life. It was really wonderful to see after this portfolio that I was able to apply the principles involved in it. I hope by writing this portfolio that each student will benefit from it and can apply it in real-life problems. (Student, 1996: letter.)
- I found it really difficult to work through most of the activities I selected. This was because some of the activities are long and involved a lot of work; others tended to tax one's insight and required a lot of time to do. I, however, enjoyed doing some of the activities, especially those dealing with ways of designing lessons on various objective levels and also those dealing with creating an environment conducive to teaching and learning mathematics in a classroom situation. Although compiling this portfolio was no simple matter, it afforded me the opportunity to learn new teaching skills and ideas. I came to realise that parts of the maths syllabus are better handled with specific methods than with others. (Student, 1996: letter.)
- This has been a wonderful experience since it is my first time to compile a portfolio [sic]. There are problems, however, encountered while compiling this; like those of trying to find clarity out of data; meaning of information and evaluation of the approach being chosen for a problem. Another problem is that of being used to the traditional methods of teaching and learning where students and teachers concentrate on the knowledge of executing algorithms and remembering them in the examination situation of pen and paper. The portfolio approach requires students to develop and utilise mathematics in real-life problem-solving. This portfolio changed my attitude towards mathematics teaching and my approach in the teaching of students maths by making it more applicable to live problem-solving. (Student, 1996: letter.)

The course had a heavy workload and "inevitably I ran out of time and did not manage to complete all the assignments - only completing chapters 1-9. I have indeed, however, put in a lot of effort and time to these 9 chapters". (Student, 1996: letter.)

In looking at the workload presented by the course, the course dealt with a relatively large volume

of work that was not a "walk in the park". However, this was consistent with the negotiated curriculum:

A number of difficulties were experienced with time. The amount of work to be covered is extensive. Chapter 8 of the portfolio includes a number of activities which require more time input than earlier chapters. This chapter is the crux of the course and an indication of its importance should come into the lecturer's instructions much earlier in the course. (Student, 1996: letter.)

Students spent a great deal of time on completing their assignments. It was clear that few finished the course in the allotted 120 notional hours per module. This could be explained by there being too much to study, by the course being too difficult, by study guidance that did not match the prior knowledge of the learners, or by students' lack of preparedness for distance education study. Some students worked throughout the year and some crammed as the examinations approached.

A student described her workload when using the problem-solving approach as a tremendous amount of work, especially with the additional roles the adult learner has to cope with:

- Ek vind ook die probleemoplossingsbenadering behels GEWELDIG BAIE WERKSINSETTE vir die onderwyser sowel as vir die leerling. (Student, 1996: letter.)
- There is a massive workload in this course if you consider that I am doing the whole PGCE [Postgraduate Certificate in Education] in one year, with 10 weeks of practice teaching included - as well as being the mother of children. (Student, 1996: letter.)

The learners considered the portfolio to be a tremendous amount of work, but a worthwhile experience:

- I do not think that I have ever worked as hard as I did on this portfolio. It was a taxing but enjoyable experience. (Student, 1996: letter.)
- I would have loved to spend more time on it. I have really struggled to complete this portfolio. (Student, 1996: letter.)
- This has been the biggest assignment I have ever tackled. Initially I had my doubts about completing this assignment. The first four chapters I battled. When I came to chapter 5, I developed a method of how to approach each section. I did not quite know how to answer the activities at first. I like using direct teaching, therefore I did not have any problems completing that section of the work. (Student, 1996: letter.)

The students felt the course expected too much and the workload was too heavy:

- [Hierdie kursus was] maar ERG baie werk; moedbrekend te veel, veral aangesien ons nie meer voltydse studente is nie maar self ook in 'n professie staan. (Student, 1996: letter.)
- A number of difficulties were experienced with time. The amount of work to be covered is extensive. Chapter 8 of the portfolio includes a number of activities which require more time input than earlier chapters. This chapter is the crux of the course and an indication of

its importance should come into the lecturer's instructions much earlier in the course.

(Student, 1996: letter.)

- The workload in trying to consistently go through all the activities is very demanding. In addition have the portfolio as the assignments, but spaced out so that activities for two chapters are handed in at a time, up to the end of chapter 4 for the first year, (which would include the present assignment 01) then to the end of chapter 9 at the end of the second year (which would include assignment 03), with credit given towards exam marks as well in each year. (Student, 1996: letter.)

Again, In most cases the portfolio was just too much work. Learners usually underestimated the time it took to complete the preparations:

- The portfolio approach requires students to develop and utilise maths in real-life problem solving. There are problems, however, encountered while compiling this; like those of trying to find clarity out of data; meaning of information and evaluation of the approach being chosen for a problem. Another problem is that of being used to the traditional methods of teaching and learning where students and teachers concentrate on the knowledge of executing algorithms and remembering them in the examination situation of pen and paper (student in letter). (Student, 1996: letter.)
- The portfolio assignment was too strenuous, too long in itself, and time consuming. (Student, 1996: letter.)
- The assignment needs a hundred percent concentration and a total commitment. (Student, 1996: letter.)

However, this learners also stated:

- The portfolio assignment exposed me to new strategies of teaching and learning maths in the classroom. I had to compare them to what I am practising in class and choose the best one (Student, 1996: letter.)

On the other hand some learners did not enjoy a portfolio:

I find Assignment 3 (portfolio) very tedious and at some points unstimulating. In a way I am thankful for this assignment in that I feel more prepared for the forthcoming exams (Student, 1996: letter.)

The assessment criteria specified did indicate the different aspects to be assessed, and the level of assessment. It was simple to use, easy to understand, reliable, and a faithful representation of the work done. The learners who sent in their assignments and portfolio sent in this evaluation instrument. None of the learners commented on the assessment criteria, so one may deduce that their perception was that it was not an important issue.

The portfolio activity was an effective learning opportunity. The criteria for assessing learning

effectiveness did include the purpose behind, the achievement of, the application of, and the reflection on the learners' development (as suggested by Posner and Rudnitsky, 1997: 198-99 and UNISA, 1997a: Addendum B):

The section I found the most difficult is designing learning activities in order to achieve the desired learning objectives at a specified learning level. I found that it was not always easy to think of appropriate learning activities, especially for intellectual-level objectives. It also highlighted to me the limits of the current educational system in S.A. as most activities are aimed at the knowledge-level. Designing lessons based on research-based principles requires a lot of thought and planning, and it is very time-consuming. However, when one considers the long-term benefits both for the student and the teacher using this approach, it is well worth spending the extra time preparing meaningful lessons. (Student, 1996: letter.)

The course team was reminded of the role of the portfolio as a possible summative assessment method as "die 3 werkopdragte, en veral werkopdrag 03 ... so omvattend is dat dit 'n eksamen oorbodig maak". (Student, 1996: letter.)

The portfolio provided evidence of the purpose and the degree to which the learner established and maintained a clear sense of purpose. Learners demonstrated a definite awareness of the task, to the point that some were "scared" of what the work entailed. In most cases the learners showed effort and perseverance towards attaining their goals. The portfolio provided evidence of the achievement of the goals, of the degree to which the learner exhibited an understanding of key concepts, of the development of essential skills, and of a feel for the subject matter. For example: "I found it really difficult to work through most of the activities I selected. This was because some of the activities are long and involved a lot of work; others tended to tax one's insight and required a lot of time to do" (Student, 1996: letter.)

The portfolio provided evidence of application and continuity, of the degree to which the learner connected new understanding to previous learning, and showed an ability to link concepts, discover underlying rules or principles, and apply those rules or principles. For example: "At times I felt that the questions and activities were aimed more at practising teachers with several years of teaching experience; it was particularly difficult for me to formulate creative lessons that had, in addition, direct relevance to real-life, or that facilitated the process of solving real-life problems" (Student, 1996: letter.)

The learners did express their reluctance to change from being recalcitrant, perhaps passive learners. They soon overcame this reluctance - perhaps because of their continued engagement in their task and a growing interest in an approach which they felt "curious" about because it could

solve problems which they encountered in the mathematics classroom:

"First and foremost, it was a tremendous task, started very reluctantly and culminated with great jest and a lot of fatigue! I had never done something like this before and the task seemed daunting and unconventional (the way I was taught maths in school comes nowhere near to what I've now been exposed to in this book."
(Student, 1996: letter.)

An excessive workload may result in learners focussing on "easy" activities, as this learner explains: Sometimes the interpretation of assignments and activities gave me problems although this could have been partly due to the open-ended character of many activities. The amount of work required for this subject came as a shock for me as I based my year planning on the experience I had with other HED subjects. The resulting time pressure caused me to concentrate mainly on the "easy" activities. If the total number of activities could be somewhat reduced (e.g. to below 100), more time could be spent on the harder and time-consuming activities. (Student, 1996: letter.)

In the second year of the pilot phase the number of activities required for the portfolio was reduced from 80% to 70%:

"Even though this portfolio was tedious work, I really enjoyed it. Almost 70% of the activities were completed from chapter 1 to chapter 8. Some of them were easy while others were difficult. Some of the activities needed real thinking and reference from the activity." (Student, 1996: letter.)

16) Reflection on problem solving skills

Learners were constantly required in many activities to solve problems. They provided evidence that they were enabled to do so.

- "I have learnt a lot about problem-solving and the way it should be taught" (Student, 1996: letter.)
- It is because of the various vignettes that I have understood the various learning levels, concepts, strategies, etc. In the past I knew that we need to relate all that we teach to our real world but I always thought that this was impossible with the content load and number of pupils in the class at present. (Student, 1996: letter.)
- My understanding and insight into teaching maths problem-solving is that maths should be made more meaningful to the students. The maths should not be confined to solving book problems, but it should be taken outside to the real-world application [sic]. (Student, 1996: letter.)

The learners found the problem-solving approach a novel concept. They indicated repeatedly that

they implemented this approach in their teaching of mathematics, sometimes with success:

- "Though I taught for many years I did not have a clear picture of the problem-solving approach. After working through Cangelosi's book I understood what the problem-solving approach is. I have already started using the problem-solving approach successfully in teaching mathematics. (Student, 1996: letter).
- The problem-solving teaching approach is both motivating to the teacher and the students. I have realised that teaching maths can be more enjoyable to the teacher and also to the learner. (Student, 1996: letter.)
- "The problem-solving teaching approach is both motivating to the teacher and the students. I have realized that teaching mathematics can be more enjoyable to the teacher and also to the learner." (Student, 1996: letter).

17) *Reflection on change*

The learners indicated that there were a lot of subject-related skills required in the portfolio. The current methodology tended to encourage rote learning and did little to stimulate learners to reflect on borderline cases and complex practical issues. Educators should promote a student-centred approach to learning, allowing learners to construct their own meanings:

- I covered over 80% of all the activities in each chapter. It was quite tiresome and difficult, because I worked individually, but nevertheless very enjoyable and motivating. The items that I selected I found exciting and enjoyable as well as answerable. Some of the activities were vague in their questions but I did indicate this at those questions. (Student, 1996: letter.)
- I honestly found the "mind-maps" quite difficult. I could not relate the various concepts as wanted by the activity/tutorial letters. (Student, 1996: letter.)
- Ek het nou 'n heel ander siening oor wiskunde-onderrig. Ek is seker my begrip en insig oor wiskunde, asook oor probleemoplossing het verbeter. Ek voel die verandering is nodig - so ook die vak "makliker", "verstaanbaar" en "toeganklik" vir die leerlinge te maak. (Student, 1996: letter.)

19) *Reflection on personal change*

There was evidence that personal change took place.

- It is completely different to the way I was taught maths and I have grown significantly in the process. I have also been able to share some of this learning with the experienced teachers with whom I worked. (Student, 1996: letter.)
- I came away at the end of the assignment more aware of opportunities and ways of moving from the traditional to the problem-solving approach to teaching maths. (Student, 1996: letter.)
- I have absorbed problem-solving principles into their lessons and have made each of their lessons problem-solving based. I have understood practical ways which allow problem-

- solving to become a basis in teaching and feel I am much better equipped to attempt this myself. (Student, 1996: letter.)
- I feel more confident and have many more ideas on how to make my teaching more applicable to the real-life context. (Student, 1996: letter.)

20) Reflection on integrated media experiences

No media was provided in the study material and the limitation was noted by the team. However, it is interesting to note that the textbook and the activities in the guide expect a number of media experiences from the learners, all based in the classroom situation.

7.5.2 Reflections on the MMAT course pilot: the course team

The course team reflections were just as exciting.

a) Reflections on the organisational structures and team roles

The interview with the lecturer confirmed my own experience of working with him in the team. In my description of this case, I often think about our experiences - what we wanted, what we thought was feasible, and what we wanted to try out regardless of all that. The interviews allowed the lecturer's voice to be heard; these interviews followed the guidelines for interviewing, and the interview schedules which had been set up (see Addendum D).

Action research into this course development process employed a number of research strategies: a case study description, an interview to explore reflections, an analysis of the study materials, a description of the process, letters, mind-maps and activity analysis, and looking at assessment results (including assignments, exams, portfolios, and letters). The results from the research strategies focussed on exploring the structure of the process as well as that of the product, the learning opportunities, and the learning outcomes that were evident.

The action research methodology was both a useful and an enabling research method for the development team and for the researcher - all of whom wished to improve their understanding of the discourse within distance education practice and mathematics education, as informed by educational theory. The course team actively invited learners to engage in the process as co-researchers.

As a researcher this part of the process was the easy part. As learning designer-as-member I also had a quiet, observing role. The lecturer worked very hard during this phase to deal with the management, assessment of the learners (especially the labour-intensive portfolios) and his tutor role, in which he provided a substantial amount of learner support.

The notes made during this study should have received more attention and should have been

discussed more as they are crucial in the data analysis phase. However, this is not always possible in qualitative research to the extent that one wishes.

b) Reflections on the team discourse:

In the second cycle the roles in the course team stayed the same. The focus was still on the design of the course. The design and production issues and methods had to be revised a number of times in order to provide the students with timely study materials of the best possible quality (see Chapter 7 for the pilot phase).

Together we took note of the events and their side-effects. It was decided that the final reports would report the effects and be presented as papers, articles, and as this postgraduate study. Initial, but limited, reports were provided in the instructional design circles of the institution and academic department.

c) Reflections on the team actions

The team followed the curriculum and course design processes as an initial plan of action. The team actions matched the clearly defined the roles of the various team members. During this stage, team members were identified and their expectations were discussed. The case study was written up later in the process, as expectations were expressed and issues came up with the passing of time.

7.6 Reliability and validity

Action research is useful in tracking the instructional design and curriculum development processes in a distance education university course such as Mathematics Subject Didactics.

Students were invited to participate as well. Students were told that the course was in the process of being designed: "the course will be evaluated and finalised for 1997 You will be involved in the evaluation process" (UNISA MMATOO-8/101. 1996a.) which addressed the ethical requirements. This aspect should be considered in a more user friendly style with more emphasis on the role of the learner and their choices. They should be asked to give their approval in writing in the portfolio letters.

Various categories emerged from the student feedback, the examination results, the assignment results, the portfolio results, the interviews, and the instructional design specialist analysis.

The target group was as anticipated. The sampling technique took place according to qualitative research strategies. The raw data classification was not done according to the concept grid method called nominal group technique which allows researchers to interpret patterns, but presented as rich descriptions following the research questions (in Chapter 4 we describe why we did not agree

with this procedure.)

The data gathering methods allowed validation to take place (see Chapter 4.6.2). The data was triangulated (see Addendum E for transcripts of the videotaped interviews). The investigator triangulation included two different interviewers. A critical reader was involved, as well as another subject specialist acting in an informal manner.

7.7 Concluding the pilot phase

This chapter describes the last cycle of the course. In this stage of the development the implementation and maintenance of the MMAT course was used as a pilot phase. The course team felt that the pilot run was successful. The course required self-assessment according to a scoring rubric in the portfolios. The focus areas were based on activities that "tap ook hulle ervaring sterk, hulle vermoë om te interpreteer, kommunikeer, nie net met die leerstof nie maar ook met ander mense en in die klas situasie. ... Ook in terme van refleksie en evaluasie" (lecturer, 1997).

The course team actively invited learners to engage in the process as co-researchers - a challenge to which the learners responded. The 1996/7 development was piloted successfully. Some aspects needed immediate attention. The results of MMAT course pilot indicated that the guide had to be re-assessed to affirm that it conformed to SAQA and NQF requirements, and to the requirements of the degree outcomes accepted by the accreditation bodies. The lecturer did a cursory glance in the beginning of 2000, but - with new SAQA specifications and recommendations - needed to revisit this aspect of the course. The guide needed a more modern design and layout, with attention to learner-focussed language, and knowledge and skills components required by South Africa mathematics teachers. All these would ensure the relevance and effectiveness of the course in preparing learners to meet the requirements of society and be responsible citizens.

The instructional designer-advisor and the subject specialist-lecturer still formed the nucleus of the team. The implementation phase, as the description of the course design model described in Chapter 3 indicates, is typical of 1996 Unisa course design. A number of assertions alerted students to consider their own knowledge of the case or modify existing generalisations about such cases. This chapter presents a body of relatively uninterpreted observations, and summarises my feelings about, and understanding of, the case. The next chapter presents the improved course, which took the results of the pilot into consideration. The revised course was maintained over five years.

III: Chapter 8

Presenting the MMAT course

8.1 Introduction

The materials were developed (Chapter 6) and piloted (Chapter 7). In the previous chapter the course piloting was described. In this chapter the course maintenance over five years is described. This is the last cycle in this action research case.

8.2 Planning the MMAT course presentation

The area of investigation was to describe events during the maintenance of the MMAT course where the use of activity-in-text has the ability to better learners' skills and change their attitudes. The problems that arose were typical of Unisa course maintenance.

The inquiry also focussed on events in the team approach.

8.2.1 Planning the MMAT course presentation: the course

The course material developed in 1995 and piloted in 1996-7 (see Chapters 6 and 7), was used unchanged from 1998 until 2003. Many changes were expected on a national scale. However, the philosophy of the course and its problem-solving approach was very much in tune with the unfolding OBE philosophy. The focus was still to foster active learning, to create opportunities through dialogue, and to allow support and role structures to support the opportunities for investigation.

The visual design was expected to change so as to fit into the established Unisa production system. The linguistic design was left unchanged. The content design was based on the same premises as the pilot. The learning design was adapted very slightly to address the issue of workload, freedom, and responsibility.

The student demographics did not change substantially from 1996 to 1998. There were three courses that received the same course material namely MMAT00-8, FDEME6-P and FDEME5-N (Addendum C). The entrance level and pre-knowledge of the learners were different. The lecturer identified this (Chapter 6 and 7).

The action research methodology would be applied in this phase also, using the same data collection strategies as before with the inclusion of assessment results (the marks and portfolio information).

8.2.2 Planning the MMAT course presentation: the course team

The design and development process included the core team and other Unisa professionals (section 2.6.3) who produced the course materials and distributed it to the students. The postmodern nature of the course design process is evident (section 6.3.1 and 3.3)- as well as the automated processes in the delivery of Unisa course material, which are based on a smooth-running industrialised system.

The team strategy focussed more outwards into the organisation, than was the case up too now. However, we expected the intensity and the workload for development to reduce. The workload for the teaching would stay the same. The roles in the team were expected to change. The research focus became more important to the researcher (2.6.4).

The problem-solving approach was still a point of departure, as were the informal theories of teaching (section 1.7.2) such as guided discovery with exploration which had always been embedded in the course.

8.3 Actions during the MMAT course maintenance

Both the process and the product were the focus.

8.3.1 Actions during the MMAT course maintenance: the course

The outline of the process on the course map was now complete, with only very small alterations being necessary. The defined parameters of the team and the institution were still evident. The data gathering techniques would stay the same (section 1.4.2).

The content was left unchanged - the textbook by Cangelosi (in 1998 there was a new edition) was used.

The visual design of the course materials was altered to fit in with the institution's printing systems requirements. A new cover colour indicated the maintenance phase in the project. The linguistic aspects of the course did not change - nor did the didactic design.

8.3.2 Actions during the MMAT course maintenance: the course team

The core team was not changed. The Unisa professionals who were not part of the earlier developments now played the biggest role, in establishing and maintaining the automated

processes that would keep the course rolling.

The lecturer's role became more important. The person who had to teach the course had less help now from the learning designer, who began to move out of the team. Collaboration was not that important for this team anymore, as decisions within the maintenance phase could be taken through the collaboration of different groups - the lecturer along with other institutional professionals, such as people in Undergraduate Affairs, Production, Dispatch and Finance. The deviation strategies were not so important anymore, as the system was stabilising.

The team members found themselves in the "consequence" and refocussing stages of professional development (section 2.6.2) with the research focus being on observation and reflection - with the view to publish (section 2.8).

8.4 Observations during the MMAT course maintenance

The MMAT course team observed the course design and team dynamics in order to get evidence of this period.

8.4.1 Observations during the MMAT course maintenance: the course

Through the course materials, portfolio assignment, personal discussions, notes and e-mail correspondence the data for this period was gathered. The students were similar to whom they were in the pilot groups throughout the maintenance years. The number of students that enrolled for the MMAT course was less, however the enrollments for the FDEME6-P and the SDMAT0-4 modules increased. The enrolments per year was divided into the first and second semester.

The layout of the guide was changed to what Unisa called a "fast-track" layout to standardise options, increase production speed, while still providing a visually pleasing document (See Addendum C).

The language is imbedded in the guide. The language in the course was kept similar to what it had been before.

Learners are guided by the content in the textbook to an awareness of their own school situation and of the South African curriculum. The learners were directed to frequent information about current changes in the South African curriculum. (Addendum C: tutorial EDUVAK-N/301 of 1999.)

The learning design remained the same as planned (Chapter 6) and piloted (Chapter 7). The assessment structure was altered to allow more diversity and give students that attended the day seminar more credit. (MMAT00-8/101 of 1998). The portfolio was still one of the most important

assessment instruments, with the same scoring rubric as 1997. The South African OBE system was an important external influence, with learners having to confront the new curriculum for mathematics classes. (MMAT00-8/101 of 1998).

8.4.2 Observations during the MMAT course maintenance: the course team

At this stage, the research actions were taken over by the researcher and there was less collaboration with, or participation from the other members. The relationship between the various operating units became smoother. However, the changed processes and outcomes of change in the institution's systems were disturbing as reverted to a segregated industrialised system. The professional development took a back seat during this phase, which was more observational than active.

8.5 Reflections on the MMAT course maintenance

The MMAT course maintenance was a period of creating an environment of guided conversation between the lecturer and the learner, between the learner and his/her environment, and between the learner and the study material.

8.5.1 Reflections on the MMAT course maintenance: the product

The course materials and the course maintenance processes were of interest here.

(a) Reflecting on the linguistic design

The effect of language was of little effect as they did not change the language.

(b) Reflecting on the visual design

The mindmaps were computer-drawn for a 'neat' appearance. This resulted in more formal computer-drawn mindmaps in the student portfolios. This is contrary to what a mindmap as a learning strategy should be as it requires computer skills and therefore they have biased the assessment. They changed the layout and font usage of the course and it resulted in a more formal approach. Learners did not comment on the enjoyable talk in the text and no conclusions are possible.

(c) Reflecting on the content design

They produced the course materials to conform with the guidelines of the University, following the course package requirements. The in-house printers produced them. The course structure is still as it was when it was first developed (section 6.5.1; Addendum C). The course is still relevant in the OBE educational situation. The outcome statements of the course have to be revised for formulation. A new edition of the textbook requires a revised guide.

(d) Reflecting on the learning design

The creative approach to mindmapping was visibly less (reflection of the instructional designer, 2001). The assessment is very appropriate, with the portfolios still being an excellent assessment and learning tool providing evidence of learning. The workload is considered too much especially because the course time was shortened (but the workload not lessened) during semesterization.

The institution adapted its processes to integrate authentic assessment practices and to accept larger articles such as portfolio files from learners. This resulted in less delays and administrative problems.

8.5.2 Reflections on the MMAT course maintenance: the course team

The reflections of the course team included issues underpinning course design and development, namely organisational structures and roles, language and discourse issues, and actions and activities expected by the institution or the team.

(a) Reflections on the organisational structure and team roles

There was no author-learning developer team. The institutional maintenance team presented the course within the organisational structures of the institution. Each functional unit fulfilled its role.

(b) Reflections on the team discourse

The core team discussed the course informally about once a year during the maintenance phase.

(c) Reflections on the team actions

The core team cohesiveness broke down naturally because of a reduced need for a sustained discourse, and as a result of there being no functional roles and tasks, and no focussed activity. A diffused university-wide course maintenance team undertook the presentation of the course that included the printing, dispatching, examinations, assignments, learner support and teaching functions.

8.6 Reliability and validity

The action research methodology reached a stage of observation and reflection. The data gathering was consolidated as the system stabilised.

8.7 Concluding the maintenance phase

The maintenance is the last phase in the course design process. But it is both an ending and a beginning, as this course is due for revision after a full DE course cycle.

The last chapter concludes the study; it summarises the main aspects of this work.

IV: Chapter 9

Conclusion, suggestions and recommendations

9.1 Introduction and overview to the study

Distance education has to change so as to keep pace with social developments - and move from a Neo-Fordist to a Post-Fordist paradigm, examining changes in pedagogics and technology systems (Moore & Kearsley, 1996: 15-16). We asked questions like: "How should we change the manner in which students learn so that they become active participants in their learning experiences?" and "How should this change in learning design change the self-study materials to enable learners to become active learners?" and "How should these changes in learning design change the course design process?" and, finally, "How would these changes in learning design affect the distance education institute to accommodate new course design processes?".

This research suggests that as a collective community of distance educators we need to "choreograph" our "dance" - our efforts - through engaging in an intelligent debate. We need to focus on research into effective distance learning design which engages our learners in an intelligent active debate. Our efforts should be shared as creative, innovative course design projects. We need to understand the enabling strategies which foster active learning.

We provide an overview to the project in Part I of this dissertation. The most important aspect in education today is change and the management of change. In Chapter 1 the researcher discussed the reasons why the study had become of vital importance to the biggest distance education institution in South Africa within a globally changing market and a "knowledge society". It was argued that course design and development is crucial for quality self-study materials. We established that in-text activities are central in the increased focus on establishing a discourse, fostering activity, and considering structures and roles in the learning environment. This case study had to consider these factors during the processes over eight years of development, as described in Chapters 5 to 8.

In Chapter 1, the complexities of the tasks were described within the context of the problems imbedded in DE, such as passive learning. The research study set a number of thematic questions to

better describe the focus question, as is required by action research methodology. In order to describe the elements of change, the various forms of adult learning are defined. Distance education is argued to be unique in nature, and it therefore requires unique solutions. To avoid misunderstanding the concepts used in this document are discussed (such as the names for the different types of learning - adult learning, action learning, action research, dialogue, distance education, and variants). The management of change provides the course team with a model to direct the course design and development. This chapter also proposes the action research methodology to collate evidence following the thematic questions. Lastly, the chapter spells out the programme of this dissertation in order to show the reader where the process is going to.

Part II provides the theoretical underpinning of the research. In Chapter 2, the macro perspective of the distance education course environment at Unisa was described. The Distance Education institute in a post-Apartheid South Africa, and its learners, were described as they were at that point in the study. The course, Mathematics Subject Didactics, was described in context of the aspects that influence the quality of learning and the problems that DE learners experience when learning. A discussion of the factors that inhibit active learning sets the scene for the investigation. The course team environment is unique at the institution: the literature study revealed reasons why individuals underwent dramatic personal development, which provided the drive to change and to consider change. This chapter argues that institutions can address change through action research projects and manage the dialogue, actions, and structures through successful teams.

Chapter 3 exposed the teaching approaches and theories that may have had an influence on distance learning. The researcher exposed different approaches to knowledge and the paradigm shifts that were required in education. These approaches had a distinct influence on the dialogue that took place in distance education, the decisions about roles and responsibilities, and the focussed actions for learning. The researcher argued that our views of reality, and knowledge, have a direct relationship to our approach to how people learn and how we should design self-study texts. We conclude that no single theory is sufficient to describe reality as different people experience it. The instructional design focussed on the role of activities in texts to foster change in order for the learner to learn. The structure of the activities, the actions required in doing them, and the dialogue that ensues provided a solid base to reduce the "distance" aspect in distance education. The researcher also gives an overview of the arguments about activities in texts - their roles, functions, relationships with other elements, and design possibilities.

Chapter 4 focusses on action research as a research methodology. As a qualitative research methodology the research criteria, characteristics, and requirements for scientific investigation were discussed. Against the background of changing perspectives on reality and knowledge, this

perspective suggests the importance of researchers-as-participants in teams to consider “moments” in the process, in the form of cyclical investigations. The methodologies to investigate aspects of dialogue, activities, and structures, were inquiry, critical analysis and reporting, analysing stakeholder letters, interviewing, data collection, and case studies. An important aspect of qualitative research is to validate the data; this section described the procedures.

Part III describes the four cycles of our practice in growing with, and developing, the course materials. The course team was constantly in a state of flux as roles changed and a changing environment became a major external force. Chapter 5 looked at the professional development of the team as the initiator in the longitudinal study of a developing Unisa course. This was considered to be the first cycle of the process. The team processes and professional development are described.

Chapter 6 describes the curriculum of the MMAT course as based on a constructivist paradigm. Constructivism recognises the role of social forces and historical contexts as impetuses for change - it is through change that learning takes place. This chapter describes how the course team planned and prepared the curriculum design and development of the MMAT course. In the light of the learning theories and DE theories exposed in Chapter 3, in the second cycle of the action research the researcher and course team observed the events and reflected upon the implications of the research for Unisa. The course materials used instructional design tools that have the potential to bring about change in the individual learner who participated in the learning process. As caring DE practitioners, we constantly strove to better the course and bring out the “authentic voices” of both the learners and the lecturer (according the action research methodology in Chapter 4). The researcher also gathered data from notes & document analysis as the course materials as product also provided evidence of the development. The team explored various strategies, tools, and devices focussing on activities in self-study texts to better the dialogue inherent in the text, to address the structures in the text and role players, and to address specific actions, as directed by the thematic questions. The investigations and developments reflected upon in this chapter, were presented in the context of the uniqueness of each course design case, of each learner, and of the DE institutional system as whole.

The pilot (the third part of the cycle) of the course, described in Chapter 7, was the testing ground for the arguments presented in the research. The actual presentation of the course (the fourth part of the cycle) indicated the period for maintaining the course and was described in Chapter 8. The students that completed underwent change because of their active participation, which brought about learning. The students' letters and mindmaps, throughout, provided evidence of such change.

This study needed to evaluate the research process, the team process and the course as product (see 9.2-9.4).

9.2 Evaluating the AR process used in this study (overall process)

The recursive nature of the course design and development process and the constant adaption to change made it necessary to document the process in a descriptive format. It also required solutions during the development. The AR process is used for this project in which the team and the learning design, which are interlinked, are embedded.

To assess the quality of the AR process of this study the validity of a number of aspects was established (Stake 1995:50-77), namely, collaborative reflection and dialogue by means of various research cycles, planned actions leading to specific outcomes/solutions to the problem and documentation of the process to obtain diverse viewpoints by democratic participation (section 4.7.3). Selective observations may be a limitation.

Participatory research is an approach which addresses the change required in a large educational institution. During course design, structures, functions and roles change in a newly established course team. There was indeed a change to attempt to bring into being a problem-solving, learner-centred pedagogy which would change the power relationship between the lecturer and learner. The team of professionals challenged the manner in which knowledge was produced and infused throughout the institution. The professionals in the course team to some extent reduced their dependency on Unisa's industrialised system and this resulted in a regard for a participatory environment where there was a lively discourse about the quality of self-study materials and actions to change the way things were done at Unisa (Chapter 5).

The project followed the AR cycles (Chapters 5-8) which were noted in the literature study in Chapter 4. This methodology has particular "moments" in its events, also limitations and successes.

9.2.1 Value of the moments in the AR Project

During each AR cycle the team constantly revised priorities to address problems as team members became aware of new events. Each year the team re-evaluated the learner characteristics as the data became known. The process was cyclical (see Chapters 5 to 8) and included planning the course, designing and developing the learning materials, producing the materials, presenting the course as a maintained product, and evaluating the process and product. The team development was incremental, and similar to the hermeneutic cycle described by Danner (1995, in Higgs, 1995: 235) with the team individuals moving from a preliminary understanding to a "higher" understanding as they engage in the case (Chapter 5). The results indicated that most of the

learners who completed the portfolio were able to move to a "higher" understanding (Danner, ditto, chapter 8). When learners encountered the learning text based on an active learning strategy their letters indicated a noticeable development (see Chapter 3). During the AR cycles a number of issues were identified, but because of the extent of the case with an already-large number of variables, only areas of concern were focussed on. The process that the team followed included the following stages, as summarised here.

(a) Planning

First a Unisa course team was established to design a course. The impetus for the team was an understanding that various specialists in a DE institution needed to be involved in designing courses. The team wanted to follow the development of issues, note interventions, and provide solutions in published outcomes.

The course design focussed on the teaching of a Unisa Mathematics Didactics self-study course to post-secondary mathematics teachers who were identified nationally as in great need of improving their competencies as teachers. Although the problems in active learning in open distance learning are many, the problem for this study was to get learners actively involved in learning through a printed self-study course and for them to develop strategies for altering their own knowledge, skills, and attitudes. Criticism against an old pedagogy and the demand for research towards developing DE theory and practice suggested an active learning approach.

(b) Acting

Unisa professionals critically analysed their unique DE institution and focussed on issues identified internationally as being "best practice" for course design and pedagogy. This took place during a staff development period in 1995-1996. They decided to reflect on how a course team designed a Unisa distance learning environment and to look at the requirements for open learning.

The course team focussed on enabling adult learners to become autonomous through active learning. The focus of the course development was to foster change in all respects in the learning environment to enable learners to develop specific skills, knowledge, and attitudes. Following international trends, the area of focus was to use activities within a self-study text to create a simulated discussion (discourse) with the learner, to provide opportunities for action, and to provide structure when learners required it. These activities focussed on improving interaction, structured learning, meta-cognition, study strategies, problem-solving abilities, critical reflection, self-evaluation, and learner motivation.

The team agreed to follow the participatory action research methodology as this process potentially allowed them to collaboratively construct their actions - as directed by the perceived

problems and issues they found in the literature, and by retrospective guidance from lessons stemming from the practical implementation of their strategic plan. It also allowed them to reconstruct their practice in the University by observing the “moments” that unfolded during the course design, and to discuss and reflect on the events they observed (as required by the methodology, see section 4.3.2).

A variety of data collection methods provided the researcher with opportunities to present the findings to readers, namely informal discussions, interviews, student portfolio letters and mind-maps, student assignments and examination details, course materials, historical events, and the issues identified in the literature research. The data provided results that informed the process in many ways. For example, the results from the interviews often provided background to a phenomenon which was unclear, and the data from the assignments exposed problems that required attention. The researcher’s point of departure was to consider each individual response as important: she believes that each person has a unique reality that needs sharing and listening to. This approach provides an acknowledgement of the complexity and uniqueness of different views. The researcher gathered results over an eight-year project period, and then combined the results. She undertook to do the following:

1. An analysis of relevant literature. This provided an overview of the characteristics and theories of adult open distance learning, and of the concepts “dialogue”, “active learning” and “structure” in self-study texts, change through learning and teaching pedagogy, theories of curriculum and course design, learning theories, and instructional design principles and staff development as platforms for change. The literature review enabled the researcher to establish the factors involved, to simplify and classify these factors within a particular course and educational environment, and to establish possible relations between elements of the research questions. The literature study provided support to:
 - 1.2 establish the factors influencing changes in learning, namely actions, language and structure of self-study texts;
 - 1.3 establish possible relations between these factors;
 - 1.4 describe criteria for the development and inclusion of activities in interactive distance education texts in a particular Unisa course;
 - 1.5 describe the role and affect of the course development on DE educators.
2. A collaborative case study which included a variety of data collection methods that included all the participants. Rich descriptions are provided in this research; these have an added depth that is not possible in other research methods. Data included qualitative data from the course materials developed and used over the eight-year period to provide evidence of the outcome of a typical Unisa course design, as well as developments and observations

arising out of the team approach:

- 2.1 qualitative data included semi-structured question interviews, informal discussions, personal experiences, as well as the actual experiences gained during the project in a reflective journal, course design correspondence with team members, the researcher's analyses of the learning design and development of the course materials, videotaped interviews with the lecturer, and student-related documents - including reflections in letters from students as well as five open questions, portfolio results with activities, and mind-maps;
- 2.2 quantitative data was available from assignments and examination results.

(c) Observing

The literature survey sensitised and focussed both the researcher and the core team members on key issues. The learning (instructional) design process and requirements provided a sustained interest in the study.

The pilot study launched the course in the targeted market. More than one course was presented to react to the needs of different target groups (see addendum A where there is reference to the MMAT00-8 and FDEME-5 (Geometry) courses). The sampling strategy suited the educational environment where qualitative research - purposeful sampling - was used, as directed by the need for information (Giddens, 1993: 74).

This researcher documented the outcomes of the processes and products during this course design and development project. The following data were collected:

- Literature study: the literature study focussed on open distance learning, trends in society, and their effects on adult learners, the institution, and the team approach. Action research and course design and development were also determining issues. The literature survey results (Chapters 2 to 4) were plotted against the events during the course design and development (see Chapters 5 to 8).
- Case study: the case study description described the context and events following the recommendations by Stake (1994), and Scriven (1997), and Reason (2001) - in section 4.8.1. The rich descriptions were selected and adapted to the style of the dissertation.
- Interviews: the researcher and a second interviewer interviewed the lecturer (in Afrikaans, at his request) on two occasions, a few weeks apart (following the guidelines summarised in 4.7.6) to support the attempts to provide investigator triangulation. The contents of the interviews were used as "authentic" voices in the report, with the approval and support of the lecturer.

- Critical analysis of the learning design as it manifested in the course materials: a cyclical postmodern learning design strategy influenced the design of the course materials. This strategy and the analysis of the materials was agreed to in the core team. The documents included tutorial letters, the study guide, the textbook, portfolio letters and exercises.
- Notes: the researcher made notes and kept correspondence, after agreement in the core team to describe techniques and to include rich descriptions of communications, roles and functions, and actions that took place during the process.
- An analysis of the study materials and assessment results: the researcher analysed the study material package and asked questions following the examination and assignment data, in collaboration with the rest of the core team.

All these techniques were combined to provide valid results (see 4.8 for validation requirements).

(d) Reflection

The students were mathematics graduates in the process of preparing themselves as mathematics educators. They were typical of the Unisa student population: multi-national, multi-lingual, widely distributed throughout Southern Africa, with varying study skills (see Chapters 1 and 2, as well as the authentic “voices” of the learners in texts collated as a sample in Addendum D). The learners provided background information about their context, on request, in a letter to the lecturer. These contextual descriptions provided the researcher with a substantial insight into the target group to confirm most of the literature descriptions of adult distance learners and of South African learners (see Chapter 2).

The number and variety of data gathering methods over the years contributed significantly to validating the results as they enabled the researcher to measure and logically interpret results where possible. As in most AR research, stricter adherence to the procedures would be advisable. Most of the evaluation techniques were useful to support or refute findings. The findings were presented, minimally interpreted for the reader, as is recommended by qualitative action researchers (see chapter 7). The data were able to provide results of interventions, difficulties encountered, the processes, and perceived solutions to problems.

The validity (authenticity/truthfulness) and reliability (trustworthiness) of the results were established through the different data sources (see section 4.6.17). This is important as this course prepares future mathematics teachers to understand the complexities of classroom teaching .

The data were valid because the research included four phases of enquiry - which made the team more critical in their questioning, and perhaps more objective. The action research cycles exposed the changes that took place, the development of further questions, problems and limitations the

course team experienced, solutions to some problematic issues, and further possible avenues for enquiry. The core team moved between acting and then reflecting on a particular area of enquiry. However, this was made more difficult because of lengthy periods of time in between the act-observe-reflect cycles. We also guarded against overgeneralisation by focussing *only* on this case, whose context is unique and which therefore yields unique results. We carefully guarded against ego involvement, which is difficult when one is so closely involved in a project. We had a good understanding of what was happening to us. Throughout the eight years of the project, our actions were repeatedly reviewed against literature and this prevented a premature closing of our enquiry. The course design process is a planned system of events that limits chaos. However, in an emancipatory environment, the constant change often creates chaos and side cycles in the action research process. In a team the diffusing focus can be negative to the process, or bring about a new direction that solves a problem. Academic freedom made it less necessary to “manage” disagreement. The team members also challenged one another in a constructive way when selective views or data were put forward. This made the process and the outcome of the research more valid. The focus on theory and practice supports divergent and convergent thinking, and allowed team members to argue from different perspectives.

The learners were required to do assignments and examinations which were taken into account in this study as qualitative data. Some students did not complete the portfolio, short-question assignments, and examinations. These responses are not included and were not available for analysis - which may effect the objectivity of the results. The sample was small, and was limited to the learners who sent in assignments. Serious bias is possible in this case. The researcher attempted to address this issue through supplementary data collection.

The most telling and important data for the course team and the researcher, however, were the qualitative data from the interviews and the students’ letters which were included in the portfolios (see Addendum D). The questions in the interview schedule was cross-referenced. The questions for the learners required them to provide evidence of something they found difficult, enjoyed doing, gave them a chance to use technology, show that they could apply mathematics to an out-of-school situation, show knowledge of mathematics area of specialisation, and their ability to solve problems (MMAT00-8 tutorial letter 103 1999).

The student numbers were small, but the research was done over a period of eight years: the results could therefore be confirmed. A disadvantage of this types of sampling is that serious bias can occur. Another disadvantage is that generalisation is extremely risky. These action research sampling techniques had the advantage that the whole population involved in the case was described. This saved time and money. The lecturer and the instructional designer remained

unchanged during the whole course design cycle; this made it easier to reflect on developments and influences.

When we used the words of researchers and students and supplemented these with uncontaminated texts, it made clear the differences in power and knowledge between the researchers and the subjects. We tried to be sensitive to each of our learners' input in this study and their names were not mentioned. We thank them for their frank input.

We also included as many perceptions from different evaluators about a number of issues in the study material (e.g. visual design, information flow, students' objectives, packaging, language and numeracy, logic, audiovisual media, active learning, content, and teaching the ability to learn independently).

9.2.2 Worth of the AR process

This study shows that action research methodology is appropriate for research in the field of human behaviour and education, especially in mathematics course design and development. Case study questions allow researchers to explore how to improve the efficiency of the process, while at the same time providing material relating to the question being researched. This results in a critical, reflective perspective on the course development process, in an approach that may be described as qualitative-illuminatory (also see Parlett and Hamilton, 1976; Evans and Nation, 1989; Carr and Kemmis, 1986).

(a) Change management

Action research is appropriate in change management. Change was evident in the course team, as well as in the development of the course, and in letters and discussions with the learners. The emancipatory process allowed the team to move to a stage of critique of the system during a period of innovative processes and products.

The researcher felt that the grounding of the experiences in change management theory provided a depth that goes beyond normal descriptive case study and participatory action research projects - it provided a theoretical grounding. The literature research provided evidence, however, that because of multiple "windows" of reality, theory triangulation is difficult.

(b) Professional development

Action research is initiated in a planned and organised manner, and in a process of self-organisation and evolution. The research started with intellectual questions and a desire to make a practical contribution (as identified in the writings about the research questions by Stake, 1995: 99). It is important to establish how DE, learning and instructional design theories underlie the practice of a

distance education course.

Action research is appropriate for planning a strategy for professional development. Action learning is also appropriate for personal or professional development of a less formal nature. Action research allows teams to develop, to live their ideals, and to apply relevant theory in their practice.

(c) Course design and development

The action research methodology allowed the researcher to monitor and describe the events. No other methodology was descriptive, allowed changes during the development period, was methodologically sound, and allowed participation and a collaborative effort in such an enabling environment.

Action research situations allowed scrutiny of learning theory in DE practice. If this study is repeated in another context it may allow for the possibility of generalization later on.

The portfolio evaluation system is no less valid or trustworthy than other evaluation systems such as tests, projects or assignments.

Action research is an appropriate method for recording the changes during course design and development projects. It allows for changes during the intervention and it often provide unexpected or novel results as was the case here where the team processes became very important.

Following an approach that engages with the quality of education (McNiff, 1993:25) action research with a rich case study description closes the gap between teaching and learning - it describes how learners participate in psychical systems (their consciousness) and social systems which form a boundary to their environment via meaningful communication (Treml, 1995: 267 referring to Parsons, 1964, on his sociological systems theory). When a description of the organisational milieu is absent from the course production description, there is a tendency for the researcher to adopt an atomic positivistic approach to curriculum design and course development, instead of a holistic approach (Letseka, 1995: 7). The framework and emphasis for developing courses here is an holistic emancipatory one (section 6.4.2). Decontextualisation may lead to an uninformed or misunderstood context where the realities concerning the practice prevailing at the time of course development remain unspecified. The case study allows researchers to formulate an holistic understanding of the realities prevalent during the development of any course (the history, culture and politics behind it), to describe the experiences during the production of a course, and to establish how the research can effect changes in practice and at the end of the course development.

9.2.3 Advantages, limitations and shortcomings of the AR process

Action research is prescriptive, and "hard evidence" is limited. Action research does not quantify - which is a limitation - but it provides rich descriptions that are surely needed in the course design and development field in distance education. This is surely one of the advantages of action research. This contrasts with the limited technical view of specialist advice (4.3.2).

(a) Advantages

These developments changed practices to such an extent that graphically designed A4 layout formats with colour covers are now accepted practice in the University's production departments: they changed their systems to accommodate the larger format. They also focus on shorter print-runs using a new printing machine which does high-speed photocopying and/or production printing plates, in volumes determined by the design team. The course is delivered smoothly and on time because of such automated systems. The students are provided with options for interactive environments. Their assignment question assessment is supplemented with authentic portfolios which provides rich evidence of their learning - both to themselves and to the lecturer.

The course was delivered using print materials and a study school contact session, which is very appropriate because of the problematic quality of South African school mathematics teachers who have to fit in their studies somewhere amongst all their home commitments.

This longitudinal study uniquely combined AR in CDD in tandem with a course team's professional development. The course team was able to plan a strategy in a fuzzy uncertain process, act on the general plan, observe the results and reflect on the outcomes. The cycles resulted in new events and new questions. Not all the side issues are important or possible to investigate.

(b) Limitations

A limitation is that action research may be criticised for its lack of generalisation. The research methodology is considered difficult to validate. However, this researcher found that in the course design field there are many validation possibilities and data strategies. Action research is descriptive and is not conclusive.

The research environment is non-static and action research has to keep up with changes which are difficult to track. In some cases, the research environment cannot be collaborative and participatory, and the researcher might have difficulty in using action research as a methodology.

Evidently, Unisa as an open distance learning institution, is at its best in a Neo-Fordist mode. This course was designed in a small team of specialists. The production of the course was adapted for a small print-run with a new layout. The system temporarily accommodated the changes required by

the team, as well as its working strategy. However, the advanced division of labour and centralised decision-making for mass delivery and industrialised systems required conformity for example, members of the Editorial Department were not allowed to be part of the team after the implementation of a few courses which required continuous input.

Similar longitudinal case studies using action research for course teamwork and CDD research on an international, national, let alone an institutional level.

(c) Shortcomings

Evidence shows that there are difficulties when trying to make value judgements using authentic evaluation methods. One of the problems associated with portfolios is how to make a value judgement over a very personal and individual piece of work, and how to communicate this judgement. Thus, the actual words of the subjects tend to be used. The authentic assessment data were perceived to be difficult to analyse and quantify.

The first year involved more than 70 students. In the Neo-Fordist paradigm the groups should be broken up into smaller, interactive groups working together as a team (also refer to Weimer, 1987). This is very difficult when learners are widely distributed, especially in rural areas. Although having small groups of learners in a particular course facilitates co-operative and collaborative learning strategies, which can be well used to facilitate active discussion, the only option was to get the students' communities involved in their learning. This study provided evidence of some learners who were able to create such environments.

The literature we consulted did not show any longitudinal studies combining action research in CDD while also focussing on professional development in a team. A vast amount of literature was consulted. Such documentation may, however, exist.

The reporting phase was particularly difficult. The many cycles of the CDD as well as the team members' development made it difficult to write the events in a linear fashion.

9.2.4 Recommendations for using the AR process in course design and development

The researcher argued that the framework of action research exposes the dialectic of theory and practice (see 4.6.1). This study tested this argument and suggests that the research methodology is worthwhile to investigate praxis in the DE context and enables the researcher to report the eight year course design and development process (figure 1.3).

AR projects focus on CDD and on institutional practices. The research results provide a substantial impetus/reward for professionals that publish the results.

9.3 Evaluating the team involved in this study (the process)

The study considered the worth of the team approach: its successes, limitations, shortcomings, and makes recommendations as a guideline to DE practitioners.

9.3.1 Value of the team process

Change and evidence of change was an important consideration in this research. The rich descriptions of the case evidence were cited to show how the lecturer, the learning developer, and the students perceived the changes that took place in the learning environment, within them as individuals, and in their working environments.

We concur with Eison, Janzow, and Bonwell (1990: 82-83) that thorough lecture notes take as long, if not longer, to prepare than active learning activities. Initially these skills-based activities may take longer to prepare because doing so is usually a new skill for the course writer. With experience, however, it may take even less time to prepare active learning strategies than teaching in the old-fashioned way.

The movement to using the action research process enables the team members to share their tacit knowledge with the rest of the institution - as it enables and requires the writing of a report.

9.3.2 Successes, limitations and shortcomings of the team process

We have much to learn still about team processes.

(a) Successes

This study provided understanding of the roles, actions and language development in the team and its impact on the institution. Extensive managerial and team competencies were recorded. This was an unexpected spin-off from the research. (Section 5.5.12-5.5.15.)

The practices for activities in self-study materials were formulated and may be used by designers. The suggestions in this regard were used in other team developments to some extent, mostly because of the success of the team and the openness of the team members to change. The effect of activities on the structure of study materials has been amply recorded in the literature on the subject (see Chapter 3) and in the experiences of the team (see Chapter 6 and 7).

Similar longitudinal case studies using action research for course team work and CDD have not been done - our overview of the literature did not show such research on an international, national, or

institutional scale.

The team members became multi-skilled and were able to provide understanding support to one another, and to learn from one another during the development. (Our experiences are described in Part II - Chapter 4.)

It is important to focus on the shift towards meeting the needs of a knowledge society and its requirements from a distance learning provider. Characteristics that should be allowed are diversity in a team that is allowed decision-making powers - with the aim of creating innovative courses for learners.

The team approach to course development in this case was successful, in contrast to unsuccessful teams. From the experiences of the team the researcher could identify some success factors for teams within an organisation and its impact on an organisation. When a team is considered a failure, there can be a number of reasons.

The pilot study indicated that the general approach resulted in deep learning with the learners particularly involved in their learning, as is evident in their assignments, portfolios, examination results, and expressions in their letters or during contact sessions. During the remaining years after the pilot the assessment structure and the activities were adjusted, with no reduction in quality. The different types of activities were included to provide prompts for action, guidance, scaffolding, and a structure to support dialogue, and (as it were) "reduce" distance. Wider investigation into possibilities for both the materials development and the methodology would enable further researchers to develop possible grounded theory for the use of activities in distance education texts. We suggest that the application of a developmental model such as the one presented here may balance the demands for quality and access. We believe that the outcomes of this study has added something to the knowledge in the field of team strategies.

(b) Limitations

Lecturers who claim that they cannot include all the material to be studied in the time allocated to the learners have the traditional content-based philosophy that limits their practice to these expectations and skills.

Each member of the team was well aware of the changes that took place in their context, both personally, in the team as micro-environment, and in the University. The "normal" expected way of developing a course was replaced by a new practice, and by other expectations. The institutionalisation of teams is a good example of the change in structure, "acceptable" discourse and "expected" actions (Unisa Tuition Policy 1998). The team described its working outside the

systems up to the scheduling for production stage as easy: we had control and decision-making powers. But the work was more difficult later on when it had to be integrated into the "normal" processes and handed over to people who were not part of the team, but used to the "mechanical", production-line way of doing things. People outside the team had no knowledge about the process of course development.

Skills, problem-solving and outcome-based learning design focusses on situations and topics in contrast to specific content. Learners tend to engage longer on active involvement. However, planning the study package for such a course is time consuming and demanding. Teams have to consider that the participative transformational teams need alternative working schedules and pedagogical approaches. This is to the benefit of the institution as lasting change is evident in contrasts to mechanical reactions.

A team succeeds in a supportive environment only such as typical post-industrial contexts. Management and administrative structures need to support and be part of teams.

(c) Shortcomings

The use of activities in an environment where dialogue and action is supported by the course and institutional structure requires a Neo- or Post-Fordist view of distance education. Innovation, process variability, and high personal responsibility are key elements to foster the creative thinking which is required in each course team when members plan and design a particular course learning environment.

The team was able to reflect on the complexities of events - using their "voices" as evidence, as Chapter 5 shows. Reflexivity is never easy, as one is subjectively involved in the process - even I, as a participant-as-member (as the literature study on teams in Chapter 2 and the research methodology in Chapter 4 clearly indicate). This team could have been more critical. The learners were critical and their insights gave an added perspective. It would be helpful to have the course formally evaluated by critical readers and external learning developers.

The team members were aware of the success of the teaching strategies. The activities in text were often not formulated clearly enough, and the language use was a factor in this. Some learners were extremely uncomfortable with the teaching strategy; this made some excited and some despondent as the student voices make clear in Chapters 6 and 7. The administrative aspects of the course were also an irritant and the lecturer was well aware of this error (see Chapter 7). The assessment strategy was totally novel to both the institution, the lecturer, and the students - dealing with portfolios was difficult in all cases.

9.3.3 Recommendations for using the team process in course design and development

When changing over to a skills- and outcome-based philosophy, cognition, reasoning and problem-solving in a variety of situations and topics becomes more important than specific content. More time is then available to the learners during the study hours to focus on active involvement in "deep" learning and skills development.

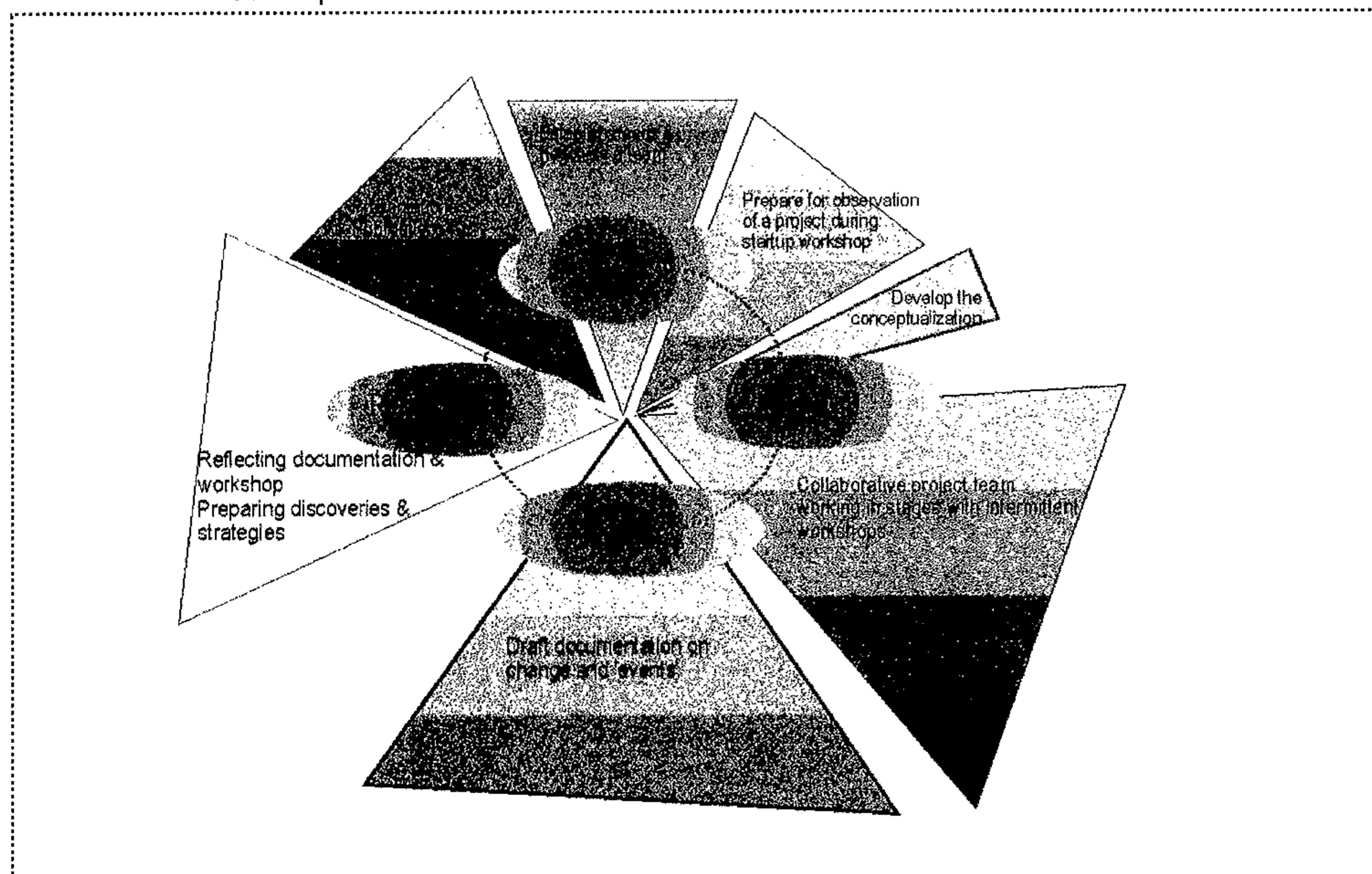
(a) Establish a supportive organisational structure

Planning the study package for such a course is very time consuming and demanding. Faculties need to consider this and devise alternative working schedules to enable a focussed period of time set aside to design a course. A team succeeds only within a supportive environment with the post-industrialised approach, so heads of department and administrative structures need to change their practices to support the team strategy (as argued in 2.6.1).

(b) Implement staff development projects for course team development

The researcher proposed that the working model on staff development processes (figure 9.1), be applied to staff development at Unisa. This model merges the staff development processes (2.6.2) with an action learning working model for managing a range of focussed course team developments.

Figure 9.1: Model for the implementation of action learning supported professional development.



(c) Strategic alignment of course development projects for change

The researcher proposed that a working model on the alignment of course development projects driven by course teams for change be applied to team management at Unisa (figure 2.4). A DE institution is a finely tuned system with dynamics between the accepted discourse, the social relationships (as manifested in the organisational structures), and good practices. When the discourse is altered, the relationships and team roles are under pressure to change, along with a change in the *way* things are done and *what* gets done. When changes take place in how things are done, or in who does them, the discussion has to focus on these altered environmental forces. Only when all three aspects that affect change align, does the tension lift - only then is there successful and lasting change. Such changes have to be dealt with in the team in order for the institution to change. Although there were great initiatives for transformation at Unisa, the sustained "locus for change" in the course teams was absent (Daniel, 1995:78, 81). This has not happened sufficiently at Unisa. Strong strategic managers need to redirect the movement of change. New learning should be brought about by a number of new projects. This is an additional insight not previously documented.

(d) Strategic management of course teams

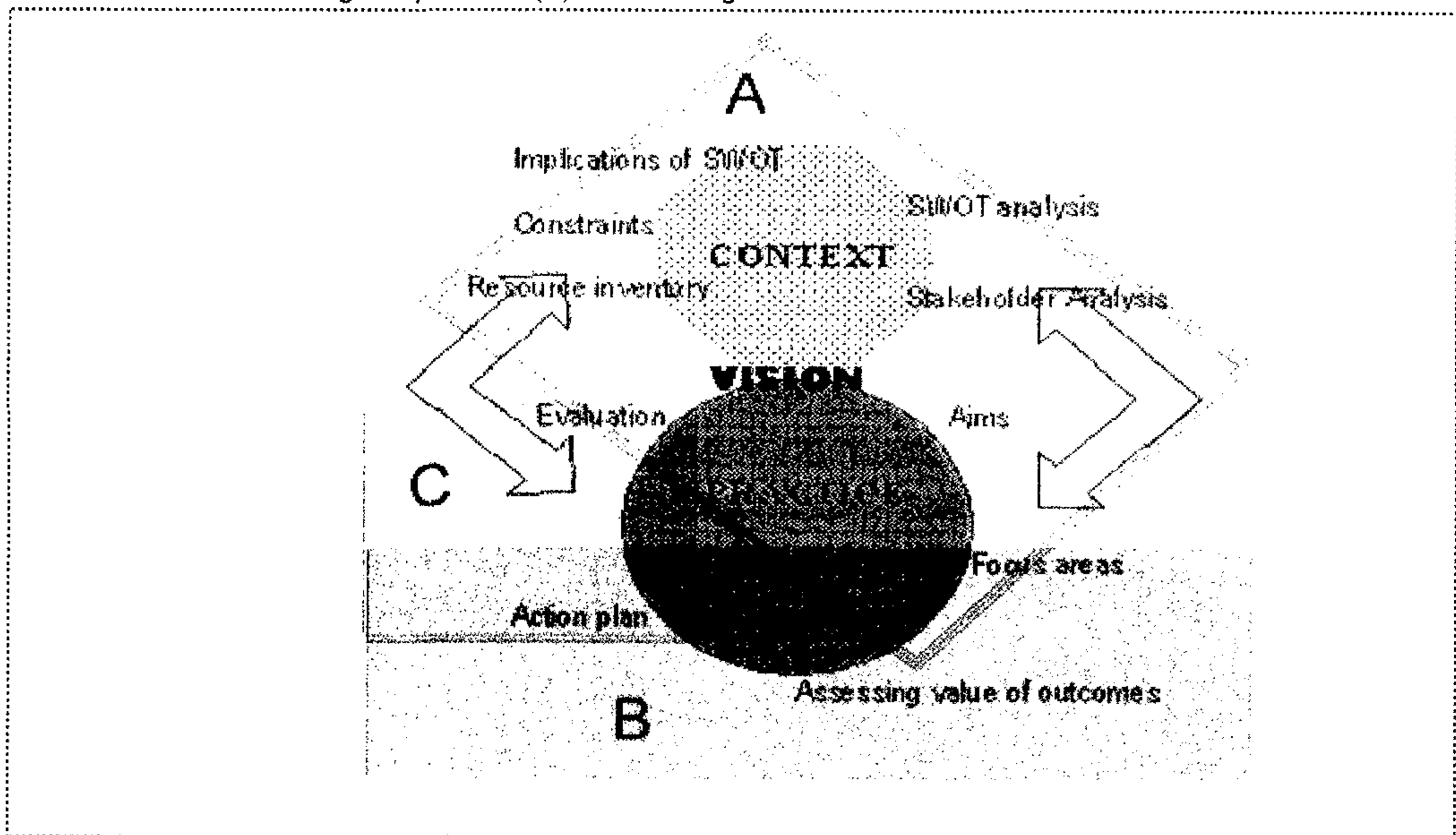
The researcher argued that a management strategy is essential for change to take place in an institution. Following the researcher's analysis of the Figure Eight strategic planning model by Zuber-Skerritt (figure 2.6) and the management processes during the course design and development at Unisa the researcher proposed that a working model for the strategic management of course team be applied to team management at Unisa. We propose the Course Design and Development Action Research Project model (Figure 9.2). The integration of action research with strategic planning makes the writing up of a project less complex, it addresses elements of the course design process, and links clearly with an action learning programme or the action research programme which manifested in the course team's practice.

(e) Managing change in a successful course design and development team

We changed as individuals and we believe we grew in our understanding of course design. The management of the course design project was a great experience. Upon reflection, over the years we were able to grow from the management model (Chapter 1.1, from Zuber-Skerritt 2000) to the notion of a "Tornado approach" (figure 9.3).

When a team is considered a success or a failure there are a number of reasons. According to the proposed Tornado phenomenon of deviation a team that is focussed, well planned with an appropriate management style for the given situation, will create a visible "ripple" of impact through the institution. Teams that are aligned to the same goal will change the organisation visibly. This change can be channelled, controlled and sustained through for example institutional

Figure 9.2: The 10 point Course Design and Development Action Research Project Model (adapted from the Figure Eight of Strategic Project Planning from Zuber-Skerritt 2000: section 8 p. 4): (A) determining the problem. (B) Intervening in the process through AL to improve practice. (C) Observing the process. (D) Establishing the results of intervention.

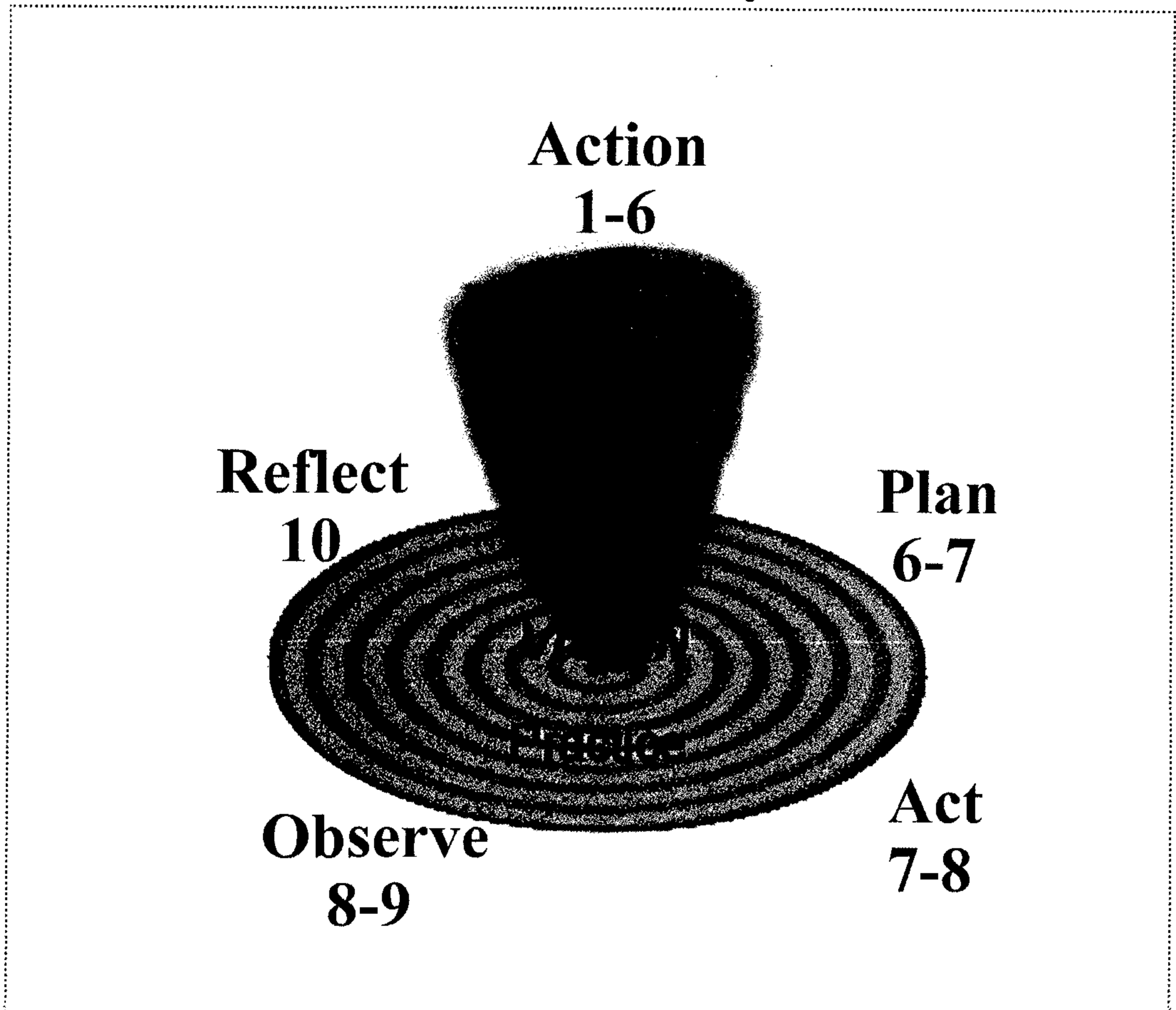


policy (A). Where there is dissent in the team with ill-defined roles or where the cohesiveness is poorly, or where a technical approach to action learning is used, there is little effect on the institution (B). When many people working individually, there is also no lasting change (C). Even if the team is well-balanced and effective, and the organisation is unable to accept change, there will be no effect (D). The last illustration is an example of a non-focussed ill-defined team (E).

Figure 9.3 indicates the Tornado approach to managing change through project teams. The five areas of context analysis form the "swirling need" aimed at the vision, and based in practice. In practice the project is implemented following the action research steps from planning the project, through action and observation, to reflection on change.

When a team is considered a failure, there can be a number of reasons for this. According to the Tornado phenomenon of deviation (Figure 5.5), a team that is focussed, well-planned and well lead in the given practice will create a visible "ripple" of recognition through the institution. Teams that are aligned will create a large Tornado effect that will change the organisation visibly. This change has to be channelled, controlled, and sustained through, for example, institutional policy (A).

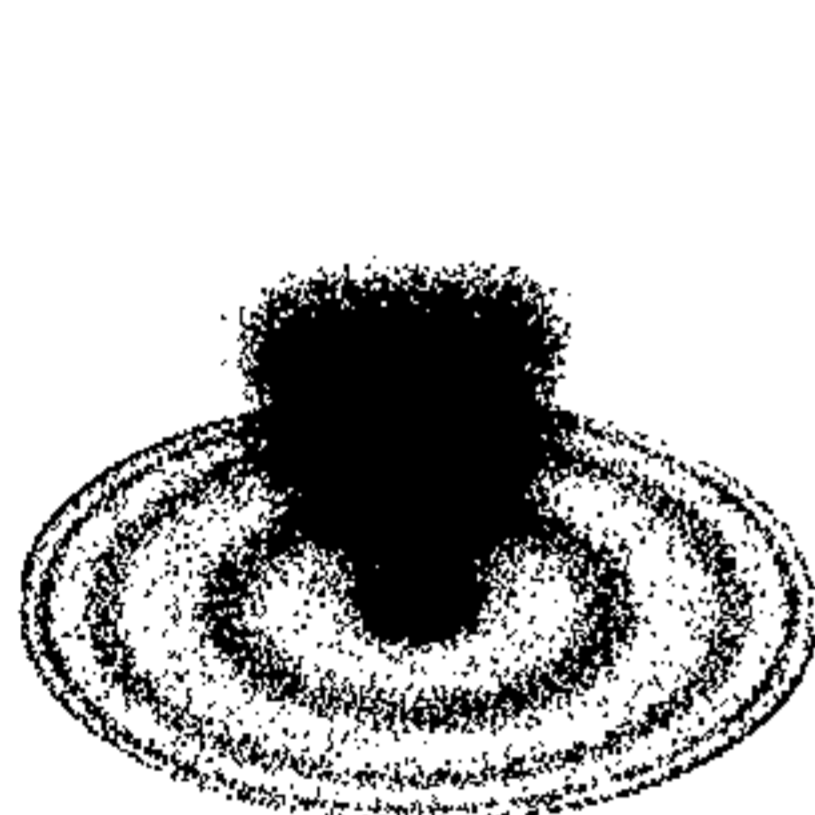
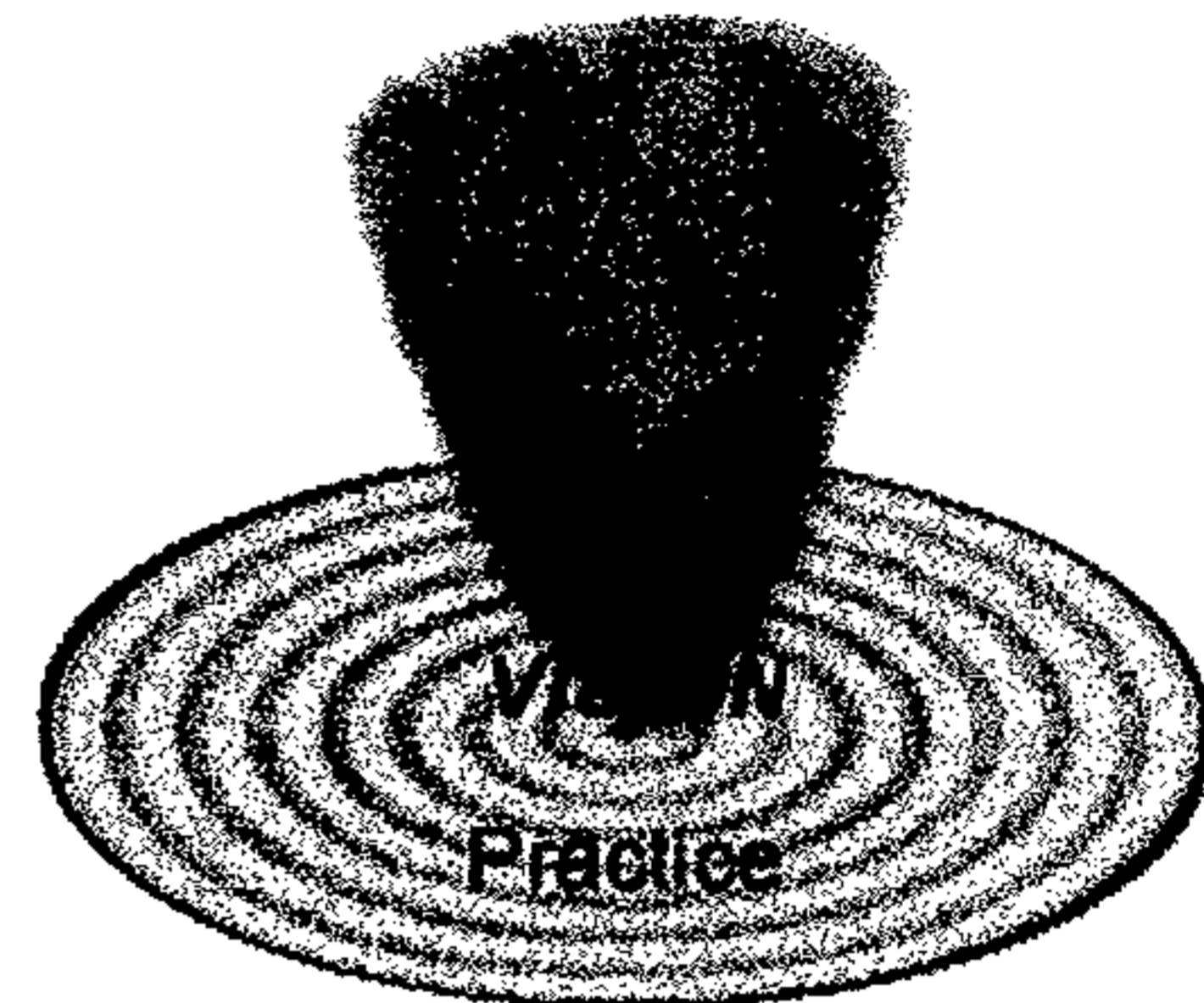
Figure 9.3: The Tornado approach to managing change through project teams. The five areas of context analysis form the “swirling need” aimed at the vision, and based in practice. In practice, the project is implemented following the action research steps from planning the project, through action and observation, to reflection on change



When there is dissent in the team where the roles are ill-defined or the cohesiveness is poor there is little effect on the institution (B). If there are many people working individually, there is also no lasting change (C). Even if the team is well balanced and effective, and the organisation is immovable, there will be no effect (D). The last illustration is the example of the non-focussed, even ill-defined team (E) (see figure 9.4).

Figure 9.4: Tornado phenomenon of deviation in teams. (A) Successful teams have lasting effects in the institution. (B) Many non-functional teams have little effect on an institution. (C) Many individuals result in little change. (D) Many successful teams in a non-responding institution have no effect. (E) Unfocussed teams have little lasting effect on the institution.

A. Successful focussed team projects with major institutional impact resulting in change



B. Less successful team projects, focussed, but with little institutional impact or change.



C. Many team projects, not focussed, with little impact on an institution to change.



D. Many successful team projects, focussed, but unsuccessful as the institution is unable to change.



E. Many unsuccessful team projects, not focussed and unsuccessful to bring about change in an institution.

9.3.4 Guidelines for best practice team strategies to improve action, dialogue and structure

From our experiences during the development cycles (Chapters 5-8) we propose a number of guidelines that other teams may take into consideration when using action research and action

learning in course design and development at Unisa:

- The success of an action research project or action learning project depends mostly on the extent to which a team adheres to its values. A project yields results: a product, a process, and relationships. Even if the answers are unwanted, the project may be considered successful if the members engage in active learning and constantly move into a deeper

understanding.

- The promise of articles and accreditation in the institution should be an added impetus to team members.
- A successful team works through difficulties, personality clashes, disagreements and wrongly or differently understood activities. No one person is responsible for the failure of the team - the whole team is.
- Teams have to work at a shared understanding of roles and relationships.
- Teams should focus on sharing a common understanding around concepts, expectations, focus areas, methods, and strategies.
- Teams should be clear about the activities required to reach the aims, as well as about the working methods and strategies to be employed.
- Teams should keep a critical approach in order to better the course through each development cycle: professional development, course development, the piloting and presentation of the course.
- Teams should keep records of the process and the products.

9.4 Evaluating the learning design of the course materials (the product)

This section describes the worth, successes, shortcomings, limitations, and recommendations of this study for DE practitioners.

The focus was to pose questions about bringing about change in a particular environment with a determined focus. In the study, the researchers posed questions about fostering change in a distance learning environment through a critique on dialogue, actions and structure brought about in a mathematics didactic course with activities imbedded in the text of the course (see 1.4.1).

These problems were addressed by analysing the role learning opportunities in texts can play in improving the dialogue, structure, and actions required imbedded in the independent learning text. The specific aim (see 1.4.2) was to develop a quality DE course (materials and methodology), employing an instructional design strategy of activities in the text (Chapter 3) in order to change the actions, dialogue and structures (1.7.3 and 3.2) so as to affect the learning and practices of mathematics teachers (see 2.3 - 2.4), and to change the course design and development practices of distance educators.

Thematic questions were formulated at the outset (see 1.4.2). The students had to develop competencies. These competencies included active discourse abilities, structured study abilities, meta-cognitive abilities, study strategies, problem-solving strategies, learning experience reflection, self-evaluation abilities, and self-confidence and motivational abilities. The second area

of concern was Unisa educators who needed to reflect on their praxis through understanding complex events, changing processes affecting actions, dialogue and structure, success and failure of applying activities in text, criteria for best practice in active learning, and understanding complex events during course design and development processes.

This course was developed in a milieu where a very simplistic manual system was in place to schedule and track movement through the system. This manual system excluded course planning, design, teaching, evaluation or quality control.

9.4.1 Worth of the learning design in course materials

The value of this research is the focus on designing an environment for effective higher education learners where their learning is linked to their needs for "learning skills" (a common argument in DE circles). This environment, according to our argument, requires a focus on the dialogue and language, roles and structures, and activities and actions that are essential components if change is to take place.

The evidence from the literature, the students, the lecturer, the researcher's observations, and from the guides suggests that activities-in-text as an instructional design strategy did produce a significant awareness and a change in the competencies of the learners in terms of their ability to critically reflect on the dialogue.

There is sufficient evidence from the course materials, letters from the learners, literature on structure and roles, and the lecturer interviews that the learning materials with activities-in-text as an instructional design strategy produce a significant improvement in the competency of the learners in terms of their ability to critically reflect on the structure of the DE course. They were clear about their roles and responsibilities as learners. They commented on the ease of use of the textbook or its difficulty, depending on their own experience. They enjoyed or disliked the guided study method. They were able to critically reflect and often wanted to do better, reminding themselves to go back to the course materials.

The activities-in-text in the learning materials in the form of the mind-maps produced a significant reaction from the learners. Some enjoyed the mind-map technique, some did not like it but found it valuable. Some decided that this technique of study did not fit their study preferences. The researcher cannot say that all learners improved because of the emphasis on meta-cognitive tools such as mind-maps.

The evidence is overwhelming that the inclusion of activities-in-text as an instructional design strategy has the potential to produce a significant improvement in the competency of learners in

terms of their ability to apply the problem-solving approach in practice. Their letters were testimony to this, repeatedly. If a learner could not apply the skills in a practical situation, they were able to identify this as a barrier.

There was very good evidence in the letters of the learners and from the lecturer experience that the learners were critical in their evaluation of the course and of their own abilities and attitudes. They were able to address change, and their ability or inability to implement a change strategy in their classroom situation.

The learners were able to reflect on the outcomes of their learning. Even if they were not successful they were able to evaluate the outcomes of their learning to some degree.

The learners who provided the portfolios were largely motivated. The non-completers were not. This results in a bias which should be addressed in a later study. The "completers" all indicated that they found the course motivating and compelling. In a few cases the new knowledge and skills provided exceptional response from colleagues or fellow teachers in the schools the learners were in. Some started to play a leading role in their community. Their knowledge, therefore, empowered them. As the textual activities supported these skills and knowledge we attribute some of these successes to the role of the activities.

Wider investigation into possibilities for both the materials development and the methodology would enable further researchers to develop possible grounded theory for the use of activities in distance education texts. We suggest that the application of a developmental model, such as the one presented here, may balance the demands for quality and access.

9.4.2 Successes, limitations and shortcomings of the learning design in course materials

It is important to report the factors that were noticed during the study which - to whatever degree - positively or negatively influenced the findings, or were without effect in the research.

(a) Successes

Our description of the distance education course design milieu in natural text was important to contextualise the course. This "story" we hope will enable the reader to make his or her own meaning from this text and critically engage in further research, and generalise where possible. We did not try to hide our subjectivity: the readers of this text can interpret the experiences for themselves.

With an active learning approach using activities in the text, teaching large groups is not problematic and this approach did not restrict the types of active learning strategies that could be

used. We suspect that the argument concerning large groups was based on contact-teaching experiences.

The evidence from the data suggests that activities-in-text as an instructional design strategy produced an awareness with the learners concerning their learning with a change in the competencies of the learners in terms of their ability to critically reflect on the dialogue.

As stated, there is sufficient evidence that learning materials with activities-in-text as an instructional design strategy produces a significant improvement in the competency of the learners in terms of their ability to critically reflect on the structure of the DE course. They were clear about their roles and responsibilities as learners. The "completors" commented on the ease of use of the textbook or its difficulty, depending on their own experience, and they enjoyed or disliked the guided study method. They were able to critically reflect and often wanted to do better, reminding themselves to go back to the course materials.

The meta-cognitive strategy in the form of the mind-maps produced a significant reaction from the learners as there was enjoyment and dislike, but useful when used as a learning strategy.

The learner's letters provided evidence that the students noted the humanatarian (Peters, 1998: 80) text-based dialogue. The activities' structure were perceived to enhance and support the textbook in a number of cases. An intense interaction was required with a tremendous workload which all the learners reacted upon. More research is needed to establish the optimal workload for this course.

(b) Limitations

A factor that was absent was contamination during the first year of study. None of the students were exposed to the course previously as it was the first time the course was presented. However, during the following years, some of the learners were repeat students or learners who came into contact with other courses that included components fostering active learning. Therefore, contamination could have taken place because they had contact with aspects fostering active learning such as the structure and nature of the dialogue contained in the other courses, the skills development strategies, and the assessment strategies. It was not possible or advisable to control any of these influences as they are a reality in distance education and, for that matter, in any learning environment.

There might be a certain bias in the research: the results were not tested in situations or environments other than Unisa (see Chapter 2). The researcher collected most of the research data and this too could lead to bias. A questionnaire evaluated by an outsider would increase the validity (objectivity) of the research (Danner, 1995, in Higgs, 1995:229).

One problem for the course team was to be able to structure the activities in such a manner that discussion was facilitated. For activities in text the designer may call on the community to support the learner through the text; sometimes the student is completely alone, sometimes the family can be a sounding-board, sometimes small community discussion is feasible. This is more difficult to do, in my opinion, than in the contact tuition situation. Writing activities assist in getting initial thoughts on paper for later reflection and evaluation.

The current global market stresses the importance of change - and with change goes the willingness to take risks. The risks we took include learners who might not have participated in the activities, or learned sufficient numbers of new concepts and material to enjoy the learning experience or find it amenable. Other risks are that the course writer might not possess the skills needed for these changes, or might not have the self-confidence to feel in control - and will therefore have to acquire new skills.

Similar longitudinal case studies using action research for course team work and course design and development have not been done - our overview of the literature did not show such research on an international, national, or, indeed, an institutional level.

(c) Shortcomings

There was a high level of non-completion of assignments. Consequently, only some students handed in the first two assignments, which has the role of pacing them through the course and provided learning opportunities to prepare for the last assignment - a learning portfolio.

The second factor was the dropout rate: several students failed to complete the course. This is a very common and worrying occurrence in distance education institutions. It resulted in a smaller number of students receiving instruction. Only the results of students who wrote the examination are reported.

The enrolled students were not all exposed to the full range of active learning strategies. There is also no alternative response as there was no "control" group because of the nature of the research. Nonetheless, we believe that the descriptive and analytical results provide useful information, as they are reported within the context of the limiting factors that we described.

Cases like these are difficult to transfer because of the context-dependancy of case studies. In this case the team "attacked" the comfort zone boundaries of the case and they ventured into the unknown, uncomfortable territories. Most teams find this a strain and this reluctance more often than not creates tension and influences both the success and the quality of a course development.

9.4.3 Recommendations for using learning design in course materials

In order to overcome the resistance in the institution to using active learning strategies (see also Eison, Janzow, and Bonwell, 1990: 82-83) one needs to consider that learners are honed in content-focussed and rote-learning skills, and have thus become adapt at addressing any content. The time spent on listening or reading can be spent partly on acquiring these skills. Content is typically introduced through the use of references, annotated bibliographies, or case studies.

Course design and development innovations should be based on the Post-Fordist notion (Edwards 1991:37; Campion1990:64, see Introduction) in the constructivist paradigm - a very difficult match to achieve in an essentially Fordist environment. The Mathematics Didactics course team was strongly influenced by this new paradigm. Macintosh (1998:18-19) warns that the critical success factors for an institution in a state of transformation and change towards post-industrialisation are: 1) that it implement an information system that mirrors the complexities of the open distance learning materials process; 2) that it accurately represents the complexities of open distance learning educational provision; 3) that it direct and evaluate its moves away from industrialisation by providing effective open distance learning opportunities for learners; 4) and that it make sound decisions about where to centralise services to support quality and economies of scale. It is noticeable that the course design process is not mentioned as a centralised pocket of industrialism.

The result of this course development was an innovative product which set a standard in the use of activities in the self-study text. Portfolios were used for authentic descriptions of the experiences of the learners and to evaluate their learning and understanding. The other post-industrialised approach was that the course was customised for the student group. For example, we cited evidence of the changes that were necessary for practical examples and activities of how the mathematics teacher can use the American-based principles and contextualise it for the South African situation. The course also included a week-long seminar for face-to-face discussions. Also, the cover had a unique design and the layout was unique during the pilot. Thereafter, the course was presented using a standardised visual presentation, called a "fast-track layout" used by many other courses. Decisions the team made included the development of a course with a variable shelf life. Decisions depended on a pilot phase (Part II - Chapters 5 and 6).

9.5 Further research recommendations

We recommend a number of research avenues. *"Activity cannot be understood or analysed outside the context in which it occurs ... the instructional design community needs to be more concerned with the context in which learning and performance, as well as the design process itself, occur"*

(Tessmer & Richey, 1997, in Jonassen & Rohrer-Murphy, 1999: 62).

9.5.1 Design of course materials at Unisa

- Wider investigation into possibilities for both materials development and methodology would enable further researchers to develop possible grounded theory for the use of activities in distance education texts. We suggest that the application of a developmental model, such as the one presented here, may balance the demands for quality and access.
- The Mathematics Subject Didactics course has to be reviewed again.
- Conduct similar research into other Unisa courses in order to document the design and development stage and search for generalisations.
- Repeat the use of the active learning strategy in different courses to refine its applications and improve the guidelines for design.
- Investigate how change in the external environment in the South African educational field will effect the text-based DE course design and development - for example: the requirements from SAQA (1998: 6) concerning modularisation of a particular size, level, and credit-weighting.
- Analyse learning theories in a comprehensive manner and postulate and suggest directions for application in distance education textual materials.
- Establish how a significant change in the student characteristics would affect the dialogue, activities and relationships built within self-study texts.
- Establish with more clarity the relationship between typographical design, content design, linguistic design, systems and media design, and learning design on self-study learning.
- Investigate the relevance of learning theories in DE.
- Explore and expose the complex relationships between actions and roles, between the different elements of discourse and structural elements - with the aim of providing new knowledge in field of distance education.
- Determine the differences bought about by using different media, such as online learning and multimedia courses.
- Discourse analysis in DE texts may expose the conditions of power affecting the lecturer and the student - and new insights will add to improving the conditions through which knowledge emerges (Foucault, 1980:69 in Preece, J, 1998:81).

These are a number of typical characteristics of post-industrialism suggested in this dissertation. A post-industrialised approach causes much unease based on the nature of the systems and processes prevalent in Unisa. As a transforming institution Unisa will have to take the "pockets of industrialism" (Macintosh 1998:18-19) into account to allow a smooth transition between centralised services (like Production, Editorial, and Dispatch) in contrast to the innovation drivers (such as the Bureau for Learning Development, Information and Telecommunications Directorate) and Faculty.

9.5.2 Process of designing courses using teams

- Repeat similar research when using different type of teams.
- Describe a course design process with different team outcomes to scrutinise the proposed “Tornado” approach.
- Focus institution-wide staff development to design team-based course teams in a trusting environment of collaboration and participation. This focus exhibition should lead to a revolutionary period of change and result in an increase in quality learning materials, give rise to reflective periods, focus on the impact between theory and practice, and improve the praxis of course development and instructional design.

9.5.3 Action research and action learning

- Scrutinise the action learning and action research methodology as a research strategy in the DE context.
- Analyse a Unisa case within the framework of activity theory as an alternative strategy for analysis (with Jonassen & Rohrer-Murphy’s framework (1999: 61-79) as a starting point). The results may provide conformation or highlight limitations or deficiencies in relation to this study.

9.6 Concluding the study

Africa has a great need for education. Educators at Unisa need to open access to educational opportunities. These learning opportunities include choice of place, time, design, individual needs, finance, admissions policy, courses, flexible timetable, content in courses, evaluation methods, contact methods and times, learning styles, and modes of learning. What is also needed is a change in philosophy to a student-centeredness, as is possible within the resource constraints of the distance education institution.

A Unisa course team wanted to produce change through planned learning experiences for diverse learners (Chapter 2) in a Unisa course’s materials, namely Mathematics Subject Didactics. The focus was on creating a radically different learning environment with a structure, activities and a dialogue which would bring about lasting transformative, emancipatory experiences (refer to Chapter 3). The team planned that these experiences would have a lasting effect on students’ practice as teachers - an improvement in teaching strategies that would bring about improved mathematics students. This lasting change (conceived by Kerr, 1996 in Beyllefelt 1998:169) was just as relevant to the teachers-to-be in mathematics. The approach in the case study had the potential to expose discrepancies that may exist between action and theory - the theory-in-practices. We believed that the study would promote a “theory conversation” and that unwilling partners in the course team would also be exposed to the values, philosophies, and strategies. These core team

conversations did much to “automate” their behaviour allowing them to explore the rationale for change - and *own* this change - thus improving their teaching practices. A case study description is therefore a part of the action research project and provides a basis for explaining the “organisational milieu” in which the research took place. This team approach is in line with Type 5 course development for a future distance education practice (Peters, 1998:73).

The core team demonstrated a personal growth towards better understanding of constructivist and problem-solving learning in the distance education context. The researcher effectively used qualitative research methods such as interviews, document analysis, and test results. Throughout the longitudinal study the course team members successfully used participatory action research for their shared enquiry and experiences. This study's rich descriptions provided evidence of feelings and change. (Chapters 5-8.)

The research provided a valuable model for change management of course teams in designing distance learning texts (Figure 9.2). The implementation of courses in an organisation and their synchronisation to a common aim, was illustrated in the model which aligned various projects and the roles of discourse, activities and relationships - or roles that need strategic management (Figure 2.4).

The researcher found a distinct relationship between actions, dialogue and structure that foster change (Wilson 2002:10, as influenced by Dlamini, 2001: 26). Changes in the learners’ learning were evident in the students’ letters, the interviews with the lecturer. The changes were evident in the different approach to Unisa study materials. The role of actions, structures, and dialogue was evident on the level of the student-student, student-lecturer, lecturer-team, and institutional structures. The three aspects were evident in self-study texts that fostered learning as a result of activities in the text. All three aspects were evident in the course team. The aspects influenced the wider University community.

The researcher also reflected on the processes of professional development and concluded that the action research process could also provide a valuable contribution here. The model developed may provide staff or skills developers with a testable hypothesis (see Fig 5.2).

This research offers a unique view into the life of a successful course team. This longitudinal study is unique in that it describes the course design and development of a particular Unisa course. DE educators are cautioned that questions which emerged were many, and that it is often difficult to narrow the focus in doing action research. Questions and interventions have a ripple effect and any change, such as adding activities into the text, will influence a great many course design elements (see Chapters 1 and 7). As the researcher I experienced the process of the action research and its

methodology to be an enlightening experience. This was a longitudinal study (Chapter 1) and therefore the planning and vision for the project were crucial. In designing the course there were many changes and the product was truly a collaborative effort. The data required was easy to collect as there was so much available during the ID design. Reflection was often a natural recourse taken by the team, especially in course design and development. Here is a summary of the researcher's position *vis-à-vis* the research process:

As the participant in the team and the researcher, it should be made clear that this report is my own interpretation of the events. I consulted and indicated all the data of this most complex case. I invite anybody to discuss the issues here with the team, or with me. This was a most rewarding exercise and it was a pleasure to be part of this project. I have much to learn still (reflection by the researcher).

The students enrolled in the Mathematics Subject Didactics course are all employed, and as adults they find their studies to be time-consuming. The freedom to pace their studies around their personal lives as parents and employees did provide an opportunity for the course developers to require constant engagement with their life-world as mathematics educators. This course expected deep learning with a thorough and holistic understanding of mathematics education principles and processes; this understanding needed to be verified in a teaching environment, and new strategies had to be constantly explored. Reflections and insights were the motivation for changes in students' teaching practices, and new collaborative, innovative connections often followed. These requirements made their studies both important and exciting, but also strenuous and stressful.

Unisa as an institution in transformation would be well advised to consider the implications of this study. A number of models may indicate problem areas in distance education course design and production, as well as suggest solutions or new areas into which to investigate. The results may have far-reaching implications in informing DE praxis and in driving the University forward in its setting of global "best practices". This researcher has already exposed areas of concern - and solutions - which have significance to the formation and implementation of policy, and to the design of texts for South African learners.

We believe that we should challenge other educators and our institution to enter the field of action for liberated learners with an appropriate strategy of emancipatory praxis for Africa. Unisa need to contribute towards developing a critical pedagogy for the future African students and to examine the types of praxis required for learners who actively participate in determining and shaping the directions and quality of their lives. When we as educators become involved in this shared learning opportunity, we take part responsibility in the shaping of students' lives. The question is: What type of praxis is required for people to become active participants in learning opportunities that

will shape their lives? Giving attention to factors in the study process such as the purposeful design of guided, active learner involvement, and learner participation in texts might even help solve one of the most elusive problems in distance education studies: When, and under what circumstances, is learning effective? We believe that this study provided some pointers.

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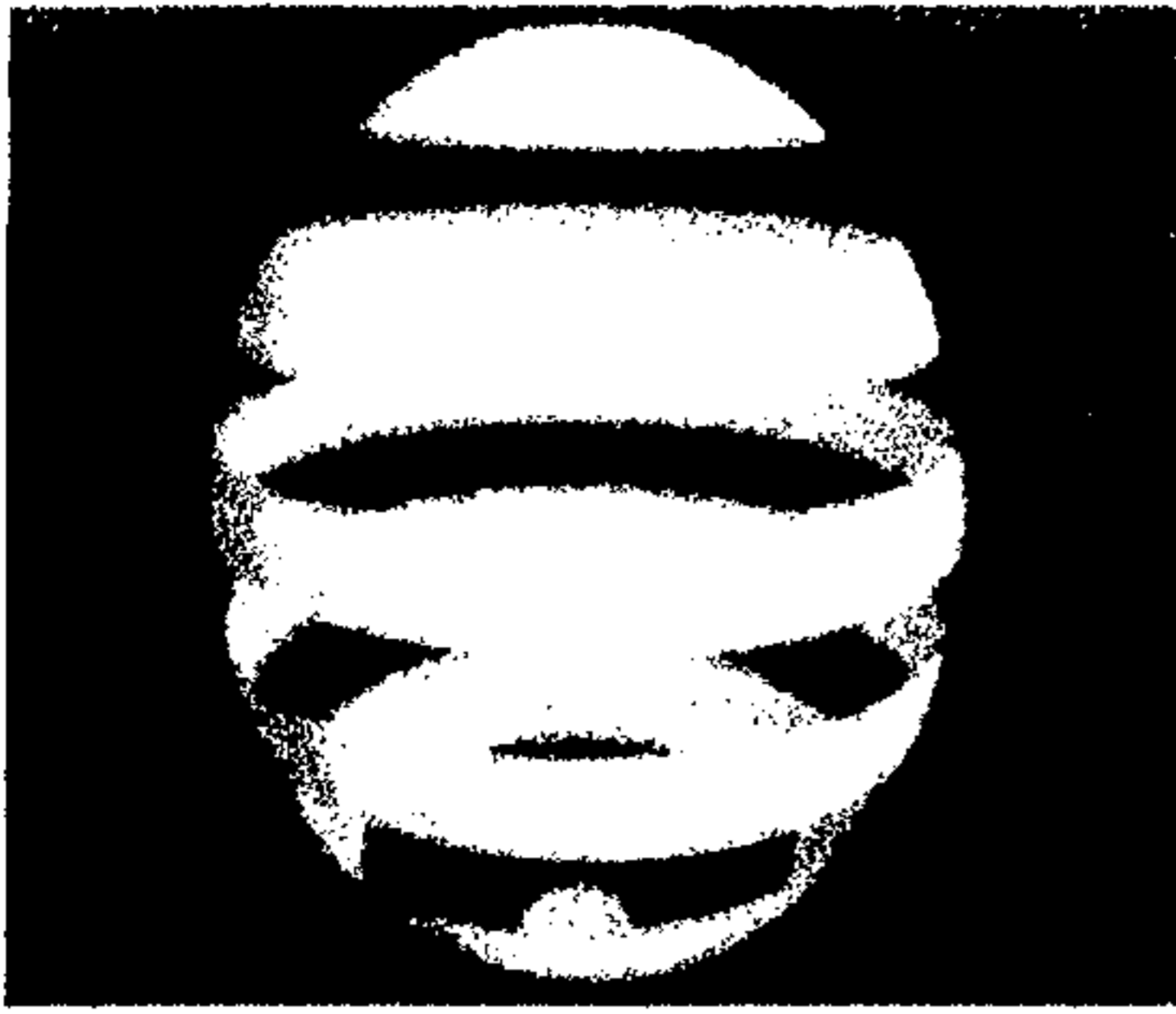
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Addenda

Addendum A: MMAT course materials' development

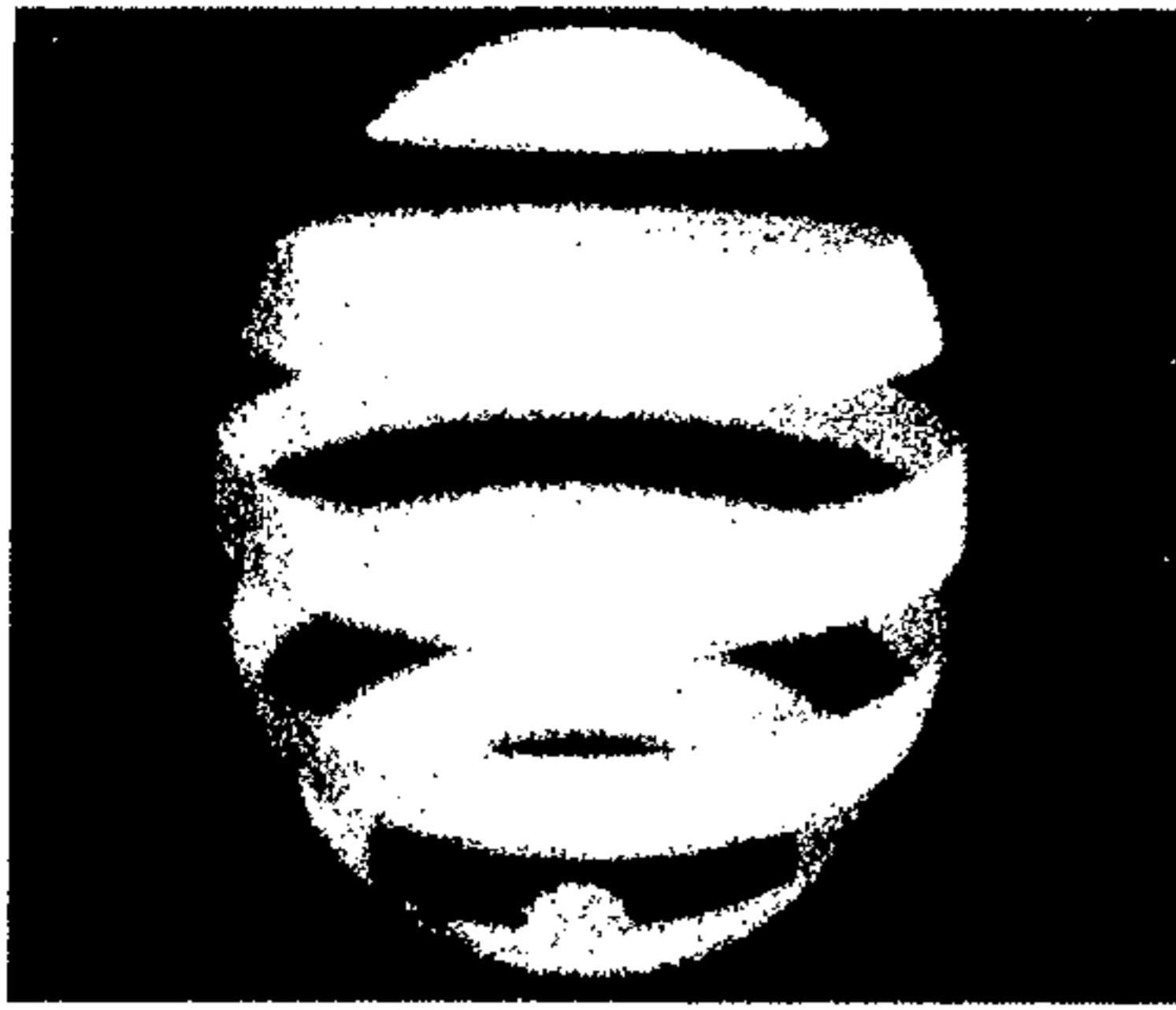
1.	Professional development course 1995-6 (Phase 1)	1
2.	Course development communication during 1995-6 (Phase II)	2
3.	MMAT course materials	
•	UNISA MMAT00-8/102. 1996b. <i>Mathematics Subject Didactics, Tutorial letter (study guide 1)</i> . Pretoria: Unisa, Department of Didactics (extract of guide)	4
•	UNISA MMAT00-8/101. 1996a. <i>Mathematics Subject Didactics, Tutorial letter (introduction, administration, study program, assessment, contact and practical sessions)</i> . Pretoria: Unisa, Department of Didactics (extract of assessment).	20
•	UNISA MMAT00-8/401/1997c. <i>Mathematics Subject Didactics, Tutorial letter (free examination paper)</i> Pretoria: Unisa, Department of Didactics (extract of guide)	22
•	UNISA MMAT00-8/101. 1997a. <i>Mathematics Subject Didactics, Tutorial letter (introduction, administration, study program, assessment, contact and practical sessions)</i> . Pretoria: Unisa, Department of Didactics (extract of assessment).	23
•	UNISA MMAT00-8, DMT300-X, FDEME6-P. 1998b. <i>Mathematics Subject Didactics: Only Study Guide</i> . Pretoria: Unisa.	27
•	UNISA MMAT00-8/101. 1998a. <i>Mathematics Subject Didactics, Tutorial letter (introduction, administration, study program, assessment, contact and practical sessions)</i> . Pretoria: Unisa, Department of Didactics (extract of assessment).	37
•	UNISA MMAT00-8/103. 1999. <i>Mathematics Subject Didactics, Tutorial letter (Portfolios)</i> . Pretoria: Unisa, Department of Didactics (extract of assessment).	44

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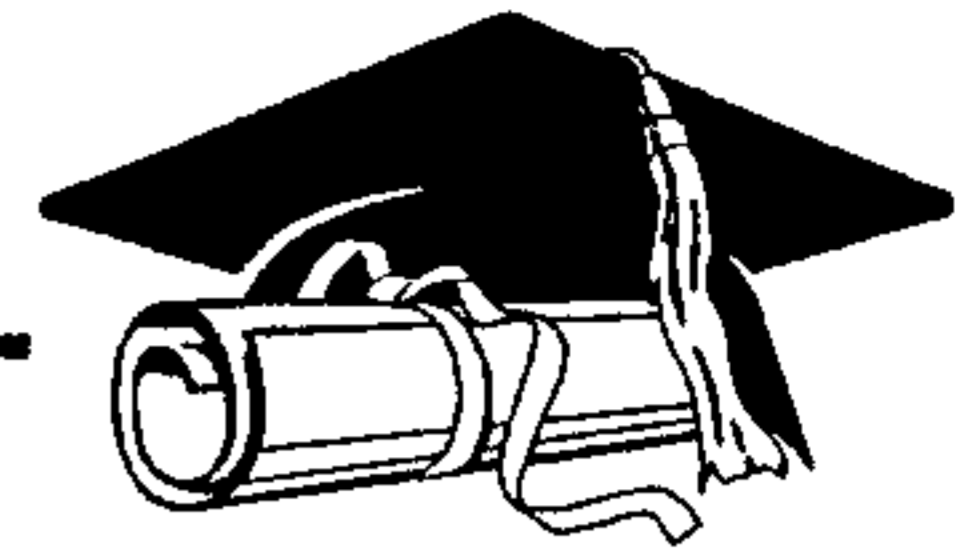
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•	UNISA MMAT00-8/101. 1996a. <i>Mathematics Subject Didactics, Tutorial letter (introduction, administration, study program, assessment, contact and practical sessions)</i> . Pretoria: Unisa, Department of Didactics (extract of assessment).	20
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•	UNISA MMAT00-8, DMT300-X, FDEME6-P. 1998b. <i>Mathematics Subject Didactics: Only Study Guide</i> . Pretoria: Unisa.	27
•	UNISA MMAT00-8/101. 1998a. <i>Mathematics Subject Didactics, Tutorial letter (introduction, administration, study program, assessment, contact and practical sessions)</i> . Pretoria: Unisa, Department of Didactics (extract of assessment).	37
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UNISA TEACHING DEVELOPMENT PROJECT
UNISA ONDERRIGONTWIKKELINGSPROJEK



Dear Colleague

PRACTICAL COURSE IN INSTRUCTIONAL DESIGN

This is a reminder re the Practical Course in Instructional Design being offered by the Bureau for Univeristy Teaching. The amended timetable also indicates the venues and the topics to be discussed.

	FACULTY					
	Arts	Economic and Management Sciences	Science TAC 1	Law TAC 1	Theology TAC 1	Education
TOPIC 1 <i>Know your target group</i>	95-03-01 Unisapark	95-03-02 Seminar 2 SP	95-03-03	95-03-06 Unisapark	95-03-07	95-03-08 Exam Room 1 TvW
TOPIC 2 <i>Concretizing objectives</i>	95-03-15 Unisapark	95-03-16 Unisapark	95-03-17	95-03-22 Unisapark	95-03-24	95-03-23 Unisapark
TOPIC 3 <i>Creating diverse learning opportunities</i>	95-03-29 Unisapark	95-03-30 Unisapark	95-04-19	95-03-31 Unisapark	95-04-20	95-04-21 Senate Hall
TOPIC 4 <i>Teaching reading and study skills</i>	96-04-26 Unisapark	95-04-28 Unisapark	95-05-02	95-05-03 Unisapark	95-05-04	95-05-05 Unisapark
TOPIC 5 <i>Reader-friendly writing for students</i>	95-05-10 Venue to announced	95-05-11 Unisapark Arts (AC) (AF)	95-05-12	95-05-15 Unisapark	95-05-16	95-05-17 Unisapark
TOPIC 6 <i>Teaching students writing skills</i>	95-05-24 Unisapark	95-05-25 Unisapark	95-05-26 TAC	95-05-29 Unisapark	95-05-30	95-05-31 Unisapark
TOPIC 7 <i>Activities in text</i>	95-06-07 Unisapark	95-06-08 Unisapark	95-06-09 Unisapark	95-06-12 Unisapark	95-06-13	95-06-14 Unisapark
TOPIC 8 <i>Setting assignments and exams</i>	95-06-21 Unisapark	95-06-22 Unisapark	95-06-23	95-06-26 Unisapark	95-06-27	95-06-28 Unisapark
TOPIC 9 <i>Course evaluation</i>	95-06-29 Unisapark	95-06-30 Unisapark	95-07-03	95-07-04 Unisapark	95-07-05	95-07-06 Unisapark

Please take note of the following:

- 1 The emphasis in this course is on the practical application of the contents of the presentation. Therefore, you are requested to bring course material on which you are currently working with you to get the most out of it.
- 2 Bus transport to and from Unisa Park is available. Buses depart at 8:00 form the bus terminus below the Administration Building.
- 3 Presentations start at 8:30. There is a tea break at 10:00, and the presentation ends at 12:00.
- 4 Buses will return from Unisa Park at 12:00, and will be back at the main campus at 12:30.
- 5 Queries: Dr M Heese (6237), Dr P H R van Zyl (6870).

• HW

From: H Wilson
To: ADMIN13(KEMPYR)
Subject: Maths subject didactics -Reply -Reply

Hi Yvonne,
Concerning Education Subject Didactics MMATOO-8

Discussions started 19 July this year. The next meetings are sheduled for 3/8 (11:30), 10/8 (8:00) and 14/8 (11:00) to discuss the Chapters in the prescribed book Chapters 4-8.

I am asked to assist in the development of activities and took over the instructional design /course mng position. Dr Dirk Wessels is the only author (writing a wrap-around SG, but the book is American). You need to give input as to an editor (as you indicated). This course will be put into the quick layout that Wayne and Phoebe put together. We are trying to get critical readers from Maths department (Carol and Joy).

This course will be the basis for Further Dipl course (FDEME1-6) and perhaps later in next year for a Certificate course which can also serve on the open market.

Post haste - The author indicated it to be ready to go out still this year to the students, thus we need to get him to write a fair course, but also get him writing well. The basic course has been written, but a lot of work (my opinion) need to still go in their to make it suitable for the target group in SA , HED group.

Regards
Hentie

From: H Wilson
To: ADMIN3.ADMIN30.WESSEDCJ
Subject: MMATOO

Dirk,
Ek het kontak gemaak met Yvonne en op haar navraag gereageer. Sy het die datums wanneer ons vergader omdat sy voel sy graag een vergadering wil bywoon voordat sy 'n editor toewys. Alhoewel sy voel dit baie laat is om nou enige insette van hulle te verwag, moet ons maar sien wat hulle kan doen betreffende redaksionele versorging.

Omdat daar so min tyd is totdat die materiaal gereed moet wees vir die studente, het Henry van Zyl aanbeveel dat jy aansoek doen om die gids liever as studiebriefe te laat uitstuur (aansoeke na Prof. Maritz). Die motivering daarvoor is dat die projek volgende jaar in 'n lootstoetsfase sal wees om die benadering te toets in SA wat die Amerikaanse handboek volg en omdat jy graag die insette van kritiese lesers, studente evalueerders, en eksterne evalueerders wil inwerk voordat die gids gedruk word.

Groete
Hentie

From: H Wilson
To: ADMIN3.ADMIN30.WESSEDCJ
Date: 18 September 1995 9:44am
Subject: Problem Solving Approach in Mathematics -Forwarded

Hi en hello Dirk,

Hier is 'n brokkie nuus op hierdie heerlike Maandag oggend vir you inligting betreffende probleemoplossing en Wiskunde.

Ek het met Lien gepraat en sy het reeds 'n grafiese ietsie wat sy wil wys aan ons (maar net sodra hulle haar rekenaar reggemaak het later in die week). Sy sal ons laat weet. Dit klink baie belowend. Hoe gaan dit met die skryfery? Indien jy klaar is, kan ek kyk na hoofstuk 4? Kan jy dit met email stuur aan my - spaar ons die loop. Of nog beter, wat van 'n ete een middag?

From: DCJ Wessels
To: ADMIN1.ADMIN10(WILSOH)
Date: 15 November 1995 8:21am
Subject: MMATOO-8 -Reply

Hentie

Die SPRING voel ek op ander plekke ook behalwe aan my bas. Ek is klaar met die hoofstukke 5 - 9 en het dit Maandag vir Reinhardt afgegee. Ek het gesukkel om alles aanmekaar te las. Die hele storie met ou gids en nuwe dinge, ou werkopdragte en nuwes was moeilik om aanmekaar te sit.

Ek stuur aan jou die [redacted] studiebrief. Timmer maar nog aan hom, want ek weet hy is nie heeltemal finaal nie. Ek weet net nie wanneer sal nog iets aan hom gedoen kan word nie.

Ek is van more af met verloftot in 1996. Ek sal nog dikwels kantoor toe kom. My [redacted] en jy is welkom om my enige tyd te bel.

Ek het nog baie hulp nodig met die artikel oor die konstruktivisme.

Groete

From: H Wilson
To: ADMIN13.SONNTRC, ADMIN3.ADMIN30.WESSEDCJ, ADMIN13....
Date: 20 November 1995 11:16am
Subject: MMATOO

Hi almal.

Die doeldatums probeer ek nou vasstel as:

MMATOO-8 Tut 102 (Hf 1-4)
Outeur/BUO: 22 Nov
Redaksie: 23 Nov-24 Nov (OK R?? vir finale afronding)
Outeur/BUO: 27 Nov - 8 Des Uitleg vir kameragereedheid
By Produksie: 8 Des. 95 - 22 Jan 96 ✓
By Student: 22 Jan - 9 Feb 96 (3 weke vir posaflewering is algemeen!)
10 weke vir studie van 5 hoofstukke
een week vir instuur (w/o in op 30 April 96)

MMATOO-8 Tut 103 (Hf 5-8) Ek is nie seker hoe julle hierdie doeldatums gaan vasstel nie, HELP ASB!!
By Redaksie: Datum R??)
Outeur/BUO: Uitleg vir kameragereedheid Datum??? Dirk????
By Produksie: 15 Jan - 30 Feb 96 ✓
By student: 15 Maart (3 weke postyd)
studietyd van 5 hoofstukke: 10 weke (vanaf 1 April)
instuur: 10 Junie
(w/o in op 17 Junie)

Hentie ek het alle
geen - gaan maar
woord en handel
af, arb... Dumbie om
wat jy doen Dirk.

Mathematical
Achievement

Opportunity to
Achieve

Name

Date of Birth

Grade

Teacher

School

Address

City

State

Zip

Phone

Fax

E-mail

Comments

Signature

Parent Signature

Parent Phone

Parent Fax

Parent E-mail

Parent Address

Parent City

Parent State

Parent Zip

Parent Phone

Parent Fax

Parent E-mail

Parent Comments

Parent Signature

Parent Date

Parent Initials

Parent Title

Parent Occupation

Parent Education

Parent Marital Status

Parent Number of Children

Parent Number of Siblings

Parent Number of Pets

Parent Number of Vehicles

Parent Number of Hobbies

Parent Number of Languages

Parent Number of Books

Parent Number of Movies

Parent Number of Games

Parent Number of Sports

Parent Number of Clubs

Parent Number of Friends

Parent Number of Neighbors

Parent Number of Acquaintances

Parent Number of Strangers

MATH MATICS

LETTERS



MMW 07-8
Tutorial letter 102/1996

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Overview

Dear student

This tutorial letter consists of the following elements:

1. Course details
2. Important information on Assignments 01, 02 and 03
3. Details of the credit system
4. An overview of the course
5. Chapters 1 to 4 of the study guide

0.1 Course details

Before starting on the first chapter of this study guide, we are first going to look at some details of the course: the subject curriculum; goals and objectives; the course package; stationery you will have to acquire; steps you should follow in order to achieve success; and the prescribed books.

0.1.1 Subject curriculum for the course

The subject curriculum for this course contains the following elements:

- The nature and essence of mathematics/the teaching of mathematics
- Goals and objectives for the teaching of mathematics
- Aspects of the school mathematics curriculum
- Strategic learning
- Teaching strategies
- Evaluation/assessment
- Classroom practice
- Problem solving
- How to teach and learn geometry
- Experimental work

0.1.2 Goals and objectives for this course

This course has been designed to prepare you as a prospective/practising teacher for the effective teaching of mathematics to secondary pupils by **starting to familiarise you with the problem-solving and problem-centred approaches to teaching, and by helping you to cultivate a positive attitude to the subject and to impart this attitude to your pupils.**

Help, Info

Studying this course will give you an awareness of your new role as a facilitator of knowledge, and of the ways of obtaining it, in the mathematics classroom.

It will

- teach you what real-life mathematics consists of in context
- help you understand how your conception of mathematics affects everything you do with the children
- acquaint you with the ways in which children learn mathematics
- sensitise you to a problem-centred classroom climate that promotes meaningful learning
- introduce you to strategic teaching and learning - in other words, teaching and learning by means of strategies - in the total field of mathematics

Help

More specifically, it will

- enable you to develop goals and objectives for problem-centred and problem-solving learning
- teach you what mathematical curricula are
- enable you to develop various lesson plans
- teach you how to make balanced assessments
- introduce you to experimental work and the handling of case studies
- help you to evaluate the goals and objectives of school mathematics syllabi in South Africa
- introduce you to the approach followed in the USA as well as that favoured in the Netherlands

Help

0.1.3 The course package

The course package consists of

- the two prescribed books:
 - Pateman 1989
 - Cangelosi 1992
- a study guide for MMATOO-8
- tutorial letters
- prescribed articles
- recommended books and articles
- the new Interim School Syllabus for Mathematics
- any school mathematics textbooks you are using

The old study guide will remain in use in 1996, but only certain portions of it (Study Guide MMATOO-8/1/94-96). The new study guide will appear in tutorial letters 102/96 and 103/96. In 1996 the course will be evaluated and finalised for 1997. The new study guide will then be published in its final form. Some of you will be involved in the evaluation process.

Pilot took
2 yrs, not one explained

0.1.4 Stationery you will need to acquire for this course

In order to be an active, participating student you will need the following writing materials:

- an A4 hardcover notebook for taking notes and also for carrying out some of the activities
- a ring binder with plastic folders so that you can compile a portfolio
- a set of coloured marking pens
- a pencil, rubber and ruler

0.1.5 Steps to be followed in order to achieve success

To be a successful student, you should follow the steps that are set out below:

- Buy the prescribed book as soon as possible: it is a workbook and you will be examined on it in detail.
- Read it word for word, and study it with the help of the accompanying tutorial letters and study guide. This may also involve drawing up mind maps and making your own summaries of the objectives and contents of chapters. Restrict summaries to one page. Be conscientious about this: it is vital to keep closely in touch with this book if you are to master its contents.
- Build up your own portfolio (concerning the prescribed book) for use in exam preparation throughout the year. **This portfolio will also serve as Assignment 03/1996.**
- Form a study group with one or more fellow students, meet regularly and work through the proposed programme together.

You are very welcome to contact me as the lecturer responsible for this course whenever you and your group get into difficulties. A positive, encouraging attitude towards the course as a whole will keep you motivated to persevere in your studies.

0.1.6 The prescribed books

Two books have been prescribed for this course. The first mainly serves the purpose of orientation while the second is the book you will be working through systematically.

- Pateman, Neil A. 1989. *Teaching mathematics - a tantalising enterprise: on the nature of mathematics and mathematics teaching*. Geelong, Victoria: Deakin University Press.

This book serves only as an *orientation* and deals with the various mathematical schools of thought in a popular style and is very easy to understand. These

Expected behavior - Control

schools have strongly influenced the previous and contemporary approaches to mathematics teaching, both worldwide and in South Africa. For instance, quasi-empirism can be regarded as the forerunner in this country of the constructivist approach which is very topical today. The book is an important source *to orientate you with regard to your other prescribed book* and the whole Subject Didactics course for Mathematics.

- Cangelosi, James S. 1992. *Teaching mathematics in secondary and middle school: research-based approaches*. New York: Macmillan.

This book is your *manual or workbook* which you will be working through systematically. It is an excellent book. No such book is available in South Africa at present, so buy it at once.

Advantages of the book

This book meets current needs (of the country, people, curriculum) and meets requirements at all levels when it comes to standard. It is written in a very user-friendly style, uses an interactive approach and can therefore be used as a workbook.

The book is based on the problem-solving approach which presents the teaching of mathematics in context. Mathematics teaching follows an integrated approach which stresses mathematical thinking.

The reader is actively involved and the book contains a large number of self-assessment exercises which thoroughly and continually expose the student to classroom realities

The book does not follow the American Standards slavishly, but offers enough examples of meaningful learning opportunities to all readers and students. Therefore, by using this book we try to help and support you as the student in a systematic progress from whatever other approach you have been accustomed to (perhaps the traditional one, or some personal and unrefined approach) towards studying and using a new approach: the problem-solving approach

Chapter division

We are going to deal with the book step by step, indeed chapter by chapter. Chapters will be numbered as in the book, but the Foreword (pp v-viii) will be called chapter 0. Let us start right there.

"Distant voice"

Who?

0.1.7 *Your study methods*

Here are a few pointers on how to use the book. Before proceeding any further, then, we take a look at three important techniques you will often be using at the start of a new chapter.

Independent study

A crucial phase in the process of understanding and learning mathematics by problem solving is to **articulate your ideas** about mathematics, and the teaching of mathematics, **both or orally and in writing**. Only when you have tried this process for yourself will you understand the full value of this exercise.

Study process

We also want to make you aware of your own studying process. We shall explain a unique learning strategy to you - an approach you may find **very useful** to follow. Try to refine your own approach. The three techniques contained in this strategy are characterised as **1S**, **2S** and **3S**, meaning **skimming**, **scanning** and **study-reading**. These three "terms" have been constructed from the subject literature for the purposes of this course. You may find other subdivisions and emphases when you come across them elsewhere, but here we are going to use them as follows:

The exercise comprises altogether six steps. In order to understand what these steps involve you need to study the example given below. An instruction to carry out this exercise, that is, to do **1S2S3S**, will usually appear at the beginning of the different chapters. This means that you will have to follow the steps carefully as they are set out below. Wherever the activity is given it will appear under the heading "Overview and exploration".

Overview and exploration (example)

● SKIMMING 1S

1. **Page through, explore.** Read the section or paragraph quickly, forming a rough idea of the contents. Concentrate on headings and subheadings, bold and italic type, boxes, tables and illustrations, and - in the case of a chapter - summaries and introductions. The objectives set for a chapter are important.

2. **Make a cursory survey.** Ask yourself this while you read: What key terms occur in this division or chapter? Stop when you identify a key term and read carefully what is said about it. Mark it in the book. What you are trying to ascertain is: **Where** is it?

● SKIMMING AND REFLECTING 2S

3. **Scan** the section or chapter.

4. **Start a mind map** (for the whole or for parts of it, as in starting a summary). You are looking for items and concepts while reading the information in the section or chapter in a more evaluative way. Reflect on interrelationships between concepts. The question now is: **What** is it? What is the meaning and the purpose? Visualisation is important and you are certainly going to start writing down key concepts. You can omit parts of the text.

5. **Deeper reflection.** Start building a structure in your mind map, work towards an entirety. As you work through the prescribed activities of the section or chapter, keep returning to the mind map to fill in the detail. Reflect on the value and meaning or categories, concepts, motivations, variables and key terms.

● STUDY-READ 3S

6. **Study-read.** This follows directly from stages 2, 4 and 5 and is done carefully, thoroughly and thoughtfully. The key terms and concepts you pinpointed have to be linked up, and in this the mind map and summaries are important. Pause while reading, consolidate what you remember and consider how new information fits in with what you already have.

Apart from the activity explained above, you will find another reading activity frequently at the beginning of a chapter, under the heading "Main elements of the chapter". Here you will find out what the chapter is all about. **We want to broaden your perspective and outlook, help you to identify problems and help you to resolve them in a new way in the context of teaching and learning.**

Activities

Whenever you get to an activity, **complete the activity in full on loose pages** which you then insert in the plastic folders of your file and group together chapter by chapter. (We shall henceforth refer to this file as your portfolio.) Supplement this

with your own notes from your notebook. Proceed, using your textbook and this study guide in tandem.

Work load

Your best working method would be to work frequently and regularly in this subject.

Method of referring to Cangelosi

Because the book is printed in a double-column format, I shall refer to the two columns as a and b respectively. Thus p 31a refers to the first column of p 31 and p 31b to the second. If there is no a or b, the whole page is intended.

Self-assessment exercises

At the end of each chapter there are **self-assessment exercises** designed to

- assess the progress you have made towards the chapter objectives (allowing you to determine your own level of competence) and what you still have to do to reach the requisite standard
- reinforce and expand the knowledge and insights derived from the chapter

That is why we use summaries and mind maps. In this way we hope to fix the knowledge more firmly in your mind. Note how many of the self-assessment questions have been anticipated by activities encountered in the chapter.

0.2 Assignments

- There are only **three assignments**, all of them obligatory. The **due date** for the first is 30 April, for the second 15 June and for the third 15 August 1996.
- Assignments 01 and 02 form part of Assignment 03, but they all have to be submitted on different dates. Assignments 01 and 02 may, however, be included in the portfolio you have to build up over the year and will be returned to you without delay.
- The **third assignment** involves submitting your own portfolio, consisting of your file of all the work done for the activities in Tutorial Letters 102/96 and 103/96. This assignment can be found at the end of chapter 8 of this tutorial letter.
- **Number of pages per assignment.** The first two assignments should be at least 10 to 15 pages, or 2 000 to 3 000 words, in length. The third assignment is the portfolio, which will be much longer.

0.3 The credit system

The credit system is as follows:

Credit marks will be $25+25+50=100$. Assignments 01 and 02 are worth 25 marks each and the portfolio, which serves as Assignment 03, counts 50 marks.

You will receive the necessary credits only if you achieve 50% or more for your assignments.

0.4 Overview of the course

0.4.1 Orientation concerning mathematics

In this foreword we shall assist you in the use of a recommended method for studying the contents of your prescribed book(s) which you may find useful. We shall then take a look at the new integrated approach to mathematics and what mathematics in context involves. But what is mathematics and how did it develop? Let us first get a general picture of the contents.

Activity 0-1: Orientation through SKIMMING (1L)

1. Page through, explore. Read Cangelosi (pp v-viii) quickly, forming a rough idea of the contents. Concentrate on headings and items, as well as bold and italic type.

2. Make a cursory survey. Ask yourself this while you read: What key terms occur in this section? Stop when you identify a key term and read carefully what is said about it. Mark it in the book.

What you are trying to ascertain is: Where is the information?

Activity 0-2: Orientation through SCANNING AND REFLECTING (2L)

3. Scan the section in Cangelosi (pp v-viii).

4. Start a mind map (for the whole or for parts of it, as in starting a summary). You are looking for items and concepts while reading the information in the section in a more evaluative way. Reflect on interrelationships between concepts. You can omit parts of the text.

5. Deeper reflection. Start building a structure in your mind map, work towards an entirety.

Study Strategy
Demonstrated

The question now is: What is it? What is the meaning and the purpose? Visualisation is important and you are certainly going to start writing down key concepts. As you work through number 5 and the prescribed activities of the section or chapter, keep returning to the mind map to fill in the detail. Reflect on the value and meaning or categories, concepts, motivations, variables and key terms.

Activity 0-3: Further orientation through STUDY-READING (3L)

6. Study-read. This follows directly from stages 2, 4 and 5 and is done carefully, thoroughly and thoughtfully.

The key terms and concepts you pinpointed have to be linked up, and in this the mind map and/or diagrammatic summaries are important. Pause while reading, consolidate what you remember and consider how new information fits in with what you already have.

0.4.2 *The new approach:*

Is this an American or a South African approach?

Your prescribed book by Cangelosi corresponds to recent South African mathematics syllabi in that, though the textbook is based on the "Standards" set by the National Council for the Teachers of Mathematics (NCTM) in the USA, South Africa is setting out on the same track. This is quite clear from the "Goals and Objectives" of the new "Interim Syllabi" (1995) for all the phases of school mathematics (see Tutorial Letter 104/96). In the USA the *Curriculum and evaluation standards for school mathematics* of 1989 (the content of the new school mathematics syllabus) and the *Professional standards for teaching mathematics* of 1991 (guidelines for the training of mathematics teachers) have been compiled which will change the whole course of school mathematics all over the world.

It is also true that to the lecturer as well (that's you in your teaching and me in mine!) the changeover to a problem-solving approach is a fairly new but nonetheless very real process and one that cannot be finalised overnight. This course will continue to evolve and will take on a progressively more South African character. We also would like to incorporate your inputs in the course and will keep on asking your opinion.

Request participation
Dustin - dialogue

Activity 0-4: What are the Standards used in the USA?

1. Read Appendix D (pp 313-322) attentively, marking pen in hand. Note that objectives are first formulated for each learning phase and then the mathematical content is selected accordingly. Write down some comment at this point.
2. List the advantages and disadvantages of each approach.

These Standards are really targets (objectives) set for the teaching of mathematics at school. There are 13 of them at Kindergarten to standard 2 level, 13 from standard 3 to standard 6, and 14 from standard 7 to standard 10 in the secondary school. This seems to me a better, more responsible way to curricula than the one we have been using in South Africa: content first, then objectives.

Activity 0-5: Compare the "standards" of the USA and South Africa

1. Use your colour pen to mark key words in each Standard and compare these with the South African school mathematics curriculum at the back of your study guide or in an accompanying tutorial level. Devote more time to the Standards for standards 7-10.
2. Identify the parts that **do not occur** in the South African syllabus. Mark these with an ordinary pencil.
3. Now turn to pp 30-35 and read those parts that receive greater or lesser emphasis in the Standards.
4. Note down your impression of how our mathematics syllabus compares with the USA Standards.

Activity 0-6: Your own role in the teaching of mathematics

1. Page ahead to chapter 9 in your textbook and read it through.
2. Now do the self-assessment exercise on pp 299-300.
3. The emphasis on your own role, on p 299, is very important.

0.4.3 Problem-solving or problem-centred?

This book is based on the new and highly popular *problem-solving approach* which reached considerable heights in the USA. It also contains many elements of the *problem-centred approach*, which is still largely experimental. A good deal of research has been done in South Africa on the problem-centred approach, though little of it has been evaluated at secondary-school level; nor have the "products" of the primary school gone through the whole system as yet. The difference between

the two approaches is this: according to the problem-centred approach, mathematics should be learnt by solving problems with little or no outside help, and the children should not be taught algorithms. The problem-solving approach, on the other hand, calls for the learner to explore the problematic character of mathematics by solving problems and to learn this skill according to specific strategies, including certain algorithms or other strategies favoured by the teacher.

Info

Our selection of this "advanced" book on teaching approaches is clear evidence of our serious intention of addressing South African needs and problems, and problems in the teaching of mathematics, in a real way. This will give us the best hope of achieving the goals and objectives of current and future syllabi. Cangelosi has long been known, via his publications, for his successful use of the problem-solving approach in elementary, in-service and advanced mathematical training - especially for teachers of mathematics. Furthermore, he has a very strong cognitive orientation.

Reason

0.4.4 Problem-solving versus the traditional teaching

This is the best available textbook that I know of. It is interactive and very user-friendly (in layout, language, approach, style and content) and sets about establishing the *problem-solving approach* in a gradual, systematic way. In the end the method is firmly established and the emphasis is always in the right place - on the learners, on how they learn mathematics and how it should be taught to make this possible. It is also a workbook, so that students can master the contents in terms of structured objectives while working their way through it. It moreover forms a meaningful unit in terms of all the components of the curricular framework.

Reason / Argument

In the Foreword (Cangelosi, p v) and also later, in chapter 5, you will find a description of the *traditional approach* to teaching:

Typically, mathematics lessons begin with the teacher telling the students a fact or giving them the steps in an algorithm. The teacher then works a textbook example and assigns students to work exercises from the textbook to help them remember the fact or the process. The lessons are void of experiences whereby students discover, invent, or apply mathematics to problems they find meaningful.

This book sets out to replace this "traditional" negative image - a fear of mathematics, the spoonfeeding syndrome in teaching it and the assumption of inability to excel in it - with a positive disposition to mathematics as something that is within the reach of all and part of human experience. It places the emphasis squarely on mathematical thinking.

0.4.5 The integrated approach

Motivation
Allow decision

The book follows an **integrated approach** that is reflected not only in how the content is handled but also in the "Guide to integrated topics" on pp ix-xii. This is followed by a detailed table of contents for the eight chapters and five appendices (A-E). Appendix B includes the 14 Curriculum Standards covering the K-12 field (in the USA) - in other words, the 13 school years from kindergarten to the final year of high school. You will have no difficulty in finding our South African school syllabus in it. A particularly helpful feature is the clearly spelled out objectives and detailed examples of the content and how you, the teacher, can evaluate it.

Activity 0-7: An integrated approach

1. Turn to p 32, vignette 2.6. (A vignette is a short, striking description of a situation, and Cangelosi uses vignettes to illustrate relevant points.) Consider this vignette, then answer the following questions: Have you had similar experiences? Would it be fair to say that this example is typical of our South African situation?
2. Work through vignette 2.7 and reflect on the same questions.

Demonstrate
Skills

This is a good example of typical mistakes made by our children because their knowledge of fractions and percentages has not been integrated. The mathematical problem in vignette 2.7 would be considered very advanced in our situation. It indicates the context in which this type of mathematics should be presented and would form a good introduction to maximum and minimum values in quadratic equations.

Activity 0-8: Integration in practice

1. Study the "Guide to integrated topics" (pp ix-xii) together with the table of contents (pp xiii-xx). Do you see how the former indicates where a given topic recurs in the various chapters?
2. Look for a particular theme in the "Guide" (for instance, a small theme such as "parents, working with") and follow it through the book. (You will find it on pp 10, 139-143 and 255-258). In other words, this theme crops up in chapters 1, 5 and 8. Now look for the same theme in the table of contents. You will find the topic "parents" only under chapter 5.

Invite

By using the "Guide", however, we can find all the references to it. Now you can hunt through the numerous other themes in this "Guide", and you will realise the extent to which the various themes have been integrated. This enhances the

quality of the book, but it also means that you have to read it with great concentration and continuity.

0.4.6 Mathematics in context

The book also follows a **contextualised approach**. This means that mathematics is never presented or taught on its own. We have selected three examples for discussion.

Activity 0-9: What is "contextualised"?

Turn to p 22 and study vignettes 2.1 and 2.2. What is the role of context in these examples? (1)

Multiplication in context

Teaching multiplication to children will mean picking up and presenting it as an ongoing process of addition in practical word problems. Pupils will gradually discover, by inductive (exploratory) thinking, that it is easier to multiply 36 by 5 than to add 36 up five times. Group discussions will give them the opportunity to volunteer the information that 36×5 is a shorter, more economic way of getting the answer 180. Only then would they be exposed to sums like $23 \times 4 = ?$ $19 \times 7 = ?$ $45 \times 8 = ?$ which contain only symbols.

What it amounts to is that the repetition of problems of the same kind is used to inculcate an algorithm. Bear in mind, though, that children soon forget the context: do not persevere with these problems too long. You will note a strong element of variation throughout the selected problems.

Activity 0-10: Multiplication in context

Now formulate, in your own words, the role of context in the above example. (2)

Thus the emphasis is on the practical situation in which mathematics is needed to resolve given problems. It is never taught to young children in a vacuum, in isolation from the problem (context). For this reason it is very important to choose suitable problems. This is true not only of young children but of all learners of mathematics at all levels.

Factorisation in context

The above remark does not apply only to the young child, but to all learners of mathematics at all levels. In factorising an algebraic expression such as

$$a^2 - b^2 = (a - b)(a + b)$$

$$100 - x^2 = (10 - x)(10 + x)$$

we see, on p 277) that the context is found in the principle of division. We therefore fall back on square diagrams divided into smaller parts and with some of the parts removed. This is not a mere demonstration: enough of it is done by the pupils themselves to give them a fair idea of the process, so that the factorisation concept is formulated more clearly. Constructions by the students themselves are also a vital part of the activity. Note the paper-folding activity on p 276 which revolves around the perfect square:

$$(a - b)^2 = (a + b)(a - b)$$

This also crops up in the test on p 279. Clearly it is not just a demonstration.

(3) **Activity 0-11: Factorisation in context**

Now use a small flow diagram to explain how factorisation is done in context.

Vignette 2.7 on p 33-34 confirms the indispensability of context and the lack of insight that results from a mere plug-in of numbers.

0.4.7 Invitation to critical evaluation

Excellent as the book is, it is not perfect. It will be a part of our task to approach it very critically. You are welcome to send me your comments on any part of it or on our handling of it.

Invite
Didactics

0.4.8 What is mathematics?

The first part of the book, up to about p 12, deals with this question both directly and indirectly. You will see as we go on that this has a bearing on a good many activities. Every activity that opposes the traditional approach to the problem-solving approach must get to grips with this question of what mathematics is. One's view of mathematics certainly has implications for the question of how to teach it and the perception of how a child learns and understands it.

Direct focus

- Activity 0-12: Demystifying mathematics: perceptions**
1. Draw up a table of two columns headed "Easy" and "Difficult".
 2. Turn to p 12 and scan the next few pages up to p 18.
 3. Look for indications of what makes mathematics easy or difficult, and note such factors down in the relevant column.
 4. Amplify this from your own experience. How can the difficult ones be made easy?

0.4.9 How did mathematics develop? (A historical time line)

We shall now give you a historical survey of the development of mathematics over the centuries. This survey should clarify some of your questions, and also place references to people who have made significant contributions to the subject into perspective with regard to the periods in which they lived.

It is certainly possible that this "time line diagram" may not represent all mathematical contributions of all cultures. The most important consideration in including such a diagram is to give you an overview and an idea, and not a comprehensive account, of the development of mathematics.

Figure: A historical time line of the development of mathematics

Reason

Info Reason

3000 BC	1000 BC	0	500 AD	1000 AD	1500 AD	1600 AD	1700 AD
<p>Early systems of numeration are developed</p> <ul style="list-style-type: none"> - Egyptians use additive system - Babylonians use place value numeration <p>Abacus (first mechanical calculating device) is used</p> <p>Babylonians develop methods to solve quadratic equations</p> <p>Babylonian tablets refer to interest rates</p> <p>Papirus shows problems of algebraic nature</p>	<p>Pythagoras works with prime numbers, music of the spheres, Pythagorean theorem (first step in development of number theory)</p>	<p>Chinese begin to use negative numbers</p> <p>Zero symbol is invented</p> <p>Ptolemy places earth at centre of universe</p> <p>Hypatia studies number theory, geometry and astronomy; her death in Alexandria is followed by decline of Alexandria as centre of learning</p>	<p>of Khwarizmi composes key book on algebra and Hindu numerals</p> <p>Early computing algorithms are developed</p> <p>Omar Khayyam creates geometric solutions of cubic equations and conic problems</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>Simon Stevin invents decimals</p> <p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Newton formulates laws of gravity</p> <p>Accademia dei Lincei is founded</p>
<p>Zero describes paradoxes such as infinite and here (first attempt at limited notions)</p> <p>Euler's Elements (axiomatic development of geometry) lays foundation for present high school geometry</p> <p>Eratosthenes develops "sieve" for catching prime numbers</p> <p>Archimedes computes "pi", anticipates geometric ideas behind integral calculus</p>	<p>Zero describes paradoxes such as infinite and here (first attempt at limited notions)</p> <p>Euler's Elements (axiomatic development of geometry) lays foundation for present high school geometry</p> <p>Eratosthenes develops "sieve" for catching prime numbers</p> <p>Archimedes computes "pi", anticipates geometric ideas behind integral calculus</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>of Khwarizmi composes key book on algebra and Hindu numerals</p> <p>Early computing algorithms are developed</p> <p>Omar Khayyam creates geometric solutions of cubic equations and conic problems</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>Simon Stevin invents decimals</p> <p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Newton formulates laws of gravity</p> <p>Accademia dei Lincei is founded</p>
<p>Brass replaces stone for tools & weapons</p> <p>People begin to use wheeled vehicles</p> <p>Egyptians oversee construction of Great Pyramid at Giza</p> <p>Babylonians develop written alphabet</p> <p>Hammurabi's legal code introduced in Babylon</p> <p>Phoenicians develop alphabet</p> <p>Iron tools are used</p>	<p>Brass replaces stone for tools & weapons</p> <p>People begin to use wheeled vehicles</p> <p>Egyptians oversee construction of Great Pyramid at Giza</p> <p>Babylonians develop written alphabet</p> <p>Hammurabi's legal code introduced in Babylon</p> <p>Phoenicians develop alphabet</p> <p>Iron tools are used</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>of Khwarizmi composes key book on algebra and Hindu numerals</p> <p>Early computing algorithms are developed</p> <p>Omar Khayyam creates geometric solutions of cubic equations and conic problems</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>Simon Stevin invents decimals</p> <p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Newton formulates laws of gravity</p> <p>Accademia dei Lincei is founded</p>
<p>Greeks develop algebraic doctrine</p> <p>Aristotle studies logic systematically</p> <p>Alexander the Great conquers most of the world</p> <p>Punic Wars are fought, Roman's achieve supremacy over Carthage</p> <p>Chinese build Great Wall</p>	<p>Greeks develop algebraic doctrine</p> <p>Aristotle studies logic systematically</p> <p>Alexander the Great conquers most of the world</p> <p>Punic Wars are fought, Roman's achieve supremacy over Carthage</p> <p>Chinese build Great Wall</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>of Khwarizmi composes key book on algebra and Hindu numerals</p> <p>Early computing algorithms are developed</p> <p>Omar Khayyam creates geometric solutions of cubic equations and conic problems</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>Simon Stevin invents decimals</p> <p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Newton formulates laws of gravity</p> <p>Accademia dei Lincei is founded</p>
<p>Greek alphabet is developed</p> <p>Independent city states arise in Greece (beginning of great period of Greek civilization)</p>	<p>Greek alphabet is developed</p> <p>Independent city states arise in Greece (beginning of great period of Greek civilization)</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>of Khwarizmi composes key book on algebra and Hindu numerals</p> <p>Early computing algorithms are developed</p> <p>Omar Khayyam creates geometric solutions of cubic equations and conic problems</p>	<p>Period of Transmission 1250 A.D. to 1500 A.D. learning preserved by Arabs slowly transmitted to Western Europe</p> <p>Modern Period (Early) 1450 A.D. to 1800 A.D. logarithms, modern number theory, analytic geometry, calculus; the exploitation of the calculus</p>	<p>Simon Stevin invents decimals</p> <p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Francis Viète simplifies algebraic notation</p> <p>Galileo Galilei applies function idea, applies math to experiments with falling bodies (contributes to beginning of calculus)</p> <p>John Napier invents logarithms (earlier techniques for working with large numbers advance astronomy)</p> <p>René Descartes and Blaise Pascal unify algebra and geometry (beginnings of analytic geometry)</p> <p>Pierre de Fermat develops modern number theory</p> <p>Fermat and Pascal help lay foundations for theory of probability</p> <p>Isaac Newton and Gottfried Leibniz independently discover calculus</p> <p>Bernoulli family makes numerous contributions in analysis</p> <p>Newton's Principia Mathematica has enormous impact throughout Europe</p>	<p>Newton formulates laws of gravity</p> <p>Accademia dei Lincei is founded</p>

Mathematical Events and Contributions

1700 AD	1800 AD	1900 AD	PRESENT
<p>Leonhard Euler pioneers work in topology, organizing calculus and using it to describe motion of objects and forces acting on them</p> <p>Joseph Lagrange develops theory of functions; studies of moon lead to methods for finding longitude</p>	<p>Karl Gauss introduces basic ideas of congruence and statistical method of least squares; publishes masterpiece on theory of numbers important to development of statistics and geometry</p> <p>Gauss, James Boyl, and Nikolai Lobachevsky contribute to development of non-Euclidean geometry</p> <p>Pierre Simon de Laplace works out mathematical formulas describing interacting gravitation forces in the solar system</p> <p>Augustin Louis Cauchy does important work in complex analysis</p> <p>Évariste Galois develops theory of groups</p> <p>Georg Bernhart founds second non-Euclidean system based on the sphere; describes flatman surfaces; develops Riemann integral in calculus</p> <p>Arthur Cayley and James Sylvester develop matrix theory (useful in quantum mechanics, economic forecasts, and analysis)</p>	<p>Felix Klein classifies links of math's very concept of groups; develops unified theory of geometry and transfinite numbers</p> <p>Georg Cantor outlines basic ideas of set theory and transfinite numbers</p> <p>Karl Weierstrass creates theory of complex functions</p> <p>Jules Henri Poincaré works on functions, non-Euclidean geometry, systematic development of combinatorial topology, probability theory</p> <p>David Hilbert poses 23 mathematical problems for twentieth century; develops "on axioms" thesis of mathematics</p>	<p>von Neumann pioneers theory of games and economic behavior</p> <p>Norbert Wiener develops control and information theory (cybernetics, automation)</p> <p>Paul Cohen shows that Cantor's continuum hypothesis cannot be disproven</p> <p>Kenneth Appel & Wolfgang Paker use computer to prove Four Color Theorem</p> <p>Classification of finite simple groups completed</p>
<p>Modern Period (Early) 1450 A.D. logarithms, modern number theory; analytic geometry; calculus; the exploitation of the calculus</p> <p>Age of French enlightenment is ushered in by thinkers such as Diderot, Montesquieu, Rousseau, and Voltaire</p> <p>First suspension bridge is completed</p> <p>James Watt creates steam engine</p>	<p>Nikolai Bonaparte attempts dominion of Europe</p> <p>André Ampère works with electrodynamics</p> <p>Grigory Ohm describes principles of electric resistance</p> <p>Joseph Jackson improves mechanical looms, allowing mass production of fabric</p> <p>Michael Faraday discovers electromagnetic induction</p> <p>Charles Babbage develops analytic engine (first model of computers)</p> <p>First telegraph is used</p> <p>Gregor Mendel's experiments lead to formulation of genetics</p> <p>James C Maxwell develops fundamental equations of electromagnetic theory</p> <p>Alexander Graham Bell invents telephonic</p> <p>Sigmund Freud pioneers in psychoanalysis</p> <p>Paul and Marie Curie discover radium</p>	<p>Modern Period (later) 1800 A.D. to Present non-Euclidean geometry and emergence of algebraic structure; arithmetization of analysis; set theory</p> <p>Max Planck develops quantum theory</p> <p>First powered airplane occurs</p> <p>World War I is fought</p> <p>Albert Einstein creates theory of relativity</p> <p>Russian Revolution takes place</p> <p>Weimar Heisenberg introduces matrix algebra into quantum mechanics</p> <p>Charles Lindbergh flies solo across Atlantic</p> <p>Sir Alexander Fleming discovers penicillin</p> <p>Claude Shannon uses logic with electric circuits</p> <p>World War II is fought</p>	<p>First electromagnetic computer (Mark II) introduced</p> <p>Atomic bombs dropped</p> <p>J Prosser Eckert and John Mauchly develop first electronic digital computer (ENIAC)</p> <p>John von Neumann creates EDVAC; writes paper that changes course of computer technology</p> <p>Soviet Sputnik begins space age</p> <p>First successful human heart-lung skirt</p> <p>Human beings land on moon</p> <p>Microprocessor chip is invented</p> <p>Researchers confront gene</p> <p>Viking mission lands on Mars</p> <p>Microcomputers become widely available for in-home use</p> <p>Space shuttle mission begins</p> <p>Voyager II sends back pictures from Saturn</p>

Cultural and Historical Events

1700 AD 1800 AD 1900 AD PRESENT

Miller, C. D. & Hester, V.E. 986 Mathematics Today, 5th Edition

Overview

0.5 Summary

We examined the integrated subject approach (in the "Guide") and, in contrast, the role of a table of contents. You should now have a better understanding of what the course involves and what we are aiming at as far as an approach to teaching is concerned.

In the following chapters we are going to deal with the factors that hinder teaching (chapter 1), structuring one's own contents in a curriculum for mathematics (chapter 2), determining mathematical content and the level of teaching by formulating objectives (chapter 3) and planning one's lessons so that students can master the content (chapter 4).

In Tutorial Letter 103 we shall look at the later chapters.

Chapter 1

The Mathematical learning environment and the Student: the Teaching of Mathematics as a Collection of Functions

In this chapter we shall take a look at the complex environment facing the mathematics teacher:

- *the complexity of mathematics teaching, determined by the design and*
- *control of teaching*
- *the resulting perceptions of the student about mathematics*
- *mathematics as a creative way of solving problems*
- *the content of mathematics as a set of discoveries and inventions by people*

1.1 Overview

In this very important chapter Cangelosi points out the complex character of the total mathematics teaching design and tries to make us aware of its different functions or aspects - such as students (their individual qualities and perceptions), lecturers' teaching and the factors that will affect the type and level of learning - as well as the interrelationships of these aspects.

It is important to get an overview of each of the chapters in the prescribed book of Cangelosi. You may use any method that will enable you to

- obtain a general view of the contents of the chapter
- gain an insight into the interrelationships of the different elements
- relate the overall objectives set by the author of the book to the contents. (The objectives, as you will see, are often not addressed directly in the contents.) One of the methods you could use is to draw a mind map to summarise the chapter (that is, the method we call **1S2S3S**).

Options

=====

Activity 1-1 Overview and exploration

*How could you use the **1S2S3S** method to explore this chapter? We shall explain the method. Read our explanation and then draw your own mind map on a loose page in order to get an overview of the contents of the chapter. You may later find it useful to put the nine loose summaries together and in this way form a general view of the contents of Cangelosi's book. **REMEMBER: After this chapter we shall no longer set out the six steps in detail; you will merely be asked to do S1S2S3 with regard to the relevant chapter.***

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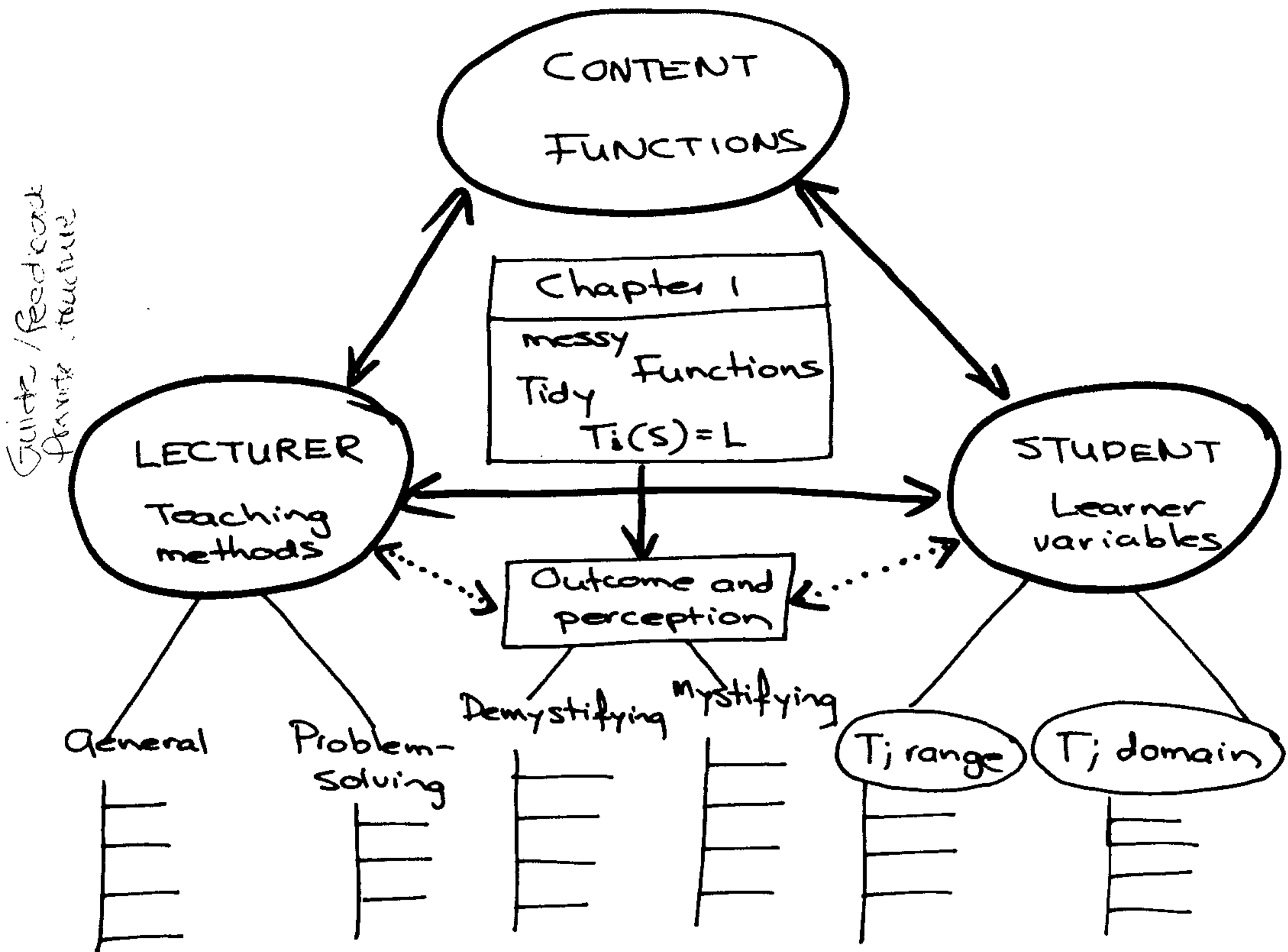
Subject action
Function

Options

THE 'READING-WITH-INSIGHT' METHOD

1. Page through, explore. **Read the chapter quickly (1S)**, forming a rough idea of the contents. Concentrate on headings and subheadings, bold and italic type, boxes, tables and illustrations, summaries and introductions. The objectives set for the chapter are important.
2. **Make a cursory survey**. Ask yourself this while you read: What key terms occur in this chapter? Stop when you identify a key term and read carefully what is said about it. Mark it in the book. What you are trying to ascertain is: "Where is it?"
3. **Scan the chapter (2S)**.
4. **Start a mind map** (for the whole or for parts of it, as in starting a summary.) You are looking for items and concepts while reading the information in the chapter in a more evaluative way. Reflect on interrelationships between concepts. The question now is: What is it? What is the meaning and the purpose? Visualisation is important and you are certainly going to start writing down key concepts. You can omit parts of the text.
5. **Deeper reflection**. Start building a structure in your mind map, work towards an entirety. As you work through the prescribed activities of the chapter, keep returning to the mind map to fill in the detail. Reflect on the value and meaning or categories, concepts, motivations, variables and key terms.
6. **Study-read (3S)**. This follows directly from stages 2, 4 and 5 and is done carefully, thoroughly and thoughtfully. The key terms and concepts you pinpointed have to be linked up, and in this the mind map and/or diagrammatic summaries are important. Pause while reading, consolidate what you remember and consider how new information fits in with what you already have.

This is what our half-drawn mind map of chapter 1 looks like:



Activity 1-2: The main elements of this chapter

We have indicated the main concepts in the half-drawn mind map above. Identify the subconcepts (which we have deliberately omitted) and complete the mind map.

The contents of this chapter centres on the following very important question which includes various aspects:

Which teaching factors (T) influence the student's (S) learning (L) in mathematics?

Could you identify the different aspects on your mind map in view of the following statement? All the aspects are interrelated in a special manner. You can see that from the arrows in the above diagram which relate the identified elements and concepts to each other.

This sounds like a very tidy situation but teaching is not always so complete and harmonious - many things can go wrong. Cangelosi explains the formula on p 2b under the heading "Teaching as a set of messy functions".

Activity 1-5: The teaching of mathematics: tidy or messy?

Consider the above statement and explain it in your own words (see pp 5a and 5b).

1. What is meant by a "set of messy functions"?
2. When is a function tidy (according to Cangelosi)? Consult pp 2 and 5.
3. Why does Cangelosi call the teaching of mathematics a set of messy functions?
4. How could the messiness be reduced?

The following questions are designed to set you thinking about teaching and learning in general. Relate the questions, and your answers, to chapter 0 and what you have done so far in chapter 1. These two chapters will not furnish final answers, but things will become clearer as you go on. Remember, a school and a classroom are places of learning! What we are concerned with is maximal and optimal learning.

Activity 1-6: A successful lesson

Write brief notes on each of the following questions. Discuss your answers with a friend or colleague.

1. When is a lesson successful?
2. What makes it successful?
3. When is it a successful learning opportunity?
4. When has a pupil understood?
5. What does the question: What is mathematics? have to do with the success of a lesson?
6. What is the connection between the teaching method and the final result?

All the answers to these six questions should centre on the idea of LEARNING, MASTERING and UNDERSTANDING with INSIGHT, and EMPOWERMENT of the student with the SELF-CONFIDENCE to be willing to apply the knowledge and experience.

CHAPTER 1

(Study Unit)

THE MATHEMATICAL LEARNING ENVIRONMENT AND THE STUDENT: THE TEACHING OF MATHEMATICS AS A COLLECTION OF FUNCTIONS

In this chapter we shall take a look at the complex environment facing the mathematics teacher:

- the complexity of mathematics teaching, determined by the design and control of teaching
- the resulting perceptions of the student about mathematics
- mathematics as a creative way of solving problems
- the content of mathematics as a set of discoveries and inventions by people

1.1 OVERVIEW

In this very important chapter Cangelosi points out the complex character of the total mathematics teaching design and tries to make us aware of its different functions or aspects — such as students (their individual qualities and perceptions), lecturers' teaching and the factors that will affect the type and level of learning — as well as the interrelationships of these aspects.

* It is important to get an overview of each of the chapters in the prescribed book of Cangelosi. You may use any method that will enable you to

- obtain a general view of the contents of the chapter
 - gain an insight into the interrelationships of the different elements
 - relate the overall objectives set by the author of the book to the contents. (The objectives, as you will see, are often not addressed directly in the contents.)
- One of the methods you could use is to draw a mind map to summarise the chapter (that is, the method we call 1S2S3S).



Activity 1-1: Overview and exploration

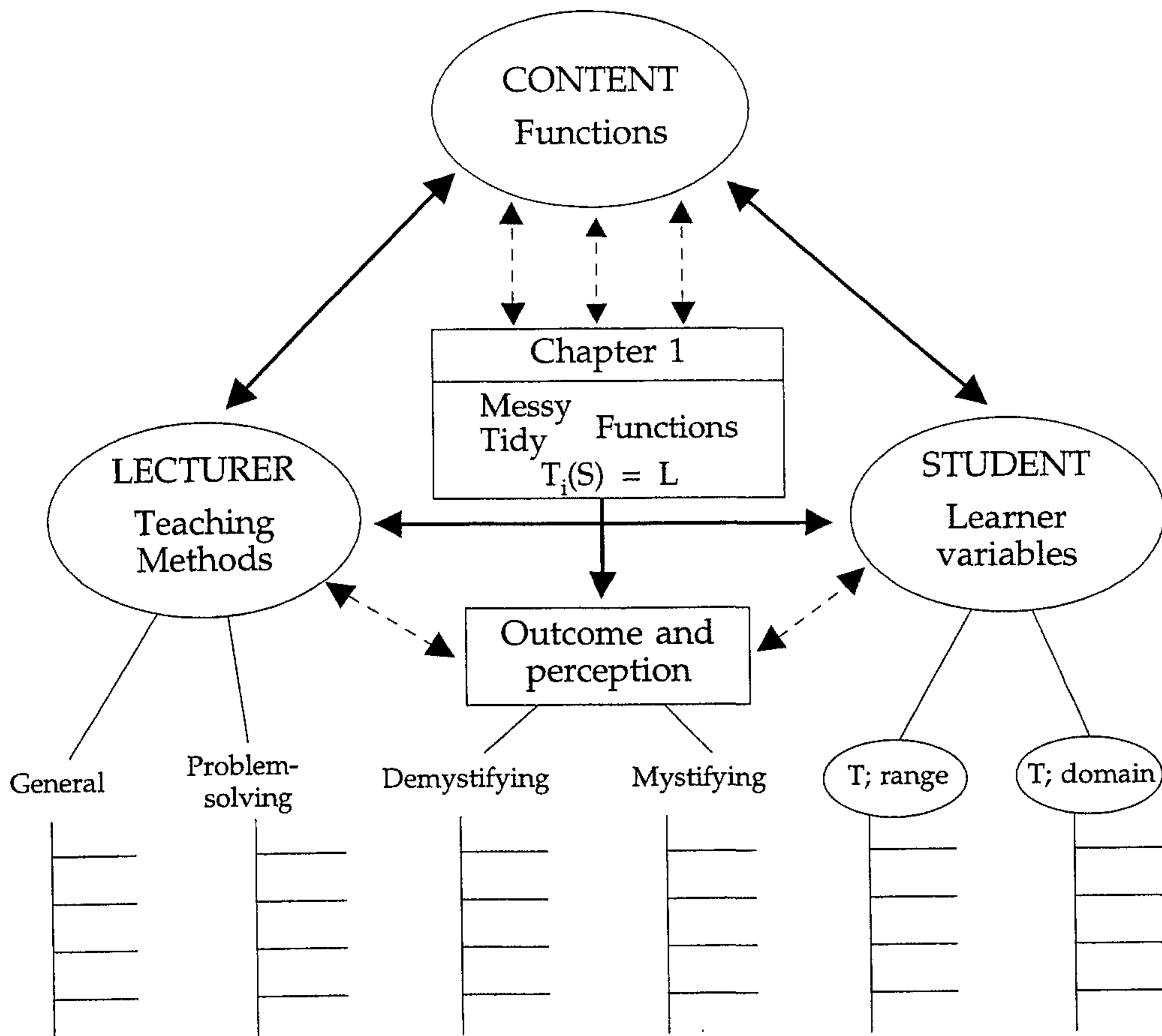
How could you use the 1S2S3S method to explore this chapter? We shall explain the method. Read our explanation and then draw your own mind map on a loose page in order to get an overview of the contents of the chapter. You may later find it useful to put the nine loose summaries together and in this way form a general view of the contents of Cangelosi's book. **REMEMBER:** After this chapter we shall no longer set out the six steps in detail; you will merely be asked to do S1S2S3 with regard to the relevant chapter.

Draw a mind map of chapter 1 which gives an overview of the contents of the chapter:

THE "READING-WITH-INSIGHT" METHOD

1. *Page through, explore. Read the chapter quickly (1S), forming a rough idea of the contents. Concentrate on headings and subheadings, bold and italic type, boxes, tables and illustrations, summaries and introductions. The objectives set for the chapter are important.*
2. *Make a cursory survey. Ask yourself this while you read: What key terms occur in this chapter? Stop when you identify a key term and read carefully what is said about it. Mark it in the book. What you are trying to ascertain is: "Where is it?"*
3. *Scan the chapter (2S).*
4. *Start a mind map (for the whole or for parts of it, as in starting a summary.) You are looking for items and concepts while reading the information in the chapter in a more evaluative way. Reflect on interrelationships between concepts. The question now is: What is it? What is the meaning and the purpose? Visualisation is important and you are certainly going to start writing down key concepts. You can omit parts of the text.*
5. *Deeper reflection. Start building a structure in your mind map, work towards an entirety. As you work through the prescribed activities of the chapter, keep returning to the mind map to fill in the detail. Reflect on the value and meaning or categories, concepts, motivations, variables and key terms.*
6. *Study-read (3S). This follows directly from stages 2, 4 and 5 and is done carefully, thoroughly and thoughtfully. The key terms and concepts you pinpointed have to be linked up, and in this the mind map and/or diagrammatic summaries are important. Pause while reading, consolidate what you remember and consider how new information fits in with what you already have.*

This is what our half-drawn mind map of chapter 1 looks like:



Activity 1-2: The main elements of this chapter

We have indicated the main concepts in the half-drawn mind map above. Identify the subconcepts (which we have deliberately omitted) and complete the mind map.

The contents of this chapter centres on the following very important question which includes various aspects:

Which teaching factors (T_i) influence the student's (S) learning (L) in mathematics?

Could you identify the different aspects on your mind map in view of the following statement? All the aspects are interrelated in a special manner. You can see that from the arrows in the above diagram which relate the identified elements and concepts to each other.

1.2 WHAT DOES THE TEACHING OF MATHEMATICS COMPRISE?

Anyone who has tried to teach will agree that it is a pleasant but comprehensive task. To teach mathematics successfully is certainly not easy — indeed, it is complicated and, as Cangelosi says, “a set of messy functions”.

Cangelosi does not take a particularly dogmatic line, and one has to read carefully to fit his input into our “traditional didactic framework”. He writes in a highly integrated way, but it is not hard to identify the didactic triangle of teacher, tutorial matter and learner, not even when the teaching role is taken over by a fellow pupil. Cangelosi furthermore fits it all neatly into the whole teaching-learning situation in the mathematics classroom, discussing all the main variables step by step. It is all handled in the context of the problem-solving approach with a view to promoting independent thinking in the maths classroom.

An example: Cangelosi gives an authentic mathematical analysis of the teaching situation in terms of dependent and independent variables and of area and domain while doing his best to place students and their learning experience at centre stage. At least 13 pages are devoted to this.



Activity 1–3: What does the teaching of mathematics comprise?

- 1. Write a definition of the teaching of mathematics without consulting your prescribed book.*
- 2. Now answer the following questions: On what does the teaching of mathematics depend? What does it include?*

Cangelosi (see p 2b) suggests a certain relationship between teaching, the student and learning by means of an equation, namely $T_i(S) = L$. It is not evident at first glance what each of the symbols stands for, but it is important to understand the mathematical relationships between the variables and the meaning of the teaching.



Activity 1–4: The teaching of mathematics as the formula $T_i(S) = L$

- 1. How would you describe this formula in words?*
- 2. Use the formula to make a graphic representation of it on an X and a Y axis.*
- 3. Supply appropriate annotations to the graph.*

This sounds like a very tidy situation but teaching is not always so complete and harmonious — many things can go wrong. Cangelosi explains the formula on page 2b under the heading “Teaching as a set of messy functions”.



Activity 1–5: The teaching of mathematics: tidy or messy?

Consider the above statement and explain it in your own words (see pp 1 to 5).

1. What is meant by a “set of messy functions”?
2. When is a function tidy (according to Cangelosi)? Consult pages 2 and 5.
3. Why does Cangelosi call the teaching of mathematics a set of messy functions?
4. How could the messiness be reduced?

The following questions are designed to set you thinking about teaching and learning in general. Relate the questions, and your answers, to chapter 0 the Orientating Foreword and what you have done so far in chapter 1. These two chapters will not furnish final answers, but things will become clearer as you go on. Remember, a school and a classroom are places of learning! What we are concerned with is maximal and optimal learning.



Activity 1–6: A successful lesson

Write brief notes on each of the following questions. Discuss your answers with a friend or colleague.

1. When is a lesson successful?
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5. What does the question: What is mathematics? have to do with the success of a lesson?
6. What is the connection between the teaching method and the final result?



All the answers to these six questions should centre on the idea of LEARNING, MASTERING and UNDERSTANDING with INSIGHT, and EMPOWERMENT of the student with the SELF-CONFIDENCE to be willing to apply the knowledge and experience.

1.3 THE INFLUENCE AND POWER OF PERCEPTIONS

There is greater general awareness nowadays, and greater sensitivity also, with regard to the question: What is mathematics? Perceptions have always been important, but their importance is more and more clearly perceived. We also have to find answers to a number of tricky questions and phenomena.

Chapter 1 deals with the whole idea of *what mathematics is*. The scope and complexity of the teaching of mathematics is explained. Cangelosi defines the teaching of mathematics in terms of a whole sequence of dependent and independent functions, most of them centred on the learner. This also shows

you how Cangelosi uses vignettes (conversations between pupils, or between pupils and teacher, transcribed word for word from tape recordings) to correlate the practice of the teaching world with the theoretical assumptions.

1.4 STUDENTS AS INDEPENDENT AND DEPENDENT VARIABLES

The teaching of mathematics comprises a number of functions of which the student is certainly an important one. Cangelosi gives us an interesting analysis of these two variables.



Activity 1-7: Students as independent variables

List those properties of your students that identify them as unique persons.

Differences between students, their interest in mathematics and their perceptions of mathematics are the first three factors in a long list. The fact that they are the first three, should not be overlooked. The other factors are actually secondary. Compare your list with that of Cangelosi in pages 5 to 11. On page 11 we find cultural background and ethnicity which we will have to deal with in South Africa specifically, because of the growing number of multicultural classrooms and the parallel-medium schools where teachers, furthermore, have to teach in their second language and the children also have to learn in their second language.



Activity 1-8: Student learning as a dependent factor

Write a short paragraph about student learning as a dependent variable in the teaching of mathematics.

Compare your answer with that of Cangelosi (on pp 11-14a). With regard to students as dependent variables he concentrates on student learning and highlights two facets: the achievement of set curriculum objectives, and incidental outcomes (side effects) that are often unforeseen.

1.5 DISCOVERIES AND INVENTIONS

The fact of mathematical discoveries and inventions is crucial to the question: *What is mathematics?* It undoubtedly plays a part in the mystification of mathematics, and clarity requires us to distinguish between discoveries and inventions.



Activity 1–9: Distinguishing between human discoveries and inventions. Read pages 13–18

1. Draw up a table with two columns, one for inventions and one for discoveries. Try to enter at least 10 of each in the relevant columns.
2. What is the connection between inventions/discoveries and teaching methods? Write short notes.
3. Answer this question also: What is the connection between mathematical discoveries and inventions and the mystification of mathematics?

Consult Cangelosi, who indicates a clear connection between inventions, discoveries and teaching methods.



Activity 1–10: A good lesson? By what functions is it determined?

1. Read vignette 1.1 on pages 2b to 3a. Ask yourself: Is it a good lesson? Why do you think so? Write it all down.
2. Read vignette case 1.2 on page 3. What about this one? Is it a better lesson? Why do you say so?
3. When exercising a choice, what determines your preference?
4. Take a look at the summative comment on each lesson (pp 3 and 5). Enter on your mind map the factors that played a part in improving each lesson.
5. What other factors might have played a part?

Various factors can play a part in making a lesson effective. Compare your answers here to those given in activity 1–6.



Activity 1–11: The complexity of mathematical instruction

1. Have you noticed how many different facets of the teaching of mathematics have emerged? Share your perceptions of the scope of mathematical instruction with a friend, colleague or fellow student.
2. Does the same apply to other school subjects? Talk to colleagues or fellow students in other disciplines and share your perceptions. What real differences are there between your experiences and theirs?

I suspect that the teaching of mathematics is larger in scope and complexity than that of other subjects. Do your conversations confirm this?



Activity 1–12: Observation of side-effects on students in a classroom

Read self-assessment exercise 1 on page 18b. Visit a classroom, as suggested by Cangelosi. Take notes of what happened during the classroom situation.

You can share these notes at the group discussion class in July.

Note: This question can be reconsidered later, when we discuss the design of a lesson plan.

Side-effects also have a wider meaning when it comes to psychological noise (see p 83 et seq).



Activity 1–13: Turning mathematical knowledge into practice

Read self-assessment exercise 2 on pages 21b and 22a. Now try to do the same thing with any other formula, for instance:

- Area of a symmetrical figure (rectangle) = $l.b$,
or
- Computation of the final amount, F , as the capital, C , invested for n years at a simple interest rate of r percent. Consider the situation when, say, r is fixed but n can change for a given amount.

If you were unable to analyse these two problems successfully, go back to the two examples on pages 18b and 19a and work through them systematically.

Example

Here is an example where r can vary and t is fixed:

- Mr Viljoen makes an investment in the PPP Bank of R20 000. The bank offers him an interest rate of R10 for every R100 per annum. How much money will Mr Viljoen receive from the bank at the end of the first year for the use of his money?
- Mrs Nkabinde wants to borrow R20 000 from the PPP Bank to add two bedrooms to her house. She applies for a loan and the bank charges her R15 interest per annum for every R100. How much must she pay the bank at the end of the first year for the use of their money?
- Where does the bank get the money to allocate the loan to Mrs Nkabinde?
- What is the bank doing with the extra money?
- Explain the meaning of “interest” and then explain why interest is an invention and not a discovery — to use the terminology of Cangelosi.

Discuss in your study group what is the connection between mathematics and this story problem. Does it have any significance for the perception of what mathematics is, and for the question: What is the origin of money?



Activity 1–14: Interview an adolescent student

1. Read self-assessment exercise 3 on page 1922. Ask yourself: What have I learnt from this interview?
2. How might your own situation, with your own students and their personalities, be influenced by what you have written down above?

Note: In answering the question, note down any questions of your own or points that you want clarified, so that you can share them with us, either in a letter or as part of our course evaluation.



Activity 1–15: What does the teaching of mathematics comprise?
Define the teaching of mathematics in considerable detail.

Compare this definition with the one you gave at the beginning of the chapter, in activity 1–3. Does it differ a lot?



Activity 1–16: Perceptions of mathematics (school mathematics)
On pages 22 and 23 under transitional activities there is an exceptional piece on perceptions of mathematics, and school mathematics in particular. Do number 4 carefully.
At the end of number 4 it is stated that the NCTM submitted a rational plan in 1989 to improve school mathematics and then to move over to a reality-based approach in schools.

Consult page 21 in Cangelosi to see why it is necessary for teachers to monitor themselves continuously with regard to their motives and the way they teach.



Activity 1–17: Monitor your own motives
Why is it important for teachers to monitor themselves continually in respect of their own motives for using a particular teaching method?

1.6 IN CONCLUSION: HOW SHOULD I TEACH?

How teaching functions are designed and conducted depends on

- the student outcomes you want to produce and
- a complex of student variables
- the content and how it is presented
- the environment in which you find yourself

Note that the way you ought to teach is not necessarily the way you actually teach or the way most teachers teach today.

CHAPTER 2

DEVELOPING MATHEMATICS CURRICULA

In this chapter we shall look at:

- the mathematics curriculum
- the contents of mathematics curricula
- the teacher and the curriculum

2.1 OVERVIEW

In this chapter Cangelosi explains what a curriculum for mathematics should be and how and why it should be compiled to cater for different situations. Other important aspects discussed in this chapter are the part played by the mathematics teacher in determining the curriculum and the resulting evaluation of the standard of the curriculum.



Activity 2-1: Overview and exploration

*Read the chapter. (You can do 1S2S3S with regard to this chapter.)
Summarise the chapter for yourself.*

Can you see how we are moving from the macro scenario to the micro sections in the teaching process?



Activity 2-2: Main elements of this chapter

1. *Could you identify this in your mind map?*
2. *Compare your exposition and summary with the half-finished mind map below.*

The content of this chapter centres on FIVE crucial questions (guidelines) are interrelated in a very particular way:

- Why should I curricula and why should one learn mathematics?
- What types of courses are there?
- What types of curricula are there?
- What does curricula comprise?
- How do I set standards?

10.2 Werkopdragte vir 1998



Werkopdrag 01:

Sluitingsdatum: 15 April 1998



Werkopdrag 01/98 handel in werklikheid oor die eerste vier hoofstukke van die handboek en Studiegids en bestaan uit Deel A en Deel B hieronder



Let op dat Werkopdrag 02 voortspruit uit Werkopdrag 01/98.



U word dus versoek om 'n eie kopie te hou van Werkopdrag 01 om weer in Werkopdrag 02 te gebruik.

Voordat u hierdie werkopdrag aanpak, maak seker dat u deeglik deur hoofstukke 3 en 4 gewerk het. Die werkopdrag moet in opvolging daarvan gedoen word. Dit is 'n uitbreiding van teorie en aktiwiteite in die sin dat u nou u eie vakinhoud en gepaardgaande doelwitte moet kies.

DEEL A

1. In hierdie werkopdrag moet u 'n dubbelbladsy klassifikasie van vyf objekte en hul doelwitte opstel, en dan die voortspruitende vyf lesse uitwerk. U sal goeie voorbeelde kry op p.34 (Cangelosi) asook uit die PowerMatric Maths reeks. Dit moet op die ou end u EIE produk wees.
2. Kies dus vyf dele uit die Gr 10-12 -afdeling van die **wiskunde-inhoud** (dus vyf temas) van die sillabus of handboek. Probeer u eie voorbeelde kies maar gebruik die uiteensettings op pp 74 e.v. as voorbeelde.
3. U moet die afdelings **Algebra, Trigonometrie, Meetkunde, Analitiese Meetkunde en Calculus** dek.
4. Formuleer 'n leerdoel vir elke tema

5. Definieer dit met 'n aantal doelwitte (ten minste vyf) wat presies verklaar wat die studente moet leer, en nog moet byleer.
6. Spesifiseer die inhoud duideliker (Omskryf die inhoud verder) met behulp van 'n objek (doelwit) of meer as een objek. Hierdie koppel u nou aan punt 1.
7. Verklaar duidelik waarom u dit so klassifiseer.
8. Spesifiseer dit verder deur daaraan 'n leervlakdoelwit of meer as een toe te ken. Vergelyk nou u werk met figuur 3.10 op pp 77-78.

U het dus vyfkeer deur die proses van klassifisering gewerk. U het hopenlik ook so die vyf soorte inhoude aan die hand van die vyf verskillende objekte geïdentifiseer. Probeer in hierdie proses soveel moontlik verskillende leervlakke dek. 'n Uitgebreide tabel op 'n dubbel bladsy word aanbeveel. Kondenseer dit sover as moontlik.

9. Vergelyk hierdie opdrag met die vier inleidende doelwitte vir hoofstuk 3 op p 49, sowel as met die breinkaart van hierdie hoofstuk wat u aan die begin opgestel het. Dis net om seker te maak dat u nog steeds in ooreenstemming met die benadering van die hoofstuk is.
10. Onthou dat u met die probleemoplossingsbenadering werk. U doelwitte se formuleringe moet rekenskap gee van die wiskunde se praktiese verwantskappe met die werklikheid. U kan in hierdie opsig vrylik gebruik maak van die idees in die PowerMatric Maths reeks.

DEEL B

Doen nou die vyf lesse:

1. Orden die gespesifiseerde doelwitte op so 'n wyse dat hulle as 'n eenheid onderrig kan word (nou werk u net met een van die temas uit Deel A).
2. Ontwerp en beskryf nou 'n les vir elke objek met sy vyf doelwitte. Die ontwerp van elke les moet gerig word deur die beginsels vir leeraktiwiteite wat uitloop op die doelwit se leervlak. U moet dus vyf lesse ontwikkel wat elk 'n volledige eenheid binne die tema vorm.
3. Sit u eie evaluering van hierdie werkopdrag as eindproduk in 'n kort paragraaf uiteen. Dink u/verwag u/weet u dat dit gaan werk in die klaskamer?

Selfevalueringsleidrade vir Werkopdrag 01/1998

DEEL A

Die belangrikste riglyn wat hier geld, is dat u die doelwitte van die lesreeks so moet orden dat leerlinge hulle optimaal en effektief kan bemeester. Dis 'n baie belangrike beginsel wat vir enige onderrigsituasie geld. Ons dink deesdae in terme van uitkomst en daarom is hierdie 'n baie belangrike saak. Die volgende riglyn sluit direk hierby aan.

Die tweede belangrike riglyn is dat leeraktiwiteite geskik moet wees vir sowel die aard van die inhoud as die leervlak van elke doelwit.

Hierdie twee riglyne verteenwoordig die belangrikste beginsels wat 'n onderwyser verontagsaam wanneer hy/sy nie toegewyd is nie en wanneer sy/haar vak- en didaktiese kennis nie op peil is en die standaard van sy/haar onderrig dan onder die normale is. Dan ly die hele onderrigsituasie daaronder en die leerlinge/studente kan nie eens dit wat aangebied word, behoorlik benut nie. Hierdie is een van die redes waarom wiskundeonderwys in Suid-Afrika nie op standaard is nie. Wanneer u dus hard hieraan werk en baie tyd hieraan bestee, moet u verseker wees dat u die moontlikhede van 'n swak les, of 'n mislukte leersituasie, minstens tienvoudig verminder. U verseker hiermee eintlik dat 'n goeie les op hoë vlak met sterk leeruitkomst afgelewer gaan word. Dit bou u eie selfvertroue en ook dié van die leerders. Ek sou dit as bemagtiging ("empowering") van uself en van die kinders beskryf.

Leidrade:

1. Maak seker dat elke *objek* korrek deur die *gespesifiseerde doelwit* beskryf is.
2. Let daarop dat elke *leervlak* reg beskryf moet wees deur die gespesifiseerde doelwit.
3. Die klassifikasie moet sodanig *gemotiveer* wees dat die gespesifiseerde doelwit duidelik gedefinieer word.
4. Werk probleemoplossend en realiteitsgerig.

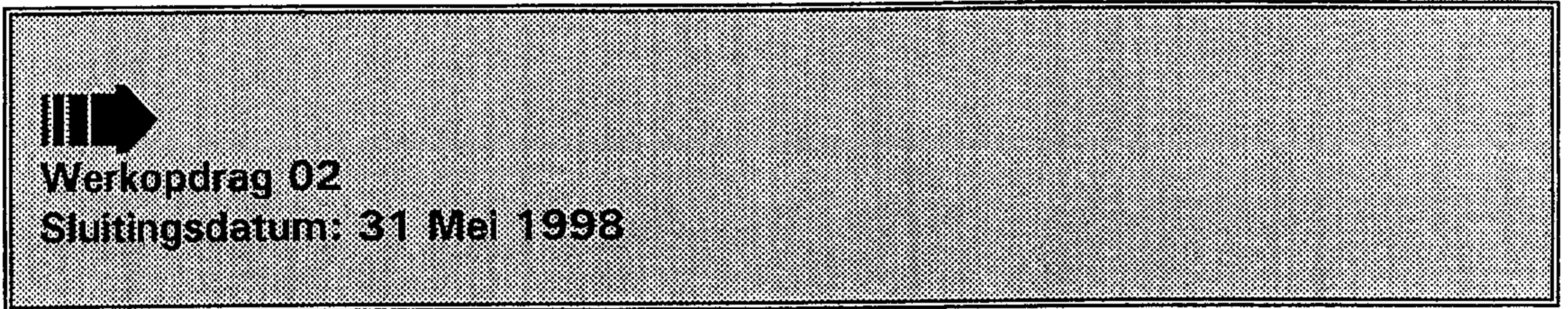
DEEL B

Wat deel B betref is die volgende leidrade van belang:

1. Nadat u deel A afgehandel het, moet u nou vir elkeen van hierdie vyf objekte (en vyf leerdoelstellinge met hul gespesifiseerde doelwitte) die doelwitte in 'n bepaalde volgorde rangskik sodat hulle in 'n groter eenheid ('n les) aangebied kan word.
2. Ontwikkel vir elke doelwit die nodige beginsels vir leeraktiwiteite sodat die leervlak van die doelwit sinvol bereik kan word.
3. U moet dus 'n les vir elk van die vyf objekte uitwerk en die beginsels vir die leeraktiwiteite moet in 'n spesifieke leervlakdoelwit uitgedruk word.

Let wel

Werkopdrag 02/98 sal alles hiervandaan verder neem tot ná die evaluering en verwerking van leerlinge se toetspunte. Dit bou bloot op die inhoud van Werkopdrag 01.



- (a) Stel 'n eenheidstoets op wat op een van die lesse se temas afgestem is. Hierdie toets sal dalk wyer werk dek as wat u in die les gedek het. Die toets moet 'n behoorlike toets wees wat genoeg werk dek, d.w.s. twee of drie weke se werk. Die gedagte is dat u al u insette in Werkopdrag 01 by 'n bepaalde tema hier en nog meer moet benut.
- (b) Gebruik 'n verskeidenheid van wyses om 'n klas se kennis oor hierdie tema te toets. Dink hier aan 'n pen-en-papierstoets, sowel as 'n projek, vrae, besprekinge, groepwerk, skryfwerk oor wiskunde (sien p.322, 324), en dalk 'n portefeulje. Beskryf dit wat u gebruik volledig. U vind riglyne hiervoor in Cangelosi (hoofstuk 10) sowel as Clarke (p71) se boeke. 'n Gewone klassikale toets met al die verskeidenheid van vraagtipes daarin opgeneem tel sowat 70, terwyl die ander komponente saam sowat 30 kan tel.
- (c) Beplan die toets aan die hand van Fig 10.11 op p 328-9, en die gewigsverspreiding van Fig 10.10 op p 327.
- (d) Verduidelik volledig hoe u die moeilikheidsgraad van die teks sal beheer. Hoofstuk 10 van Cangelosi gee goeie idees hieroor.

LEIDRADE

1. Werk deur hoofstuk 10 van Cangelosi se boek.
2. Analiseer en verreken die sinvolheid van elke doelwit en die gestelde leerdoel deeglik (dis nou die koppeling met Werkopdrag 01).
3. Gaan nou deur die onderskeie stappe (soos in die voorbeeld in die boek) en stel 'n standaardtoets op wat aan al die nodige vereistes voldoen. Laat die toets 70 punte tel. Die proses van standaardisasie van 'n toets moet gevolg word.
4. Stel ook 'n gedetailleerde memorandum op wat by die toets pas en wat al die momente van die raamwerk in 1, 2 en 3 hierbo reflekteer. Die memorandum moet die toekenning van elke punt aantoon. Moenie halfpunte gebruik nie.

5. Verklaar ook duidelik wat u met die uitslae van die toets gaan doen en hoe u dit verder gaan gebruik. Raadpleeg p 331a e.v. daarvoor in Cangelosi, asook Afdeling 3 in Clarke.
6. Verduidelik ook watter invloed die proses van formatiewe evaluering deur middel van die uitslae op u eie onderrigeffektiwiteit sal hê (dit koppel met punt 5!).
7. Onthou om probleem-oplossend en realiteitsgerig te werk.



Werkopdrag 03

Sluifingsdatum: 15 Julie 1998

Hierdie werkopdrag bestaan daaruit dat u 'n portefeulje (vergeelyk Studiebriëf 103/98) moet saamstel, voltooi en dan instuur vir evaluering. Die portefeulje bestaan uit 'n dun boogknipleër met gekleurde kartonblaaie wat die onderskeie hoofstukke se aktiwiteite apart van mekaar moet hou. Dis met ander woorde 'n weergawe van hoe u deur die jaar die boek van Cangelosi deurgewerk het.

Dis belangrik dat u moet weet dat hierdie portefeulje 'n weergawe van u toewyding en motivering in die onderwys en studie is. Hoe beter u u portefeulje afhandel, hoe 'n beter onderwyser gaan u wees, want dan het u uself intens bewus gemaak van al die belangrikste probleme in die veld van wiskundeonderwys.

Die portefeulje:

- 1) Bestudeer Studiebriëf 103/98 ten opsigte van die hantering en afhandeling van die portefeulje.
- 2) Doen 70% van die aktiwiteite en stuur dit geliasseerd in. Daarvoor het u net die boek van Cangelosi, die wiskundevakkurrikulum vir die sekondêre skool (Studiebriëf 102/98) en die stel boeke van PowerMatric Maths nodig. U is welkom om ander bronne by te werk. U sluit ook u werkopdragte 01 en 02 daarby in.
- 3) Nommer u antwoorde baie deeglik volgens die aktiwiteite met hul onderafdelings.



Werkopdrag 04

Sluitingsdatum: 15 Augustus 1998

- 4(a) Onderskei tussen 'n formele en informele benadering tot die onderrig en leer van Trigonometrie en Euklidiese Meetkunde. Gee voorbeelde (2-4 bladsye). Vgl die benadering in die reeks van PowerMatric Maths. U kan heelwat voordeel hieruit trek.
- 4(b) Bestudeer die toepaslike hoofstukke uit Breen et al (die aanbevole boek in die Studiebrieff 101/98) en bied 'n les in elkeen van die afdelings van meetkunde en trigonometrie aan op 'n informele basis. Plaas besondere klem op die seleksie van inhoud en die skep van leerervaringe en beplanning van leeraktiwiteite. Gebruik die skemas vir lesontwerp in Cangelosi se boek (6-8 bladsye vir elkeen). U kan maar Breen se boek ook koop, dis 'n goeie aankoop.
- 4(c) Verduidelik hoe u die beginsel van kontinue evaluering in die onderrig van hierdie twee afdelings tot sy reg sal laat kom. Hier kan u ook van Breen et al se boek gebruik maak, maar veral van die voorgeskrewe boek van Cangelosi (2 bladsye).
- LW:** Die informele benadering beteken nie 'n swakker of makliker eindproduk nie. Die eindproduk bly dieselfde maar die weg waarlangs leerders geneem word om hierdie resultaat te bereik, lyk heel anders. Dit het duidelike implikasies vir die onderrig en leer van daardie afdeling en op die ou end vir wiskunde.

BRONNELYS

Voorgeskrewe boeke



Cangelosi, James S. 1996. *Teaching Mathematics in Secondary and Middle School: An Interactive Approach*. Merrill. An imprint of Prentice Hall. New Jersey.

(Agter op p. 451 in die indeks in Cangelosi se boek is daar verwysings na "geometry" wat u maklik kan opvolg. Dieselfde geld vir "trigonometry" op p 455. U kan met vrug die boek van Serra, M in die aanbevole lys gebruik Dis 'n skitterende boek - veral vir Meetkunde, daar is egter genoeg Trigonometrie in om u te help. Diè van u wat reeds Serra vir die Meetkundemodule aangekoop het in die VDO Wiskundeonderwyskursus, is eintlik hier bevoorreg. Ander studente kan my nader wat ook in hierdie boek belangstel. Ons het kopieë wat R240 goedkoper is as die winkels s'n).



Venter, P en Dreyer, H 1997. *PowerMatric Maths: Learner Growth Guide for Senior Certificate Mathematics*. Africa Growth Network.

LEVEL 4

The portfolio contains sections demonstrating that

- * problem situations or statements have been accurately interpreted more or less throughout
- * the given data have been properly used
- * appropriate strategies and approaches have been used that are logically compatible with the stated problems
- * there are few errors or none in the mathematical procedures
- * it is apparent that answers were reconsidered and evaluated

The LEVEL 4 portfolio displays at least ONE of the following attributes:

- (a) evidence of creative or insightful, but atypical, approaches to problems
- (b) the use of technology either in presenting or in solving the problem
- (c) decisive handling of complexity, vagueness and ambiguity in mathematical (teaching) problems

LEVEL 3

The portfolio contains sections demonstrating that

- * problem situations or statements have been accurately interpreted more or less throughout
- * the given data have been properly used
- * most of the strategies and approaches used are logically compatible with the stated problems

LEVEL 2

The portfolio contains sections demonstrating that

- * problem situations or statements have not been accurately interpreted throughout
- * there has been a frequent erroneous use of the given data
- * the strategies and approaches used are not always logically compatible with the stated problems
- * basic mathematical and procedural errors have frequently been made
- * answers have not been considered and evaluated in the context of the relevant problems

LEVEL 1

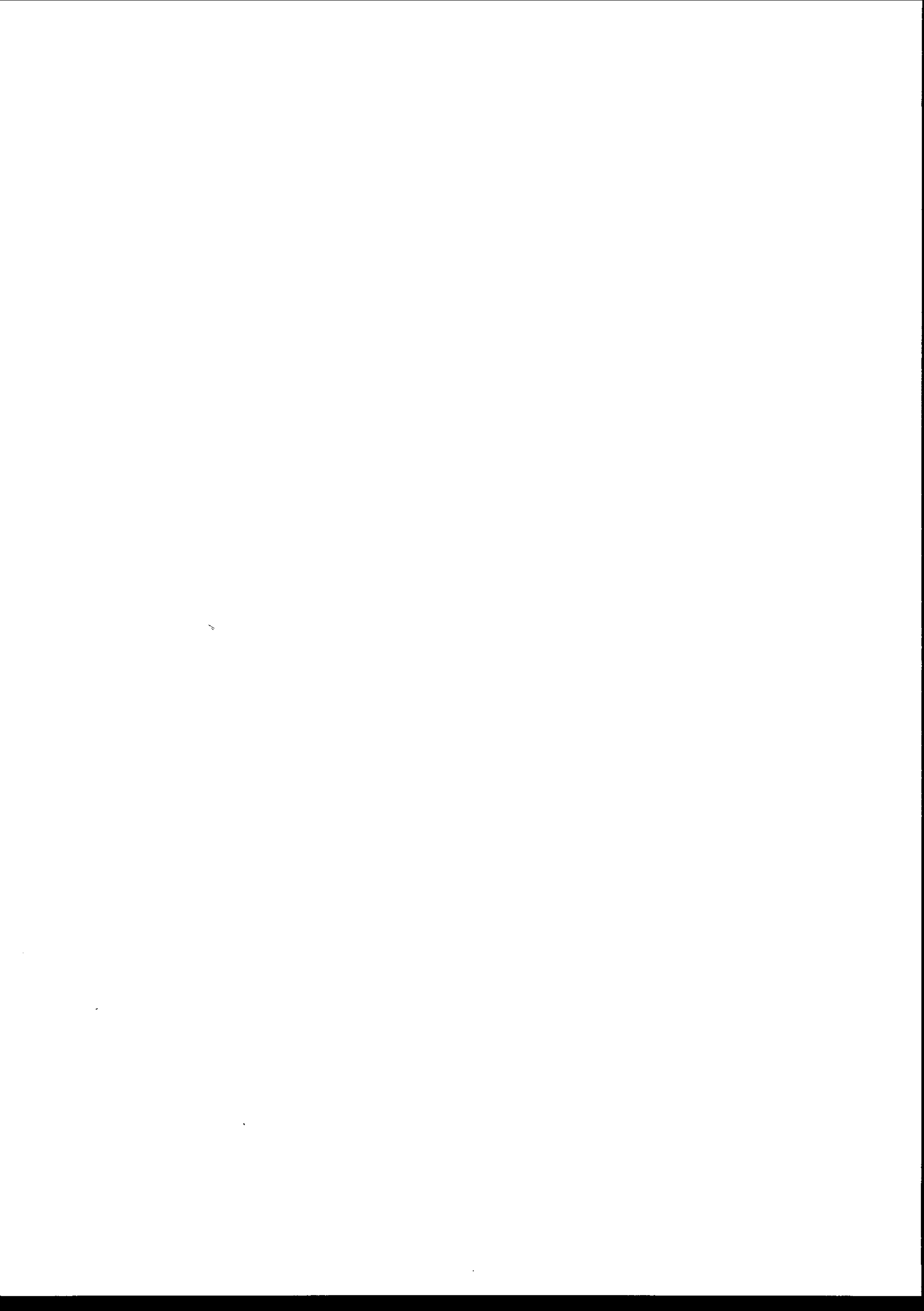
The portfolio contains sections demonstrating that

- * problem situations or statements have been inaccurately interpreted
- * very few of the strategies and approaches used are logically compatible with the stated problems
- * basic mathematical and procedural errors have frequently been made
- * answers have not been considered and evaluated in the context of the relevant problems

LEVEL 0

The portfolio is incomplete or does not contain work that meets any of the above requirements.

Figure 2: The focused holistic rubric (Kuhs 1994: 334)



WELCOME

Dear Student

As you already know, the course package comprises the following:

- general information, including assignments (Tutorial Letter 101)
- this guide: general course introduction and guidance to Cangelosi's book
- the new Interim Mathematics Syllabus (Tutorial Letter 102)
- two prescribed books: Cangelosi 1996 (workbook) and Power Matric Series (1997)
- dealing with and criteria for the portfolio (Tutorial Letter 103)
- prescribed articles (see Tutorial Letter 101)
- recommended books and articles (Tutorial Letter 101)
- additional tutorial letters that will be sent out

We assume that you have already started working and are working regularly on your activities to enable you to do the assignments. The largest component of the work is the completion of Assignment 03 — your portfolio. This regular work is a natural and evolutionary process in which the emphasis in this kind of teaching is on the "process" in which you are involved when you learn.

I am aware that your studies at present are a **substantial task** for you. Therefore your portfolio need contain only 70 percent of the activities in the various chapters. That is the standard you have to meet. You yourself can determine the 70 percent content — see Tutorial Letter 103.

CONTACT

You are welcome to contact me at any time — please do not wait until there is no time left to do things properly.

STUDY METHODS AND STUDENT STUDY GROUPS

The book by Cangelosi is **pretty comprehensive**, as is the study guide. You are advised to form study groups to work together on the assignments and activities. The tutorial matter calls for in-depth study and discussion — which will be very much to your advantage.

EXAMINATION

The examination will be based on the content of the portfolio and before the examination you will receive a further, final demarcation. The themes in Cangelosi's book will emphasise important questions that may be set in the examination.

The **course package** will be evaluated in 1998 and you will be approached to participate. However, you are welcome to **send your impressions and comments to me**. They will be greatly appreciated. Specific suggestions for improving the course will be even more welcome — particularly on how we can change the American slant to a more strongly South African one.

USE OF ICONS

To assist you further in working through this study guide we have used a

(ix)

number of icons. One or more appear in the same boxes as the activities and they are a visual indication of what you need to do in that specific activity.

Here follows a list of these icons with brief descriptions of their meaning:



a writing activity, naturally linked with the preceding reading



an investigation, sometimes involving a case study



a reading activity requiring further study and re-reading



a group activity indicating a discussion that you must conduct with a fellow student or another mathematics teacher or colleague



an interview that you must conduct with a specific person, such as a mathematics pupil or a parent



a tape recording (sound) that you must make



a calculator activity

Enjoy your studies.

Prof DCJ Wessels

ORIENTATION OVERVIEW

COURSE DETAILS

Before starting on the first chapter of this study guide, we are first going to look at some details of the course: the subject curriculum; goals and objectives; the course package; stationery you will have to acquire; steps you should follow in order to achieve success; and the prescribed books.

SUBJECT CURRICULUM FOR THE COURSE

The subject curriculum for this course contains the following elements:

- The nature and essence of mathematics/the teaching of mathematics
- Goals and objectives for the teaching of mathematics
- Aspects of the school mathematics curriculum
- Strategic learning
- Teaching strategies
- Evaluation/assessment
- Classroom practice
- Problem solving
- How to teach and learn geometry
- Experimental work

The subject curriculum is dealt with in chapters in the prescribed book, but is handled in a totally integrated fashion. The experimental work is presented on a continuous basis as are classroom practice and strategic teaching and learning.

GOALS AND OBJECTIVES FOR THIS COURSE

This course has been designed to prepare you as a prospective/practising teacher for the effective teaching of mathematics to secondary pupils by starting to familiarise you with the problem-solving and problem-centred approaches to teaching, and by helping you to cultivate a positive attitude to the subject and to impart this attitude to your pupils.

Studying this course will give you an awareness of your new role as a facilitator of knowledge, and of the ways of obtaining it, in the mathematics classroom.

Changed tone.

You should be aware of how it will

- teach you what real-life mathematics consists of in context
- help you understand how your conception of mathematics affects everything you do with the children
- acquaint you with the ways in which children learn mathematics
- sensitise you to a problem-centred classroom climate that promotes meaningful learning
- introduce you to strategic teaching and learning — in other words, teaching and learning by means of strategies — in the total field of mathematics
- show you how the outcome-based teaching (OBT) approach in the RSA will influence mathematics teaching

It will

- enable you to develop goals and objectives for problem-centred and problem-solving learning
- teach you what mathematical curricula is
- enable you to develop various lesson plans
- teach you how to make balanced assessments
- introduce you to experimental work and the handling of case studies
- the goals and objectives of school mathematics syllabi in South Africa
- introduce you to the approach followed in the USA as well as that favoured in the Netherlands
- enable you to apply the OBT approach in your teaching in the RSA

STATIONERY YOU WILL NEED TO ACQUIRE FOR THIS COURSE

In order to be an active, participating student you will need the following writing materials:

- an A4 hardcover notebook for taking notes and also for carrying out some of the activities
- an A4 writing pad with two holes on the left-hand side
- a ring binder with coloured partition pages so that you can compile a portfolio
- a set of coloured marking pens
- a pencil, rubber and ruler

STEPS TO BE FOLLOWED IN ORDER TO ACHIEVE SUCCESS

To be a successful student, you should follow the steps that are set out below:

- Buy the prescribed book as soon as possible: it is a workbook and you will be examined on it in detail.
- Read it word for word, and study it with the help of the accompanying tutorial letters and study guide. This may also involve drawing up mind maps and making your own summaries of the objectives and contents of chapters. Restrict summaries to one page. Be conscientious about this: it is vital to keep closely in touch with this book if you are to master its contents.
- Build up your own portfolio (concerning the prescribed book) for use in exam preparation throughout the year. **This portfolio will also serve as Assignment 03/1997.**

- Form a study group with one or more fellow students, meet regularly and work through the proposed programme together.

You are very welcome to contact me as the lecturer responsible for this course whenever you and your group get into difficulties. A positive, encouraging attitude towards the course as a whole will keep you motivated to persevere in your studies.

THE PRESCRIBED AND RECOMMENDED BOOKS

Prescribed books

Two books have been prescribed for this course. The first is the mathematics content for Grades 11 and 12, while the second is the book you will be working through systematically.

Book 1: Venter, P & Dreyer, H. 1997. *PowerMatric Maths: Learner Growth Guide for Senior Certificate Mathematics*. Africa Growth Network. ^{new}

Book 2: Cangelosi, James S. 1996. *Teaching mathematics in secondary and middle school: an interactive approach*. New York: Merrill (Prentice Hall). ^{new edition}

This book is your *manual or workbook* which you will be working through systematically. It is an excellent book. No such book is available in South Africa at present, so buy it at once.

ADVANTAGES OF THE BOOK

This book meets current needs (of the country, people, curriculum) and meets requirements at all levels when it comes to standard. It is written in a very user-friendly style, uses an interactive approach and can therefore be used as a workbook.

The book is based on the problem-solving approach which presents the teaching of mathematics in context. Mathematics teaching follows an integrated approach which stresses mathematical thinking.

The reader is actively involved and the book contains a large number of self-assessment exercises which thoroughly and continually expose the student to classroom realities.

The book does not follow the American Standards slavishly, but offers enough examples of meaningful learning opportunities to all readers and students. Therefore, by using this book we try to help and support you as the student in a systematic progress from whatever other approach you have been accustomed to (perhaps the traditional one, or some personal and unrefined approach) towards studying and using a new approach: the problem-solving approach.

CHAPTER DIVISION

We are going to deal with the book step by step, indeed chapter by chapter. Chapters will be numbered as in the book, but the Preface (pp v-viii) will be called (Orientation overview). Let us start right there.

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Recommended books

- New,
Serra, M. 1997. *Discovering Geometry — An inductive approach*. 2nd edition. Berkeley: Key Curriculum Press.
- Moodley, M (ed). 1992. *Mathematics Education for In-service and Pre-service Teachers*. Pietermaritzburg: Shuter & Shoofer.

OUTCOME-BASED TEACHING (OBT)

In 1998 an outcome-based teaching method will be introduced in South Africa. If you study the Standards of the USA well you will see that we are in principle following the USA. However, it's been worked out with a firm South African orientation. You will receive through the course of this year a separate tutorial letter in this regard.

The book of Cangelosi is also using the OBT approach. The way objectives have been formulated and the patterns of evaluation have been developed, illustrate this clearly. This is reflective of the Standards of the USA.

You will also note that the educational officials of South Africa introduced new terminology for old concepts. They replaced curriculum with "learning area", and aims and objectives with "outcomes" and "specific outcomes". This will definitely favour the transformational process in order to establish a new frame of mind — it is not only because of political motives. Renewal must be accompanied with a complete metamorphosis. The OBT approach does not necessarily have a behaviouristic basis, although many of the outcomes, especially at the very specific levels, start with "demonstrate ...", which is extremely behaviour oriented. Teachers who are required to implement this curriculum will certainly have to guard against the approach systematically moving in this direction.

YOUR STUDY METHODS

Here are a few pointers on how to use the book. Before proceeding any further, then, we take a look at three important techniques you will often be using at the start of a new chapter.

INDEPENDENT STUDY

A crucial phase in the process of understanding and learning mathematics by problem solving is to articulate your ideas about mathematics, and the teaching of mathematics, both *orally and in writing*. Only when you have tried this process for yourself will you understand the full value of this exercise.

STUDY PROCESS

We also want to make you aware of your own studying process. We shall explain a unique learning strategy to you — an approach you may find very useful to follow. Try to refine your own approach. The three techniques contained in this strategy are characterised as 1S, 2S and 3S, meaning

Evaluation instrument for your portfolio (Assignment 03/99)

NAME STUDENT NUMBER.....

LEVEL 4		YES	NO
4.1	more or less consistently accurate interpretation of problem situations or statements		
4.2	proper use of the given data		
4.3	appropriate strategies and approaches that are logically compatible with the stated problems		
4.4	few errors or none in mathematical procedures		
4.5	evidence that answers have been reconsidered and evaluated		
SELECT (a) and/or (b) and/or (c)			
(a)	evidence of approaches (to problems) that show creativity and insight but are atypical	(b)	the use of technology either in presenting or in solving the problem
(c)		(c)	decisive handling of complexity, vagueness and ambiguity in mathematical (teaching) problems
(a)		(b)	
(c)		(c)	
LEVEL 4 (Mark)	75% - 79%	80% - 89%	90% +



LEVEL 3		YES	NO
3.1	virtually consistent accurate interpretation of problem situations or statements		
3.2	proper use of the given data		
3.3	appropriate strategies and approaches that are logically compatible with the stated problems		
3.4	few mathematical or procedural errors		
3.5	evidence that answers have not been considered and evaluated in the context of the relevant problem		
LEVEL 3 (Mark)	60% - 64%	65% - 69%	70% - 74%

LEVEL 2		YES	NO
2.1	problem situations or statements not accurately interpreted throughout		
2.2	frequent erroneous use of the given data		
2.3	appropriate strategies and approaches inconsistently used but logically compatible with the stated problems		
2.4	frequent mathematical and procedural errors		
2.5	evidence that answers have not been considered and evaluated in the context of the relevant problem		
LEVEL 2 (Mark)	45% - 49%	50% - 54%	55% - 59%

LEVEL 1		YES	NO
1.1	inaccurate interpretation of problem situations or statements		
1.2	erroneous use of the given data		
1.3	infrequent use of appropriate strategies and approaches logically compatible with the stated problems		
1.4	frequent basic mathematical and procedural errors		
1.5	evidence that answers have not been considered and evaluated in the context of the relevant problems		
LEVEL 1 (Mark)	30% - 34%	35% - 39%	40% - 44%

LEVEL 0			
The portfolio is incomplete and the work does not meet any of the above criteria.			
LEVEL 0 (Mark)	0 - 19%	20% - 24%	25% - 29%

Percentage awarded _____



Student's signature

Date



Addendum B:
Evidence of assessment and
feedback from students

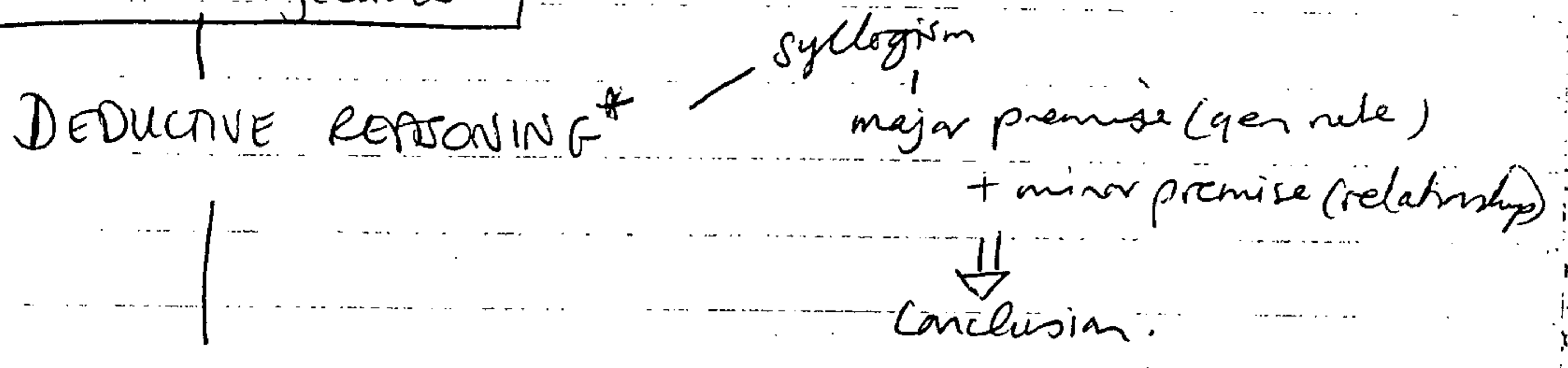
- 1 Examples of mindmaps learners made as learning devices 47
- 2 Extracts of required reflection letters with students' authentic 'voices' demonstrating
problems learners experience and their context (from Ass. 3: Portfolio) 52
- 3 Extracts of MMAT student 'voices' provided in the reflection letters required for
the portfolio (from Ass. 3: Portfolio) 57
- 4 Evaluation instrument for the portfolio 66

Chapter 6

Activities 6-1, 2

BLEM SOLVING - Decide on content - Decide on objective - Decide on activities - Decide on assessment.

Application Objectives



Use acquired concepts
relationships
Info
algorithms

\Rightarrow apply to real life problem
determine when + how
to use a relationship/info/algo

Deductive learning activities
4 stage lesson

9 stages of problem solving in here

- ① Initial problem confrontation + Analysis
- ② Rule articulation Subsequent problem confrontation + analysis
- ③ Rule articulation
- ④ Extension into subsequent lessons.

Measurement / indicators of achievement

Deciding how to solve problems

- avoid giveaway words.
- extraneous data
- missing data
- mixing eg & non-eg problems.
- non-mathematical topics.

interven into
Can struct-a-cepts
Discover-a-relationship

creativity objectives

Synectics*

Preserving
Fostering

- ① Direct analogies
- ② Personal analogies
- ③ Campared conflicts.

Resources and Technology



Activity 6-1 + 6-2

4-stage lesson plan

- 1. initial problem confrontation and analysis
- 2. subsequent problem confrontation and analysis
- 3. rule articulation
- 4. extension into subsequent lessons

Problem solving = application using deductive reasoning

life-skill why?

Assessment

- is maths. cont useful in soln
- don't use giveaway wor
- add extraneous data
- leave some data out
- mix example non-example
- choose fam topics

long-range integrated

Assessment

CHP 6: Leading Students to Solve Problems, be creative with Mathematics and willingly do Mathematics

= divergent thinking

Creativity

- why? → decline in creativity with age
- leads to new ways of thinking

Attitudes

Lessons

- how? → synectics
- direct analogies
- personal analogies
- compressed conflicts

Appreciation

- preferences
- opinions
- desires

avoid lip-service

Willingness to try

→ lack confidence

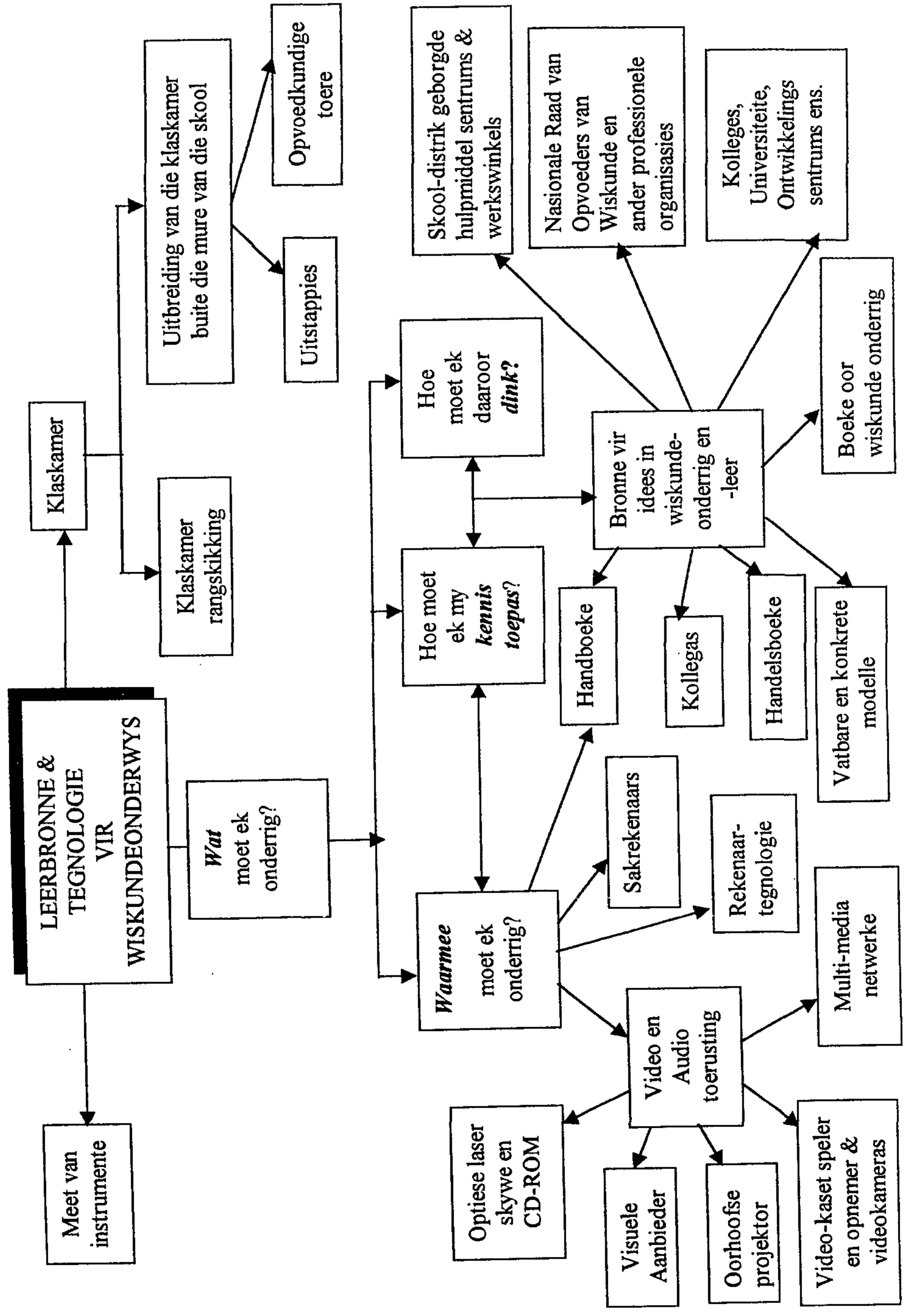
Assessment

self-reporting direct observation how?

- what? → belief in the value allow early successes
- tendency to try find interesting topics
- not ability allow students to feel free
- use previously

ACTIVITY 6-1 + 6-2

Aktiwiteit 7-2: Die hoofmomente van die hoofstuk



Woori ✓

Most of the work I have done individually than group work because of the problems we as teachers in remote or rural areas encounter. We do not have access to technology; use of computers; access to telephones, road network systems are poor, which make it extremely difficult to communicate or contact other schools or colleagues for discussion sessions. Sometimes you need to wait for a weekend to come before making an appointment with someone since during the week we are at work and time is always against us.

Prior to registering for the PCE this year, I had been tutoring maths part-time to Grade 10 pupils, possessing a degree but no formal teaching qualification. I was employed in an unrelated career, but I have always been passionate about maths, and the request for extra lessons by these students was very welcome! I often reflected on my tutoring methods to the individuals, and I sometimes found that I was getting more of a challenge out of the lessons than they were. I was thus prompted to study the Subject Didactics Mathematics course to equip myself with the correct and effective teaching tools. I have since taken up a new career and I am currently employed as a full-time maths tutor at a school in Johannesburg. This has provided me with invaluable opportunities for putting some of the theory into practice. The content of Cangelosi seems to be universally relevant to teaching maths, and I have seen how applicable his subject matter is to teaching maths, even in our current South African situation. While observing maths lessons of a maths teacher, I was able to match her lesson plan and strategies for an algorithmic objective to that detailed by Cangelosi, and I found this quite remarkable. The experience clarified my interpretation of Cangelosi's messages, and simplified his teaching approach, as I realised that effective teaching involves a few basic fundamentals.

Ek gee ook Rekenaarstudie as 'n vak en selfs in Rekenaarstudie het ek van die beginsels soos om egtewêreld probleme te gebruik toegepas en die resultate gesien. Nog 'n probleem wat ek opgetel het is dat ons leerders sukkel met die probleemoplossings beginsel in die algemeen. Hulle is nog altyd net geleer dat somme of wiskunde op net een manier gedoen word en die manier is vir hulle geleer en dit al hou jy dit kan doen. Hulle kan nie die probleem self oplos en uitredeneer en bevraagteken nie, hulle kan nie verbande sien tussen beginsels en konsepte nie. Hulle is nog nooit toegelaat om Wiskunde te ontdek nie. As hulle dit nou in 'n vak soos Rekenaarstudie moet doen, kan hulle nie. Die hele idee van probleemoplossing is dus nie net gebind tot Wiskunde nie, maar dit sal toepaslik wees in al hul ander vakke. Dit leer die leerder dus lewensvaardighede wat hy/sy in enige veld kan toepas.

I have really struggled to complete this portfolio. I started my teaching practical on the 16th of July when the schools opened and will be completing it on Friday the 17th of August (in 2 day's time). I had to be at school from 07h30-14h00, at my company Master Maths from 14h30-18h30 giving extra lessons, have supper and then study until 23h00. In addition to this, I was thrown in the deep-end in the first two weeks of my teaching practise. I had to be a substitute teacher for a mathematics teacher who had been hi-jacked, and only had 5 free periods in a week. This meant that a large portion of my evening study time was now taken up with lesson preparation for the grade 8's 9's and 10's. To say that I am exhausted is an understatement.

The activities that involved group-work, I tried as best I could to do them by myself. As I have explained, time was a major issue and these discussions would have taken up more than I had available.

An enjoyable course, however I feel that the work load is unnecessary (especially if this is only 1 course out of a total of 7 courses that 2nd year H.E.D students are doing. Most UNISA H.E.D students have full-time jobs.)

isolated and I must admit I haven't tried very very hard to find others to talk to. I wrote to UNISA to obtain the names of others doing my course - the one in Pinetown (I'm in Durban North) didn't have a clue, hadn't gotten started by the end of April and I decided it wasn't worth communicating with her, as she would sap my time! The other lady, who lives close to me is doing the Maths Learning Area course and not the didactics course - we chatted some over the phone, but she couldn't really help. As far as I know there are no other UNISA maths didactics students in Durban!

I think the biggest help in this area has been communication with my 2 maths prac supervisor teachers. I have alluded to and discussed many conversations with them in this portfolio. My 2 prac teachers are so different - the one is pro OBE and very creative, she follows a problem solving approach, and teaches Grades 8-10 and the senior maths teacher (Grades 10-12) follows the traditional approach. I have thoroughly enjoyed this experience of 2 opposite teachers! Thank you for allowing me to hand in this portfolio ^{late} during my prac so it could add to the richness of the portfolio!

I did not work with a group as I knew of no other people doing the course so all the group questions I did on my own.

as due to the fact that I do not have a school textbook to refer to, am not presently teaching, do not have colleagues with whom to discuss questions and am not part of a study group. Also some of the page numbers given were incorrect.

I work full time and simply do not have the time to meet with other students or colleagues. I have also battled to complete this portfolio ~~as~~ and have had to rush through the work to complete it. The problem arose from the fact that I had to do my 10 weeks practical from April to end of June. During this time I also had to work part-time in order to earn money to pay my bills, after all I am a single lady and have to support myself. Anyway as a result of this I found no time during those 3 months to do any work and had to begin it in July when my practical ended and I went back to my full time job. I can honestly say that I have been working flat out since the beginning of July in order to complete this portfolio. I am very sorry that it is

assignments to which references were directed at Cangelosi's 1992 version, as I did not have access to it. I also left out some of the assignments which were school based because much of the assignment was completed during school holidays. Inevitably I ran out of time and did not manage to complete all the assignments - only completing chapters 1-9. I have indeed, however, put in a lot of effort and time to these 9 chapters and do feel that I now understand maths teaching in a totally different dimension.

new teaching skills and ideas. I came to realise that parts of the mathematics syllabus are better handled with specific methods than with others. I am already using some of the ideas I gained by doing these activities. For instance, I am already using the inductive approach to teach Euclidean geometry and certain parts of Trigonometry in Grades 11 and 12; this seems to be bearing fruit. Instead of stating theorems and then giving proofs, I now engage my learners in activities that lead them to 'discovering' them for themselves. After completion of this portfolio, I feel more confident that I am better equipped to take the bull by the horn by confronting head-on problems facing most South African schools (especially those in rural areas, where I teach) today. I think I am now in a good position to try and motivate them and instil in them a desire and feel a need to learn mathematics so that they could use it to solve real-life problems.

Cangelosi's book. The approach that I adopted was to link up with another student, Clasina Stofberg, once I had read through the whole book for the first time. We then discussed the activities together, sharing ideas, brainstorming and reaching consensus in some cases. We then divided the workload in terms of writing up our initial responses, before adding any personal additions to our own portfolios. This portfolio reflects the output of this process. I have tried to focus on problem solving in the teaching of mathematics.

I am not sure exactly how many hours it took, since the ideas were generated over a period of time, from the first week in March when I first started reading Cangelosi's book. I have tried to do most questions, but have omitted those that go into detail of the syllabus and the comparisons with the American syllabus. The reason for this is that I am not a practising teacher yet, and am not 100% familiar with all aspects of the syllabus. Based on the fact that I did my degrees from 1981 to 1987, I am a little rusty on certain aspects. I thus elected to focus on processes rather than content details for the purposes of this portfolio. I figured that if I can gain a solid understanding of the processes, the content will be easier to pick up. In this busy year there simply is not time to do everything!

There is so much I can do with maths that I have not thought of. Maybe more time should be spent on planning initially using worksheet seem to be a good idea. Chapter 9 was a disaster because I could not find the activities or the references because it was in the 1992 edition. Where we supposed to buy that book or only 1996 edition? Each section had its difficult parts. Cangelosi uses a lot of examples which I only did in first year university. Is the standard higher or do they just cover more work?

I find it easier to learn from my own summaries and have summarised most of the chapters. It took me some time to get used to creating mindmaps for this work. I found it difficult at first to condense the information.

Een van die groot probleme wat my nog altyd gekonfronteer het in my kontak met kinders en wiskunde (ek gee al vir 20 jaar ekstra lesse) is die groot *Hoekom dan tannie?* 'N kind wil die nut insien van dit wat jy vir hom leer en ek glo hy het die reg daartoe om daarop aan te dring. Ek het al met baie mense hieroor gesels, maar die deursnit antwoord was maar: *Vir wat? Ek het wiskunde gedoen sonder om ooit te weet hoekom al die reëls daar is en ek het my graad/diploma... sonder probleme verwerf. Nee wat hulle moet maar net leer en werk, wiskunde gaan oor oefen-oefen-oefen.*

The workload in trying to consistently go through all the activities is very demanding. I found that within each activity especially in chapters 5 and 6, extremely long questions. A suggestion I would like to make for this assignment is: to keep it as comprehensive and to encourage students to complete as much of the assignment as possible, is to spread it over 2 years, as a complete course, and be exempted from the full course of Didactics (DIDHOD). In addition to this, have the portfolio as the assignments, but spaced out so that activities for two chapters are handed in at a time, up to the end of chapter 4 for the first year, (which would include the present assignment 01) then to the end of chapter 9 at the end of the second year (which would include assignment 03), with credit given towards exam marks as well in each year.

The section I found the most difficult is designing learning activities in order to achieve the desired learning objectives at a specified learning level. I found that it was not always easy to think of appropriate learning activities, especially for intellectual-level objectives. It also highlighted to me the limits of the current educational system in S.A. as most activities are aimed at the knowledge-level. Designing lessons based on research-based principles requires a lot of thought and planning, and it is very time-consuming. However, when one considers the long-term benefits both for the student and the teacher using this approach, it is well worthwhile to spend the extra time preparing meaningful lessons.

In conclusion, a comment that stood out in my mind when studying the book by Cangelosi was from a student who noted that, although the teacher did not teach them very much, they did the work themselves and learnt a lot. I have tried to look for the relevant page, but I am afraid I could not find it. To me, it summarises what research-based teaching is all about.

Exercises that requires one to discuss with friends, I personally feel that they should be reduced in number, since in most situations one does not any person doing this very same course to discuss with. For assignment 03 I feel that questions that should be submitted should be reduced in numbers. This exercise almost consume all the time to study other courses. I have not included mind maps. I find it not easy to draw a mind map.

I have found this course extremely demanding as regards the amount of time that has been devoted to the completion of this portfolio. I can see the need for preparing new teachers for curriculum 2005 and believe the ideal of outcomes based education is a good one.

I do not think that I have ever worked as hard as I did on this portfolio before. It was a taxing but enjoyable experience. When I paged through tutorial letters 102/1997 and 103/1997 I did not think that I would ever get through. If mathematics is to be viewed differently, then this negative attitude to maths must be eliminated.

I have been attempting for 10 years to teach in the problem-solving way, but have found myself stifled by the syllabus which must be covered, boring problems in textbooks and apathetic students who have been conditioned to boredom. Now at last I have some ideas!

Die werkslading van die kursus voel ek was 'n bietjie onbillik, veral gesien in die lig dat die boek so laat beskikbaar gestel is.

Heelwat van die aktiwiteite was egter, volgens my, onduidelik geformuleer. Die aandrang op die 1h2h3h metode en die breinkaarte het ek baie frustrerend gevind, ek het nog nooit m.b.v. breinkaarte geleer nie en sal ook na alle waarskynlikheid nie in die toekoms nie! Akt. 5-10 se voorkoms alleen het my dadelik laat besluit om dit uit te laat - dit is, volgens my, heeltemal te lank vir een aktiwiteit, daar is bloot nie tyd of energie vir sulke tipe aktiwiteite as mens eerder ander kan doen wat korter is nie.

Byvoegings agter in Cangelosi, voel ek die 'standards' is wonderlike en goed, maar baie daarvan is ontoepaslik vir die S.A. situasie, daarom sou ek sê die baie verwysings daarna en aktiwiteite daarvoor, is dalk te veel.

Die moeilikste gedeelte was hoofstuk 3, leerdoelstellings en doelwitte. Ek het die meeste tyd hieraan afgestaan om dit te probeer baas raak.

I therefore decided to concentrate on the chapters that provide me with real experience if not competency to have my pupils benefiting in my math lessons. Chapters that I have found more interesting, challenging and relevant to my teaching situation include chapters 3, 5, 7 and 8.

Another short come is that I am isolated from many students who are taking this course. I am therefore left with one option, to do the exercises alone.

The way I approach the portfolio I do not think is 100% right. The reason is the fact that I got the prescribed book at the end of July. I find chapters 4 and 6 time consuming to read since I was not having any time to do my portfolio thoroughly.

Wat betref die benadering van probleemoplossing wat voortdurend gehandhaaf word: aanvanklik was ek uit onkunde negatief daarteenoor ingestel.

Wat betref die uiteensetting van die portefeulje: by gebrek aan tyd kon ek nie soveel insette lewer as wat ek graag wou nie. Om die aktiwiteite deeglik en intensief te doen, was vir my 'n groot frustrasie, aangesien dit so tydrowend was. Ek wou 'n ander wyse van ordening volg as bloot volgens hoofstukke. Waar lesse (vinjette) ontleed moes word, het ek dit in my handboek gedoen. Aangesien dit moeilik is om die ontledings oor te skryf en ons net 80% van die aktiwiteite moes doen, het ek hierdie ontledings soms nie in die portefeulje ingesluit nie.

My begrip en insig van die sake rondom probleemoplossing het baie verander. Ek beseft die noodsaaklikheid van die nuwe benadering wat wiskundige denke bevorder en leerlinge leer om self dinge te ontdek en dit wat hulle leer toe te pas op egte wêreld probleme. Hoe om dit prakties toe te pas in ons oorvol klaskamers waar taalbemeestering 'n groot probleem is, weet ek nog nie. Maar dit het my

nuwe perspektief op die onderrig van wiskunde gegee en 'n ideaal om na te streef in my eie wiskundeklas.

Regarding this assignment 3 really it was tedious. Unfortunately some of the activities were not clear to me. I have tried to do many as I could. Lack of time was one reason for not doing all.

Concerning this assignment I am not satisfied with chapters 0, 1 and 2. I could not write those activities up to my satisfaction. I thought that I can improve those activities after finishing the whole assignment. Unfortunately due to lack of time I could not revisit to those chapters and write according to the numerical order.

Die praktiese oefeninge was 'n probleem, aangesien ek tans nog voltyds werk en min kontak het met die skole. My grootste bekommernis is die toepassing van wat ek geleer het. As 'n gegradueerde, het my oë nou oopgegaan vir baie hoërskool wiskundekonsepte wat my onderwysers of dosente nooit aan my uitgewys het nie (bc. Die faktoriseringsoefeninge). Sal ek dit kan toepas? Is daar genoeg bronne om my te ondersteun? Sal ek self hierdie konseptualiseringsaktiwiteite moet uitdink?

Van al die hoofstukke was hoofstukke 3 en 4 vir my die moeilikste gewees, maar nadat ek dit bemeester het, het ek die kursus makliker gevind en meer geniet.

I like your suggestion for forming study groups, although this needs to be given practical substance in the form of guidelines for contacting other students.

An enjoyable course, however, I feel that the work load is unreasonable (especially if this is only 1 course out of a total 7 courses that 2nd year HED students are doing. Most Unisa HED students have full-time jobs).

I find assignment 3 (portfolio) very tedious and at some points unstimulating. In a way I am thankful for this assignment in that I feel more prepared for the forthcoming exams.

My understanding and insight of mathematics teaching problem solving is that maths should be made more meaningful to the students. The maths should not be confined to solving that book problems. But it should be taken outside to the real-world application.

There were many activities that I could only do half of or that I could not do due to the fact that I do not have a school textbook to refer to, am not presently teaching, do not have colleagues with whom to discuss questions and am not part of a study group. Also some of the page numbers given were incorrect. I have also battled to complete this portfolio and have had to rush through the work to complete it.

Even though this portfolio was a tedious work, I really enjoyed it. Some of [the activities] were difficult while others were easy.... needed real thinking and reference from the activity.

Sometimes the interpretation of assignments and activities gave me problems although this could have been partly due to the open-ended character of many activities. The amount of work required for this subject came as a shock for me as I based my year planning on the experience I had with other HED subjects. The resulting time pressure caused me to concentrate mainly on the 'easy' activities. If the total number of activities could be somewhat reduced (e.g. below 100), more time could be spent on the harder and time-consuming activities.

I am finding this course totally frustrating and confusing. I am finding the questions in the study guide totally confusing. I am finding the mind-maps in the S.G. totally confusing. I find it very difficult having one's studying of a textbook so rigidly guided.

I dink dat die 3 werkopdragte, veral werkopdrag 3, is so omvattend dat dit 'n eksamen oorbodig maak.

Heelwat van die aktiwiteite was .. onduidelik geformuleer.

Die aandrang op die 1H2H3H metode en die breinkaarte het ek baie frustrerend gevind, ek het nog nooit m.b.v. breinkaarte geleer nie en sal ook na alle waarskynlikheid nie in die tokoms nie! Akt. 5-10... heeltemal te lank vir een aktiwiteit ... eerder ander doen wat korter is.

"Standards" is wonderlik en goed maar baie daarvan is ontoepaslik vir die SA situasie, daarom sou ek sê die baie verwysings daarna en die aktiwiteite daarvoor is dalk te veel.

Die moeilikste gedeelte was hoofstuk 3.

The difficulties I encountered were mainly being alone and doing everything by myself. ... no colleague or friend .. discuss some of the issues. No much communication among the different schools ... could not visit any other classroom where maths is taught.

Die praktiese oefeninge was 'n probleem, aangesien ek tans voltyds werk en min kontak het met die skole.

My oë het nou oopgegaan vir baie hoërskool wiskundekonsepte wat my onderwysers of dosente nooit aan my uitgewys het nie. Sal ek dit toepas? Is daar genoeg bronne om my te ondersteun? Sal ek self hierdie konseptualiseringsaktiwiteite moet uitdink?

Aanvanklik was ek uit onkunde negatief [teen die probleemoplossingsbenadering] ingestel. Aktiwiteite ... was 'n groot frustrasie ... so tydrowend . Ek wou 'n ander wyse van ordening volg as bloot volgens hoofstukke. [vra verdere kritiese vrae oor Wiskunde as opsie vak, lae IK Tegnieë studente en die hantering van hulle.]

I do like the tentative form. I feel strongly that opportunities should be provided for students to assess the course and contribute to the final product.

I like your suggestion for forming study groups, although this needs to be given practical substance in the form of guidelines for contacting other students. .. problem with the textbook is the difference in context of teaching in SA.

I am concerned that the value of ASS 1 will be lost as it does not address the practical reality of having pupils in a class with a wide variety of ability, language, age-range and motivation.

BAIE keer vind jy groepsamewerking wil net nie realiseer nie, of slegs een of twee persone doen die dinkwerk alleen. Dit word dan 'n tipiese "boring", moeilike werkswinkel. Al die byvoeglike naamwoorde wat al negatief aan Wiskunde gekoppel is, geld dan. SOMS weer kry jy fantastiese, spontane interaksie; 'n regte spanpoging. En dan word gesê: Dit was lekker, netsoos in Wiskunde. 'N Groot deel van Cangelosi se strategie en dus ook die probleemoplossingstrategie hang ten nouste saam met hierdie interaksie.

Ek vind ook die probleemoplossingsbenadering behels GEWELDIG BAIE WERKSINSETTE vir die onderwyser sowel as vir die leerling. Ek sou selfs voorstel dat as hierdie kursus nou klaar geskommel is en al die baie stof gaan lê het dat hierdie selfevalueringsoefeninge as kernaktiwiteit behoue bly.

Initially I found the process to be very time consuming but with practice Goal 5 took a lot less time to break up into objectives than Goal 1. Before I would just follow the textbook because someone else had done the hard work for me, but then I would get frustrated (and so would my students) as the lessons were not addressing their needs.

Not having an extensive math background is a disadvantage as I could not rely on my own knowledge of the subject to help me plan the correct steps. I had to resort to a text to provide me with the details and that is when I encountered the problem of not being able to follow Cangelosi's suggestions as the text book structure was overwhelming.

The students lack many of the basic skills and if they are not familiar with simple knowledge they will never attempt the more challenging aspects of math. The text book obviously ignores the ability of the students, so the goal setting is crucial in meeting their needs.

Finding real life applications was virtually impossible. The textbook had none and the examples that my colleagues provided were merely contrived problems. Again my lack of mathematical background proved to be the limiting factor.

I enjoyed reading through Cangelosi, but what gave me tough time were chapters 3 and 4 (learning goals and lesson design). Lesson design appears so comprehensive such that I was tempted to use the short notes of a lesson which I was taught 10 years ago.

The idea of "a hint is not always a help" seems to run through the course and forces one to employ more inductive thinking than some other courses. The use of Vignettes was helpful but one wonders how closely the course content and examples would be relevant to the South African syllabus.

A number of difficulties were experienced with time. The amount of work to be covered is extensive. Chapter 8 of the portfolio includes a number of activities which require more time input than earlier chapters. This chapter is the crux of the course and an indication of its importance should come into the lecturer's instructions much earlier in the course.

I would have liked the Day Seminar to have been dynamic and exciting, well-organized, well-structured and informative. I found it lacking in certain of these key elements. It did not inspire students to diligence and involvement with the course material. I found this course interesting, worthwhile and very difficult. It has convinced me that I know how to teach in terms of the research-based approach. Turning theory into practice is the challenge.

Active participation of student should take place in every learning situation. Teachers should help the students to realize that maths is not just a group of numbers and calculations, it is needed in every day life situations. I have tried to look at all these aspects in my portfolio. Assessing portfolio is done not only in schools but in the higher institutions also. A number of techniques are used for assessing what students have learned from lessons.

Some of the activities required real thinking. These activities can be applied in S.A. schools. Some of the activities were difficult to understand. In real life problems, students will be confronted with puzzling questions, where they have to apply the insight and require to make value judgement.

Inevitably I ran out of time and did not manage to complete all the assignments - only completing chapters 1-9. I have indeed, however, put in a lot of effort and time to these 9 chapters and do feel that I now understand maths teaching in a totally different dimension. The activities I thought I would least enjoy ended up not being so bad. Mind maps are always difficult for me to construct and I often do not enjoy doing them - however, I decided to attempt them for this assignment.

Mind maps are always difficult for me to construct and I often do not enjoy doing them — however I decided to attempt them. The S.G. was very helpful in this regard and in this way I wish to commend it. The activities were set out in such a way as to address the content without simply regulating it.

Difficult assignments for me included those that required a school context/classroom situation as the majority of the activities were completed in the school holiday period. I do feel I applied maximum effort.

I find it easier to learn from my own summaries and have summarised most of the chapters. It took me some time to get used to creating mindmaps for this work. I found it difficult at first to condense the information.

Die selfevalueringsoefeninge na elke hoofstuk is 'n groot hulp. Dit is samevattend en 'n MOET ook met die oog op die eksamen. TOP.

Ek het dus alleen gewerk en al my werk is *individuele besinning*.

Terwyl die *vinjet* voor die geestesoog afspeel kan jy ast'ware uit die adgtergrond geraas "hoor" hoe die interaksie tussen dosen/student en studente onder mekaar plaasvind. BAIE keer vind jy groepsamewerking wil net nie realiseer nie, of slegs een of twee persone doen die dinkwerk alleen. Dit word dan 'n tipiese "boring", moeilike werkswinkel. Al die byvoeglike naamwoorde wat al negatief aan Wiskunde gekoppel is, geld dan . SOMS weer kry jy fantastiese, spontane interaksie; 'n regte spanpoging. En dan word gesê: Dit was lekker, netsoos in Wiskunde. 'N Groot deel van Cangelosi se strategie en dus ook die probleemoplossingstrategie hang ten nouste saam met hierdie interaksie.

Ek vind ook die probleemoplossingsbenadering behels **GEWELDIG BAIE WERKSINSETTE** vir die onderwyser sowel as vir die leerling

Ek moet erken hoofstuk 2 was vir my die slegste en moeilikste - die ontwikkeling van jou eie kurrikulum bly vir my duister.

Een van die groot probleme wat my nog altyd gekonfronteer het in my kontak met kinders en wiskunde (ek gee al vir 20 jaar ekstra lesse) is die groot *Hoekom dan tannie?* 'N kind wil die nut insien van dit wat jy vir hom leer en ek glo hy het die reg daartoe om daarop aan te dring. Ek het al met baie mense hieroor gesels, maar die deursnit antwoord was maar: *Vir wat? Ek het wiskunde gedoen sonder om ooit te weet hoekom al die reëls daar is en ek het my graad/diploma... sonder probleme verwerf. Nee wat hulle moet maar net leer en werk, wiskunde gaan oor oefen-oefen-oefen.*

I selected very few in the overview chapter as I found them irrelevant and confusing. I found the mind maps quite difficult to put in all the important points without elaborating too much. A lot of the page references and case numbers did not match the 1996 edition and I found once I obtained a 1992 edition that the case no. of 1996 and page no. of 1992 were put together. This was a great source of frustration for me and made me feel very negative towards the course.

I also felt that the book is very Americanized. We do not have all the technology (graphing calculators etc.) And so I found parts irrelevant for me at this point. There are questions I left out that I felt incompetent to deal with but now I have finished going through the book I would like to revisit them.

I battled with the incorrect page references, until I received the errata in mid-March. There was much repetition with some of my education courses! This has been very difficult! I wanted to include everything and more!!! additional items I included are the classroom management assignment, notes I made on assessment from D. Clarke's book, and some item pool ideas. All the other stuff is peripheral.

The most frustrating aspect of the portfolio was the incorrect references in the list of activities, which took a lot of detective work to try and identify what was actually required. Two examples are Activity 00-7, where Case 2.6, page 19b does not exist, and Activity 8-6, where Case 8.5, page 249 is not a lesson plan. I recognize the reasons for this, but nonetheless it created some significant frustration!

There is a massive workload in this course if you consider that I am doing the whole PGCE in one year with 10 weeks of practice teaching included as well as being the mother of children.

This has been the biggest assignment I have ever tackled. Initially I had my doubts about completing this assignment. The first four chapters I battled. When I came to chapter 5 I developed a method as to approach each section. I did not quite know how to answer the activities at first. I like using direct teaching, therefore I did not have any problems completing that section of the work.

There is so much I can do with maths that I have not thought of. Maybe more time should be spent on planning initially using worksheet seem to be a good idea. Chapter 9 was a disaster because I could not find the activities or the references because it was in the 1992 edition. Where we supposed to buy that book or only 1996 edition? Each section had its difficult parts. Cangelosi uses a lot of examples which I only did in first year university. Is the standard higher or do they just cover more work?

I would have loved to spend more time on it. I have really struggled to complete this portfolio.

EVALUATION INSTRUMENT FOR YOUR PORTFOLIO

NAME Mrs. A. K. Siddings

STUDENT NUMBER 6467571

LEVEL 4			YES	NO	
4.1	more or less consistently accurate interpretation of problem situations or statements		✓		
4.2	proper use of the given data		✓		
4.3	appropriate strategies and approaches that are logically compatible with the stated problems		✓		
4.4	few errors or none in mathematical procedures		✓		
4.5	evidence that answers have been reconsidered and evaluated		✓		
SELECT (a) and/or (b) and/or (c)					
(a)	evidence of approaches (to problems) that show creativity and insight but are atypical	(b)	the use of technology either in presenting or in solving the problem	(c)	decisive handling of complexity, vagueness and ambiguity in mathematical (teaching) problems
(a)	✓	(b)	✓	(c)	✓
LEVEL 4 (Mark)	75% - 79%	80% - 89%	90% +	100%	


LEVEL 3			YES	NO
3.1	virtually consistent accurate interpretation of problem situations or statements			
3.2	proper use of the given data			
3.3	appropriate strategies and approaches that are logically compatible with the stated problems			
3.4	few mathematical or procedural errors			
3.5	evidence that answers have generally been reconsidered and evaluated in the context of the relevant problems			
LEVEL 3 (Mark)	60% - 64%	65% - 69%	70% - 74%	

LEVEL 2		YES	NO
2.1	problem situations or statements not accurately interpreted throughout		
2.2	frequent erroneous use of the given data		
2.3	appropriate strategies and approaches inconsistently used but logically compatible with the stated problems		
2.4	frequent mathematical and procedural errors		
2.5	evidence that answers have not been considered and evaluated in the context of the relevant problem		
LEVEL 2 (Mark)	45% - 49%	50% - 54%	55% - 59%

LEVEL 1		YES	NO
1.1	inaccurate interpretation of problem situations or statements		
1.2	erroneous use of the given data		
1.3	infrequent use of appropriate strategies and approaches logically compatible with the stated problems		
1.4	frequent basic mathematical and procedural errors		
1.5	evidence that answers have not been considered and evaluated in the context of the relevant problems		
LEVEL 1 (Mark)	30% - 34%	35% - 39%	40% - 44%

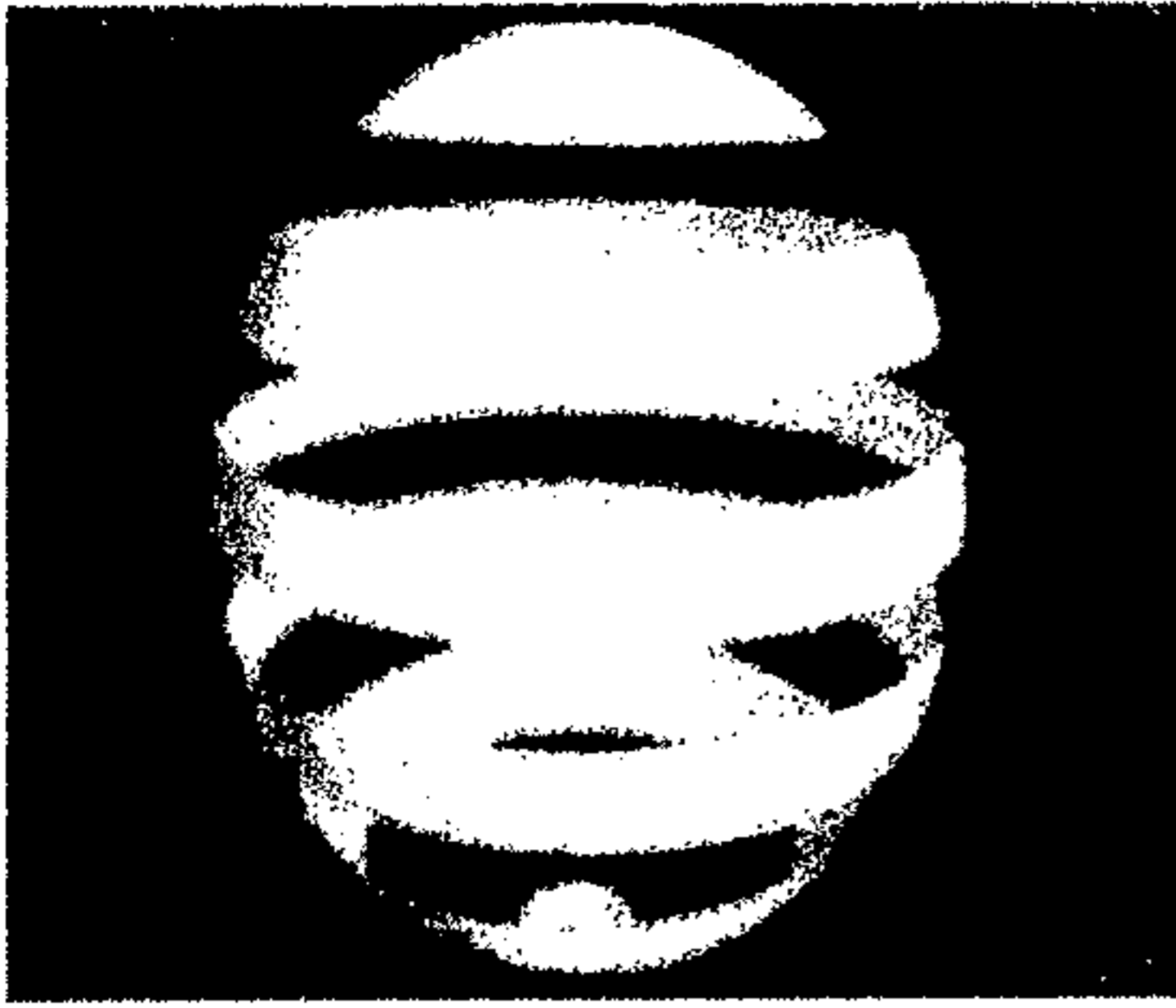
LEVEL 0			
The portfolio is incomplete and the work does not meet any of the above criteria.			
LEVEL 0 (Mark)	0 - 19%	20% - 24%	25% - 29%

Percentage awarded 100% Credit mark achieved 40


Lecturer's signature

25/8/2001
Date

..... letters inters good! Base geluk fy is no
 placed on in queue and answer in the
 twee. Eh glo. In gaan in vershel in aak



Addendum C: Evidence from team reflections

1	Interview schedules 1 and 2	67
2	Transcribed video taped interview 1 (Interviewer 1)	69
3	Transcribed video taped interview 2 (Interviewer 2)	80
4	Matching of the focus questions and the interview questions according to research issues .	85

INTERVIEW SCHEDULES

These interviews are personal open-question interviews concerning the Unisa course, Mathematics Subject Didactics (MMAT00-8) as data for the M.Ed research by Ms Hentie Wilson.

INTERVIEW 1

Interviewer: Hentie Wilson

with: Prof Dirk Wessels

on:

in:

Environment:

Video taped on tape numbers

The video environment did/did not have an influence on the interview. Why?

Instructions:

Feel free to discuss your feelings openly as this is a research environment. All the discussions will be confidential.

- The discussions are being recorded on video tape for research administration purposes. May we continue with the recording? Yes/No
- May the researcher refer to the comments made on the tape in her research? Yes/no

QUESTIONS:

1. When did you start with the development of this course?
2. How would you describe the **focus** of the course?
3. In your opinion, what were the **course development phases**? Please describe these phases. You may draw a mindmap to illustrate your description.
4. How would you describe **the students** in this course? [characteristics, needs, type of study, preknowledge, etc.]
5. What **environmental aspects** did you have to consider for course planning and development? [DE, philosophy, etc.]
6. How did the **team approach** affect the development of your course?
7. What did you want to **achieve** during the course development?
8. In your opinion, which **learning theories** that you employed in the design of the course had a decisive influence on the actions of the students?

INTERVIEW 2

Interviewer: Prof A I le Roux

with: Prof Dirk Wessels

on:

in:

Description of the Environment:

Video taped on tape numbers

The video environment did/did not have an influence on the interview. Why?

Instructions:

Feel free to discuss your feelings openly. All the discussions will be confidential.

- The discussions are being recorded on video tape for research administration purposes. May we continue with the recording? Yes/No
 - May the researcher refer to the comments made on the tape in her research? Yes/no
-
-

QUESTIONS:

8. What did you want to **achieve** during the course development?
9. What factors in the **learning environment** influenced learners' actions and understanding of study material?
10. In your opinion, which **learning theories** that you employed in the design of the course had a decisive influence on the actions of the students?
11. What **active learning strategies** did you **employ** in the design of the course?
12. What **active learning strategies** had a **decisive influence** on the development of competencies, skills and knowledge of the students?
13. What course **design factors** had a *positive* affect the learning and understanding of students? Motivate your answer.
14. What course **design aspects** had a *negative* affect the learning and understanding of students? Motivate your answer.
15. How would you describe the ability of your course to promote **dialogue** between participants?
16. How did your course assist your distance education students to learn **independently**?
17. How did particular course **assessment strategies** contribute to getting students actively involved in the learning process?
18. How did you as the lecturer manage the particular course **assessment strategies**?
19. How did the **textual layout** contribute to promoting active learning? Which textual layout aspects were incorporated in the study material?
20. Are there any **other** aspects that you would like to add?

INTERVIEW 1

Topic: Descriptions of the *Mathematics Subject Didactics* course (MMAT00-9)
Researcher: Hentie Wilson (HW)
Course Coordinator and lecturer: Prof Dirk Wessels (DW)
Interviewer: Hentie Wilson
Date and time: 29 Maart 1997; 8:20 a.m.
Strategy: Semi-open questions.
Recording method: Video tape A and B

TAPE C

Environment: The interview environment was comfortable, quiet and private. The interview started calmly and fairly tense (because of the novelty of the interview), however, because the parties really know one another, the atmosphere became very relaxed. The interviewer was caring and close to the interviewee.

Instructions:

Feel free to discuss your feelings openly as this is a research environment.
All the discussions will be confidential.
The discussions are being recorded on video tape for research administration purposes.
May we continue with the recording? Yes
May the researcher refer to the comments made on the tape in her research? Yes
Request to interview and to ask question granted.

INTERVIEW STARTS

Hentie Wilson: Ek wil graag 'n paar oop vrae een jou stel. Ek wil hê jy moet so vryelik voel omdat dit navorsing is en dit word as vertroulik gehou. Net vir navorsingsdoeleindes - the discussions are taken down on video tape so may I use the details for my research for my Master's thesis? [agreement]. To start off, when did you start with the development of your career?

Prof Wessels:: Kan ek in Afrikaans praat. [Interviewer agree to Afrikaans.] Ek het in 1984 hier begin en die afgelope jare die kursus aangepas nadat ek van Prof. Harley oorgeneem het met relatiewe min veranderings. En om vrae aan te sluit by die gidse en meer visueel te werk in terme van die teks dat dit moet meer aandag kry. Ek het ook agtergekom die studente se werkopdragte moet doen net met 'n Gids sonder 'n voorgeskrewe studiegids. en ook later besluit om 'n gids voor te berei.

Hentie Wilson: Wanneer het jy spesifiek begin met hierdie oefening. Of het jy spesifiek navorsing gedoen.

Prof Wessels:: Ek het in 1994 reeds al die bepaalde boek ontvang van James Cangelosi en toe meer bewus geraak van die waarde van die teks en in 1995 die projek begin wat die studiestelsel in 1996 - dit is bietjie verander in 1997 en in 1998 is die studiegids gedruk.

Hentie Wilson: Hoe sal jy die fokus van hierdie spesifieke studie omskryf?

Prof Wessels:: Ek dink dit was 'n enorme verandering van wat dit vroeër was en wat dit toe geword het en die fokus was beslis om die studente in staat te stel om beter te kan leer en a.g.v. hierdie leer daadwerklik onderrig styl veranderinge en gedragspatrone sal verander. Om dit te bewerkstellig in 'n bepaalde persoon wat 'n bepaalde kursus doen en die impak op die student sal groot wees en juis met wiskunde onderrig nodig om die persepsies te verander vanaf die ou tradisionele onderrig in die klaskamer.

Hentie Wilson: In jou opinie was hierdie kursusontwikkeling enigins gewees of was dit net in tydgebonde fase in 1984? Byvoorbeeld, in 1994 het jy 'n teksboek gekry en in 1995 net begin en in 1996 die eerste fase studiebriefe daar geplaas, en elke jaar veranderings aangebring. Was dit die enigste ontwikkelingsfase of was daar ander ontwikkelings?

INTERVIEW 2

Topic: Descriptions of the *Mathematics Subject Didactics* course (MMAT00-9)
Researcher: Hentie Wilson (HW)
Course Coordinator and lecturer: Prof Dirk Wessels (DW)
Interviewer: Hentie Wilson
Date and time: 29 Maart 1997; 8:20 a.m.
Strategy: Semi-open questions.
Recording method: Video tape A and B

TAPE C

Environment: The interview environment was comfortable, quiet and private. The interview started calmly and fairly tense (because of the novelty of the interview), however, because the parties really know one another, the atmosphere became very relaxed. The interviewer was caring and close to the interviewee.

Instructions:

Feel free to discuss your feelings openly as this is a research environment.
All the discussions will be confidential.
The discussions are being recorded on video tape for research administration purposes.
May we continue with the recording? Yes
May the researcher refer to the comments made on the tape in her research? Yes
Request to interview and to ask question granted.

INTERVIEW STARTS

Hentie Wilson: Ek wil graag 'n paar oop vrae een jou stel. Ek wil hê jy moet so vryelik voel omdat dit navorsing is en dit word as vertroulik gehou. Net vir navorsingsdoeleindes - the discussions are taken down on video tape so may I use the details for my research for my Master's thesis? [agreement]. To start off, when did you start with the development of your career?

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Hentie Wilson: Wanneer het jy spesifiek begin met hierdie oefening. Of het jy spesifiek navorsing gedoen.

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Hentie Wilson: In jou opinie was hierdie kursusontwikkeling enigszins gewees of was dit net in

Prof Wessels: Ek het in 1994 studieverlof gehad. My navorsingskema was oor die matrikulisme, ek het veral toe bewus geword van die groter aktiwiteite and onderrig. Ja, die fases van die projek hang af van 'n persoonlike ontwikkeling en dis hoekom ek in 1994 en in 1998 studieverlof gehad en het ek ook my Ph.D voltooi. Dit het in die begin rof gaan in onderwys. Toe daarna die hele ontwikkeling gekom in die wetenskap. Terwyl ek met studieverlof en die oorsese reis was, wou ek dit opvolg ... van al die wetenskapsvelde het ek seker met die partikulisme die meeste sukses behaal in wiskunde onderwys en so my blootstelling daaraan was baie goed. In die veld van die konstruktiewe onderwys was dit 'n baie belangrike begin. Ek dink was die finale soort van oriëntering om te besef dat die vorige benadering tot die studiemateriaal wat ons gevolg het min effek gehad het op die studente. En toe begin die projek in 1995 waar julle ook die kursus aangebied het en ek deel aan gehad het en dit het uitgeloopt op die eerste studiebriefe. Ek dink dat die ontwikkeling wat plaasgevind het in die studie tot by die gids veral daarop gerig was op die aard van die werkopdragte en die aard van die kontak te probeer verbeter. Ek het ook in daardie tyd - omdat dit 'n geweldige omvang was - ek het dit nou eintlik verkeerd gestel - dit wat van die studente verwag is in die projek, was nogal baie en ek het mettertyd van die 150 aktiwiteite gehad en almal vereis van die studente het ek dit afgeskaal na 80% en daarna 70%.

Ek het elke keer net die keuse gelaat in terme van die totale tema - dit gaan oor onderrig in die hand van wiskunde in die hand van probleem oplossings en die onderrig hierin is fundamenteel hiertoe en is vir my baie belangrik. Die student moet weet wat hy moes kies, hy moes die keuse maak van sy eie strategieë.

Hentie Wilson: Na die ontwikkeling watter fase het die kursus verder deurgegaan. Watter ander fases sou jy nog kon sien?

Prof Wessels: Ek dink die bepaalde tipering en afbakening van die portefeuljes was 'n belangrike toevoeging daartoe. Ek het hulle ook gevra hulle moet elke jaar hierdie pakkette evalueer en veral in 'n oopbrief skryf wat is hulle invloed daarvan op hulle lewende as onderwysers. Dit het ook die kwaliteit en die interaksie met die groep besoekers baie positief beïnvloed. Dit hang alles saam met die korrektheid van interaksie en van soort van vrae wat hulle vra was net anderste gewees.

Hentie Wilson: Voel jy gelukkig oor die Studiegids soos hy op die oomblik staan en vir hoe lank sou jy gelukkig wees?

Prof Wessels: Nee, ons het by die punt gekom dat jy dit [die studiegids] nie dieselfde kan hou nie. En dis afgesien van die speelveld van die HOD wat verander het. Ek dink ek het reeds in 1994 kragdadige begin het met 'n bepaalde uitkoms en benadering. Ek glo ook dat die vestiging van 'n bepaalde metodologie in hierdie uitkoms gebaseer baie belangrik is.

Hentie Wilson: So u sal graag weer die Gids wil hersien?

Prof Wessels: Die hersiening van die Gids is belangrik in die sin dat 'n mens sal moet kyk na bepaalde aspekte.

Hentie Wilson: Goed, hoe sal u studente beskryf?

Prof Wessels: Ek is seker bevoorreg om 'n klomp studente te hê, behalwe in die HOD-groep. Ons het nou eintlik drie soorte studente. Die een is die HOD-groep en daar kry ons nou die gegradueerde mense. Hulle het almal tenminste hulle standerd 10. Jy kry van hulle wat ook Honneursgraad wiskunde het of dalk 'n M-graad in 'n ander rigting. So dit is werklik opgevoede mense en dit het 'n wye reeks van ervaring. Die tweede groep is die B-Sec-Ed, die VDO-groep en hulle is mense wat hoofsaaklik die Senior Teachers Diploma, die STD3 wat hulle geregtig in swart onderwys kollege is en van hulle is baie laag en minder as Wiskunde 1 omtrent die helfte van Wiskunde 1 hopelik. Maar in terme van hulle ervaringe rondom die vak wiskunde onderwys, is dit baie laag amper so laag as wat jy dit kan tel. Dit beteken dat jy dit duidelik verskil is tussen die studente met dié van die gegradueerde mense.

Hentie Wilson: En gebruik u selfs onderrig en didaktiek?

Prof Wessels: Dit is nog dieselfde groepe. Die enigste belangrike element van hierdie kursus is dat hy Engels en Afrikaans moet kan lees en verstaan. Dit is die probleem met die VDO-groep wat hulle taal is bietjie swakker as wat die ander is. Die derde groep is die B.Sec Ed, dis 'n graad maar dis 'n addisionele graad. Daar is ook hoofsaaklik swart studente en hulle kom nou as inisiële studente in en daar het ek nog nie kursusse gekry (derde jaar). Ek hoop om vanjaar die eerste studente te kry. Ek verwag dat hulle omdat hulle min studente is, hulle hoef nie 'n graad te hê nie so hulle hoef nie te vra nie - verwag dat hulle probleme sal hê.

Hentie Wilson: U het al 'n paar probleme met u studente gehad. Is daar ander probleme wat u wil noem op hierdie stadium?

Prof Wessels: Ek dink 'n baie kragtige element in die handboek - wat ek ook deurgeloop het - is die kommunikasie met ander studente en met ander kollegas en mense. Dat hulle gaan met hulle probleme en uit eie ervaring die probleme moet neerskryf en ook in terme van 'n gesprek, die antwoorde moet deurgee. Daar is min seker studente in dieselfde kursus naby hulle. En derdens interessant omdat die soort van vrae nie die tradisionele vrae wat in die onderwys gevra word nie, sukkel die studente om onmiddellik met iemand ... te vind wat met hulle kan kommunikeer. Maar ek wil dit gladnie verander nie. Dit is 'n baie kragtige proses wat ek wil beoog.

Hentie Wilson: How would you describe the environment you find yourself in in planning and found yourself. Uit die aard van die saak in afstandsonderrig

Prof Wessels: Ek was bevoorreg om in afstandsonderrig te wees vanaf 1984 tot 1994 toe ek hiermee begin het, maar tog was die omgewing a.g.v. nuwe wyse waarop mense skryf en kommunikeer. Maar ek het daardie kursusse baie sinvol gevind.

Hentie Wilson: Is dit nou wat die Buro aangebied het?

Prof Wessels: Dalk is ek die enigste een wat dit bygewoon het! Dit was baie sinvol gewees. Die omgewing was relatief nuut omdat die medium waarin ek dit gedoen het vir my nuut was.

Hentie Wilson: As u praat van die medium waarin u dit nou wou doen is dit nou die filosofiese benadering waarvan u praat?

Prof Wessels: Ja die pakket waarin ek dit moes verpak het op die ou ent. Die benadering en strategie en die bepaalde Studiegids. Dit was die maklike oplossing omdat 'n ou dit makliker so vinnig kon insink en wat meer veranderbaar is.

Hentie Wilson: So die omgewing is - samevatting, hier is 1996, 1997 en die Gids van 1998 en 1999 loop. Is daar enige - wat is veranderings tussen die opeenvolgende jare, binne die Gids, behalwe nou vir die kleur?

Prof Wessels: Ja die buiteblad was so verkies omdat die kleur duurder was. Ek dink dit was maar hoofsaaklik redaksioneel van aard en sommige van die formulering het ek duideliker gemaak.

Hentie Wilson: So dis na aanleiding van terugvoering wat u ontvang het van die studente?

Prof Wessels: Wat natuurlik ook gebeur het is dat die 1992 uitgawe van [die handboek] waarmee ek in 1994 begin het, vervang met 'n 1996 uitgawe en ek het eers in 1997 daarvan gehoor toe die studente sê hulle kry nie meer die uitgawe nie.. Toe moes ek inderhaas met Unisa se goedkeuring van Unisa 'n Unisa-uitgawe publiseer. In die volgende jaar het ek met die nuwe Gids begin. Die verskil tussen die twee nuwe boeke was dat herordening plaasgevind in terme van die leerstof en stof indeling deur Cangelosi bladsye gehad.

Hentie Wilson: Waaroor het die uitbreiding gegaan?

Prof Wessels: die uitbreiding was veral artikels wat ek ingesluit het meer klem op tegnologiese ryker as die vorige een. Ek het natuurlik 'n gemengde groep in my klas, swart, 40% blank en Indiers. Dit is nog steeds gemeng.

Hentie Wilson: Wat die volgorde van die materiaal aanbetref. Dit was eers opsigtelik, en gevra is oor wiskunde onderwys versameling van funksies. En dan het hy gepraat oor die proses en hoe 'n mens curriculum ontwikkel en dan die detail gegaan. Hoe het jy dit verander in die nuwe boek?

Prof Wessels: Daardie gedeelte het nog dieselfde gebly want ek dink dit is fundamenteel tot die hele benadering van wiskunde. Baie belangrik om die studente in die eerste en twee hoofstukke te oriënteer in wat is wiskunde onderwys en wat is die wiskunde benadering. Want jy moet doen is om die proses te laat waai en intensief te maak omdat die entoesiasme toelaat dat jy dink jy het 'n klomp ervaring, maar dit is nie so nie.

Hentie Wilson: Watter ander aspekte moet u kondoneer in die ontwikkeling van hierdie kursus, behalwe die kursus wat uniek is aan Unisa a.g.v. afstandsonderrig.

Prof Wessels: Ek dink daar is 'n paar dinge wat 'n mens kan doen maar ek dink belangrik is die taalkomponent. Vir my is dit belangrik om op 'n vatlike wyse vir hulle te skryf omdat ek agtergekom het dat hulle dit moeilik vind met die nuwe veranderinge. Dit was vir my belangrik om te verseker dat ek by daardie komponent kom. Die taalkomponent is baie belangrik. Ek het ook die rol van taal in die onderrig van wiskunde sterk oorweeg. Hulle sê wiskunde is 'n taal maar dan weet hulle nie wat hulle presies daarmee bedoel nie. Ek was bevoorreg om in 'n span te kon werk maar die span was vir my relatief baie klein. Jy het as ontwerper opgetree en wat daardie insette betref was, maar in terme van die wiskunde onderrig se kant het ek ook 'n klankbord gesoek wat ek in die fakulteit nooit gehad het nie.

Hentie Wilson: So dit was dat u alleen as vakspecialis hierby betrokke?

Prof Wessels: Dit was eintlik vir my 'n beperking.

Hentie Wilson: Wat wil u hê behoort gebeur het in so 'n geval. Wou u graag meer vakspecialiste betrek het?

Prof Wessels: Ek sou dink dit sou baie sinvol wees.

Hentie Wilson: Watter tipe vakspecialiste?

Prof Wessels: Uit die veld van wiskunde onderrig. By ons is daar nie wiskunde onderrig nie. Soos byvoorbeeld die veld van education hang ook deesdae saam en in die teorie van wiskunde onderwys dat die studente eintlik daardie agtergrond moet hê om 'n sinvolle bydrae te kan lewer. Ek het 'n kollega in Pretoria wat help met die sertifikaat kursus in wiskunde onderrig, maar wat hierdie kursus net so gebruik plus die ander module van die inhoud van wiskunde Std 9 en 10. En sy het 'n M.Sc in science education by Wits voltooi en sy het o.a. haar skripsie gedoen in onderrig van breuke wat 'n primêre veld is maar ek kon agterkom dat selfs by haar - dat hierdie benadering is baie nuut en vreemd. Dit is so asof jy die som kan doen en verduidelik maar die ander is nie so belangrik nie. Dit is een aspek in die ekstern veld wat ek sal wil verander.

Hentie Wilson: Watter ander aspekte sou u sê ook byvoeg.

Prof Wessels: Ek dink dat die moontlikhede wat die elektroniese veld bied van enige ander omdat ek glo aan 'n stewige teorie vorm en 'n bepaalde ontwikkelingslyn. Dit is vir my belangrik. Ek dink en agtergekom met tyd die boek Amerikaanse boek omdat twee so oor te kry na ons sisteem toe is nie moontlik nie. Daar is beperkinge wat mens kan uitskakel. Ekskuus u het gevra: wat is die ander ding?

Hentie Wilson: Hoe het die regering se benadering tot Uitkomsgebaseerde Leer en SAQA u geraak?

Prof Wessels: Ja in terme van die sogenaamde OBE, dink ek dat ons in S.A. nog worstel om uit te vind wat is wiskunde onderrig in terme van die OBE. Die probleem is dat ons met die onderrig met wiskunde met twee dinge te doene het. 'n Vertikale en horisontale matematisering proses wat jy moet volg en om die goed bymekaar te bring sou beteken dat jy goeie wiskunde onderrig moet gee. Nou horisontaal was vir my eintlik die konteks skepping wat jy kry waarin wiskunde alles voorkom. En vertikaal is wat jy kry die werklike aard van wiskunde. ... Die tradisionele benadering het baie nadele gehad en ook in terme van die vertikallyn. Op die oomblik konsentreer die land te veel op die horisontale konteks skepping en die sinvolle opbou van wiskundige konsepte en die bou van wiskundige strukture. Dit word nie erken nie. En dis my probleem daarmee. So my besluit in terme van OBE is dat die klem sal bly val op 'n behoorlike onderrig metodiek.

Hentie Wilson: Binne dan die OBE

Prof Wessels: Ja en die OBE sal dan die raamwerk wees waarin die onderrig uitgeoefen behoort te word. As mens dit andersom doen, gee dit vir jou probleme.

Hentie Wilson: Baie dankie. Were there any particular purposes in mind that you wanted during the course development?

Prof Wessels: Die heel belangrikste was die feit dat 'n mens voel as jy 'n verskil wil maak in onderwys, en die onderwyser behoort aan die einde van die kursus te kan sê ek was so georiënteerd in die begin en nou sien ek die saak so en nou is ek bly ek het die kursus geloop. As mens terugkyk na die tydperk voor dit dan kan 'n mens nie eintlik dink dat jy werklik beter gedoen het nie.

Hentie Wilson: Ons het nooit vir hulle gevra oor hulle ervaringe nie.

Prof Wessels: Dit was 'n belangrik aspek ek dink ook dat die hele motief om studente kommunisering belangrik is en dat 'n Unisa-student net kan baat by 'n ander student as iemand wat met hom oor die vak kan kommunikeer, en ook by die studente van dorpe gery om dit te laat plaasvind om terugvoering te kry en oral uit my pad gegaan en bekend maak.

Hentie Wilson: Die afstandsonderrig is beperk in daai opsig, né?

Prof Wessels: Die ander tekortkoming is dat die boek van Cangelosi is nie so goed as wat die vertikallyn betref nie en nou kan die gids verbeter daarop.

Hentie Wilson: En dit is nou by die wiskunde?

Prof Wessels: By die aard van die wiskunde ja. Maar nou in die gegradueerde lot se geval het 'n mens altyd iets waarop jy kan terug val in die sin dat jy 'n wiskundige agtergrond het. Dis eintlik 'n probleem met die studente wat nou nie 'n volle wiskunde I het nie.

Hentie Wilson: 'n Mens sou daar 'n addisionele hulp moet inkry? In die vertikallyn.

Prof Wessels: Ja, dit is so.

Hentie Wilson: Dit is nou die swak studente.

Prof Wessels: Op die ou ent moet die saak so besleg die vak didaktiek moet net verbeter om die bestaande wiskunde leer in 'n lyn te plaas. Dit gaan nie help om daardie studente hoër wiskunde te leer nie. Daar sal ek tot 'n hoër mate komponente moet byvoeg en bywerk wat buitekant die Cangelosi se boek is. Die handboek is baie goed in terme van probleemoplossing en bied ook 'n hele paar lesplanne aan op doelwitte om hierdie verskillende vakinhoud op 'n probleem gesentreerde manier aan te bied. En die ander aspek is die wiskunde wat hy nader bring aan die student se omgewing. Die keuse van wiskundige inhoud om wiskundige begrippe te verduidelik, dit is nog 'n vreemde ding. Maar nou dink ek 'n mens kan met 'n artikel of 'n boek, internet program wat dit makliker kan maak. Ek het die literatuur, so dit sal eintlik dan so gekoppel kan word. Ek het besef dat die ander mense wat vir ons geskryf het vir Std 9 en

10 ongeveer 1200 bladsye is, en hulle al klaar ekstra betaal afgesien daarvan om net te skryf. En om nou nog 'n leesbundel saam te stel sal die omvang van die kursus te veel maak.

Hentie Wilson: Which teaching approaches are you using to get students actively involved?

Prof Wessels: Dalk is dit meer 'n vraag wat jy uit jou veld beter verstaan. My interpretasie daarvan is nou die feit dat ons 'n klompie aktiwiteite ingesluit het in elke hoofstuk wat die student help. Die student het dan die geleentheid om 'n bepaalde hoofstuk te lees en die oorsig te kry.

Hentie Wilson: Het dit gehandel oor studie metodiek?

Prof Wessels: Ja maar studie leiding in wiskunde is altyd baie baie groot belangrik ding. Dit het 'n belangrike kenmerk van die gids en van die materiaal en ook 'n baie kragtige middel wat ons die student daar gegee het. Daarmee is ingesluit die saamstel van 'n 'mindmap' en ek kan net getuig van fantasiese berigte ook in terme van hulle waardering om vir hulle die kennis te gee, want voorheen was dit nie so omdat integrasie van die kennis maar 'n bietjie moeilik was. Die tweede aspek was die gebruik van aktiwiteite. Dit is beskou as 'n 'wrap around guide' - dit was met genoeg geskrewe teks om die lyn die handhaaf. Maar vir die aktiwiteite gaan hulle na die handboeke toe en wat hulle verder moet lees. En die handboeke bestaan ook wat hulle noem die 'vingette'.

Hentie Wilson: Is dit amper in?

Prof Wessels: En daaruit moet hulle lees die essensieel van die materiaal en dit het gaan oor die bespreking. Daarvan het ek baie positiewe terugvoering gekry. Die aktiwiteite was baie oop vrae en dit tap ook hulle ervaring sterk, hulle vermoë om te interpreteer, kommunikeer nie net met die leerstof nie maar ook met ander mense en in die klas situasie. Dit is miskien van die belangrikste en ook in terme van refleksie en evaluasie. Die refleksie element is 'n baie sterk kenmerk. Die evaluasie dan ook om ook die klaskamer situasie gedurigdeur te evalueer maar ook die materiaal waarmee hulle werk asook die curriculum waarmee hulle werk. Ek het hulle keer op keer gevat om met die Amerikaanse boek te vergelyk; ook omdat die boek Cangelosi 'n weergawe is van die ou bedeling uitgehaal is om dit dan ook in terme van ons eie situasie te interpreteer. Dit sal natuurlik weer 'n nuwe evaluering wees want ons land gaan baie sterk in op hierdie komplekse tegniese raamwerke om dit vir die onderwyser moeilik te maak. Wat die Amerikaanse se stelsel is, is regtig meer eenvoudig. Dit gaan 'n goeie basis wees om dit te vergelyk. Die Amerikaners het ook goed geleer uit hulle vorige foute uit so hulle plaas nou groter klem op die vertikale lyn dit gaan ook verrykte inligting en 'n nuwe uitgawe wees.

Hentie Wilson: Dan het jy ook genoem die probleem oplossing.

Prof Wessels: Ja dit is interessant hoe hierdie dinge bevestig word, 'n mens se aanvoeling daarvoor wat dan ook uit die literatuur kom van die veld. Dit is seker die enigste sinvolle manier. En in die verlede was dit gladnie die benadering nie. So die studente leer lekker van 'n nuwe benadering. Ook natuurlik die realiteitsbenadering, nie net die probleem oplossings nie maar die probleme wat die werklik praktiese probleme.

Hentie Wilson: Sou u dit beskryf as ervaring leer?

Prof Wessels: Ja ek sou so dink ja. Om die verskynsels in die praktyk te verstaan. Ek het ook agtergekom dat die student die praktiese probleme meer duidelik sien. Ek wil net graag terugkom na die integrasie. Ek het gesê in die boek dat goed op 'n bepaalde wyse geïntegreerd word en die benadering wat na vore kom is die kennis en taal wat geïntegreerd moet word. So die integrasie van verskillende afdelings van die wiskunde - hulle moet elektrisiteitstaal en die terminologie kan verstaan. Dit word nou sterk na vore gebring. In sekere sin as hulle die winter kursus gevolg het, dan besef hulle nou die waarheid van die oriëntering en die benadering wat konsekwent deurloop.

Hentie Wilson: What was particularly good about the whole exercise?

Prof Wessels: Ek dink die baie groot skommelings wat gemaak is van 'n ou benadering in terme van teksontwerp en materiaalvoorsiening en gepaardgaande met ervaring. Ek dink vir die aard van die probleem wat aangespreek moes word, het dit belangrike terugvoering van die studente was uitstekend. Ek het ook nou die dag gesê a.g.v. werklading en departementele verskuiwing beteken dat jy nie so vinnig kon voortbou op die nuwe ontwikkeling soos 'n mens sou wou nie.

Hentie Wilson: Is daar nog iets positief?

Prof Wessels: Die aspek van spanontwikkeling was op sigself baie goeie idee. Die feit dat jy ook nie gehuiwer het om te vra ek dink dit moes regverdig of dan verandering aanpas in terme van dit wat ons oor gepraat het en aangepas het. In die verlede was dit nie so nie. Net ek wat in die Fakulteit in hierdie veld gewerk het. Die wyse waarop mens hierdie teks skryf was nuut gewees. Die moeilikste daarvan was seker vir die student om op verskillende vlakke van die teks te beweeg en toe die aspek van terugvoering wat gegee moes word op die aktiwiteite.

Hentie Wilson: Hoekom die verskillende vlakke in die aktiwiteite?

Prof Wessels: Jy kry 'n verskillende groep en verskillende uitkomstes uit die hand van bepaalde aktiwiteite

Hentie Wilson: Soos, kan jy 'n paar verskillende voorbeelde noem? [Prof Wessels lees van die gids aktiwiteit 6.6. Hy citeer van student letters.] In die verlede sou 'n mens wonder of so 'n aktiwiteit as 'n volledige werkopdrag kon gevra word vir die student, maar hier het ek 'n deel van die vraag ingesluit. En was op die internet nie nodig om hierdie opgradeer..... dan vergelyk en identifiseer hy.

Hentie Wilson: Was dit nie die terugvoering van die studente se kant af in die portefeulje wat gaan sien nie.

Prof Wessels: Ja die oorgrote meerderheid het dit moeilik gevind om hierdie soort van kommunikasie te bewerkstellig, want jy altyd jou 10% studente wat dit werklik doen. En hulle terugvoering was vir ons van groot waarde.

Hentie Wilson: Wat is die probleme met so 'n aktiwiteit gewees?

Prof Wessels: Ek dink dis die sisteem en die geskiedenis van 'n onderwyser hou sy ervaring naby en hier gaan ons uit na wiskundige onderwys. Hulle eie oriëntasie van "hoe moet ek myself blootstel" is belangrik. En dit is hier wat ek wou afbreek. Hy moet kommunikeer met ander mense. Ek het baie keer gedink ek klim binne in 'n onderwyser in met hierdie benadering.

Hentie Wilson: Is dit tipiese vrae wat u gevra het, of is daar ander vrae wat u gevra het.

Prof Wessels: Dis die spektrum wat ek onderskei het om te besin en met daardie soort oriëntasie en met en dan om dit te gaan bespreek met ander studente.

Hentie Wilson: En wat dan ook in die wiskunde situasie as onderwyser?

Prof Wessels: Ja hierdie was 'n mede-student. Hier is beslis van hierdie aktiwiteite waar hulle moet 'n ding self uit probeer en dan in die klaskamer daarvoor rapporteer. Ek dink die refleksie is belangrik. Die aktiewe doelwit en die aktiwiteite leer van mense - ons leer net in wiskunde en in onderwys hoof ons net van wiskunde. So hier is nou 'n poging om dit aan te spreek.

Hentie Wilson: Baie dankie, wat was nog problematies?

Prof Wessels: Problematies was die omvang van die kursus. Die studente het in groot getalle gesê en het dit ook bevestig. En ek het ook gesê as ons van die kursus praat moet nie vir my

sê hoe baie werk nie. Ek weet dit is baie werk.

Hentie Wilson: Is dit binne 120 uur?

Prof Wessels: Dit sal vir die gemiddelde student pas. Dis hoekom ek ook die omvang van die aktiwiteite in die portefeulje afgeskaal het na 70%.

Hentie Wilson: Wat was nog problematiese gewees?

Prof Wessels: Nog 'n probleem is die riglyne vir die portefeulje is baie goed opgestel, die aktiwiteite is duidelik, die verwysings in die handboek, maar die vertaling van die Engels en Afrikaans was nie altyd goed gedoen nie, . Maar die evaluering van die portefeulje voel ek dit moet meer dieper en intensief plaasvind.

Hentie Wilson: Watter probleme het u daar gehad?

Prof Wessels: Laasjaar het 80 ingeskryf in die drie kursusse saam. Daarvan het so 55 eksamen gaan skryf. As hulle nou inkom en was dit nog 'n 20 tal - 'n groot klomp.

Hentie Wilson: So die hoeveelheid portefeulje wat inskryf is nog problematies self.

Prof Wessels: Ja en dan die omvang van die portefeulje is 'n ander aspek. Om die student ook te laat voel, hy kry erkenning, was nog 'n belangrike saak. Daarom het ek nie gehuiwer om vir 'n student wat redelik moeite doen in terme van dat hy besluit om 70% wil hê en hom daarvoor erkenning te gee nie. Moeite beteken vir my dat hy die eerste 70% van die totale gekry het.

Hentie Wilson: Ja, dis belangrik aangesien dit 'n proses is waardeur hulle moet werk. En die laaste afdelings het te doen met evaluering.

Prof Wessels: Ja, en die model onderwyser wat hy nou gekies het en die teorie van die eerste klompie hoofstukke wat saamval met die Case Studies.

Hentie Wilson: So dis dan 'n integrering van Hoofstuk 8?

Prof Wessels: Omdat ek vroeër die verenigings en verbintenisse met die onderwyser was dit ook belangrik om te sê in die laaste hoofstuk: - hier is ek? Adres en telefoonnommers, ens.

Hentie Wilson: Was daar nog iets wat u as problematies beskou?

Prof Wessels: Veral by die sertifikaat kursus - hulle lê op die heel onderste lyn. Ons het geld ontvang as 'n borgskap sodat ons die twee motiewe in te stel by bepaalde gebiede, so het ons 'n Yskor-toekenning gekry - rondom Sasolburg en Vereniging. Hulle het die modules gratis ontvang - studiemateriaal waar hierdie sertifikaat ontwerp is. Daardie studente het net R50,00 betaal maar hulle het studiemateriaal van R2 500 ontvang.

Hentie Wilson: Is hulle evaluering dan dieselfde as die gewone evaluering? Sal hulle eksamen skryf.

Prof Wessels: Hulle skryf ook byvoorbeeld 'n 2-uur eksamen hieroor maar die vraestel sal totaal anderste lyk. Nou is daar nog die inhoud. Hulle betaal net R250 en hulle werkgewer. Hierdie twee modules is deel van die VDO diploma en word erken. Dit sal beteken dat die standaard van die vraestel tog vergelykbaar moet wees in terme van die kwaliteit.

Hentie Wilson: Wat was nog problematies?

Prof Wessels: Taal, hulle verstaan nie wat hulle lees nie. Maar vir hulle het ons Cangelosi en hierdie materiaal naamlik vier voorgeskrewe boek gegee waar die ander studente net een kry wat net wys wat die ondersteuning nodig was vir hulle. In die werkwinkel sou dit op 'n ander manier doen - dat as 'n mens net die vier aspekte die kursus kan skei - bloot net by 100% - En

volgende dag 'n 3-uur sessie.

Hentie Wilson: is daar enige terugvoering na die student d.m.v. studiebriefe?

Prof Wessels: Ja, hulle kry tenminste twee terugvoer studiebriefe.

Hentie Wilson: En die groepbesoek?

Prof Wessels: Dit is 'n voldag seminaar waaraan hy praktiese blootgestel word aan probleem situasie, hulle moet probleme oplos en hulle werk in groepe. Dit vind plaas in Julie-maand. Die kursus is 'n jaarkusus, self in die semestersisteem.

Hentie Wilson: Enige ander problematiek?

Prof Wessels: Die eksamen situasie is ook iets wat hulle met die tyd sal ontwikkel en sal die klemming toenemend skuif na toepassingsvrae en nie net opsteltipe waar kenmerke beskryf word. Of beskryf die bepaalde metode van hoe jy die metode bv. 'n toepassingsonderrig. Ek dink dit sal moet skuif na toepassing in die sin dat hier is 'n bepaalde onderwerp soos bv. die oplossings van faktore of enigiets, beskryf aan die hand van daardie bepaalde metode of waaruit jy sal skeep, of spesifieke wase assosiering sal toepas. Daar is vrae daaroor maar ek dink dit sal die studente deur die jaar moet wys daarop dat hulle op daardie vlak sal moet kom wat die eksaminering betref. Die eksamen situasie moet die studente op sy voete kan skryf, uit leer ervaring om te wys wat hy weet.

Hentie Wilson: Is ook die portefeulje 'n evalueringsmetode? U het genoem dat daar 'n redelike uitval syfer is, maar al daardie studente eksamen moes skryf. Is die voltooiing van die portefeulje 'n probleem?

Prof Wessels: 55 uit 80 het die portfolio ingehandig. Vroeë was die portefeulje se sluitingsdatum 15 Augustus, ek het toe geskuif na 15 Julie en dit baie sinvol beleef omdat die studente as hulle by die dag seminaar opdaag het reeds baie aan die portefeulje gewerk. Dit was sinvol gewees. Daarmee het die hoeveelheid studente wat die portefeulje sinvol voltooi het, het toegeneem. Maar as ek by die eerste week in Julie kom en ons praat van portefeulje, dan weet hulle of 'n duidelike prentjie gekry. M.a.w. ek het gevind dat die kwaliteit baie goed is. Die omvang van die portefeulje en ook goeie begrip en dat dit moeilik is as onderwyser om so oor 'n ervaring te praat om so te ontleed en so daardie vlak te analiseer, waarop die vrae gerig, ek sou dink om dit te ondervang sal ons die proses langer moet maak. Dit is 'n onbekende veld vir die student.

Hentie Wilson: As ek reg verstaan, is die kritiese beskrywing van 'n ervaring 'n vreemde beginsel vir sekere studente?

Prof Wessels: Ja, vir definitief meer as die helfte van hulle.

Hentie Wilson: So dit sal herskryf moet word met spesifieke begeleiding wat dit aanbetref, oor hoe om dit te doen byvoorbeeld die skryf van sy eie case study en dan krities daarna kyk.

Prof Wessels: Van dink en praat is skryf is die moeilikste vir die studente. Ons het dit natuurlik dit probeer ondersteun - ek was bewus deur die gesprekke het ons gesê bespreek dit met bepaalde persone, "Gaan kyk, en neem waar en op die ou end gaan bespreek dit met 'n mede-studente."

Hentie Wilson: Hoe voel jy oor die spanbenadering in hierdie spesifieke onderrig

Prof Wessels: Ek dink 'n ou sal moet baie goed wees om dit op jou eie te kan doen. spanbenadering is vir my deurslaggewend in so 'n situasie. Die insette van die span as ek kyk na hierdie eerstens, daar het van die redaksie bepaalde insette gekom.

Hentie Wilson: Enige probleme met spanbenadering?

Prof Wessels: Ek sou dink wat die tempo, die soort van verstaan van die projek en die lyn wat opgetel moet word uit die projek. Die vermoë van die span, dit is belangrik. Daar kan sekere 'n lys van probleme opduik. Maar ek het daarvan min beleef omdat ek hoofsaaklik dit deurgewerk het. En die ander op 'n later stadium bygekom. Ek weet nie wat is die ideale span nie.

Hentie Wilson: Is daar enige probleme wat jy wil byvoeg, want ons is klaar met die vrae wat ek wil vra. Ek sê vir jou baie dankie.

Prof Wessels: Vir die rekord wil ek net sê dat sonder die spanbenadering en sonder jou hierdie projek nie so goed sou afloop nie. Jy het regtig baie intensiewe vrae aanhoudend gevra wat ek dink die kwaliteit van hierdie projek gemaak het. Ek is dankbaar vir die ervarings wat ek daaruit kon leer.

END OF INTERVIEW

INTERVIEW 2

Topic: Descriptions of the *Mathematics Subject Didactics* course (MMAT00-9)

Course Coordinator: Prof Dirk Wessels (DW) - lecturer
Interviewer: Prof le Roux (AR)
Date and time: 29 November 1997; 8:20 a.m.
Strategy: Semi-open questions.
Recording method: Video tape A and B

TAPE A and B

Environment: The interview environment was relaxed, comfortable with little noise, but private. The interview started calmly and fairly relaxed, however, neither of the parties really know one another. This is an added advantage. However, later in the interview the Prof Wessels becomes visibly irritated. Prof le Roux is a calm, methodical interviewer, with a slightly detached attitude.

Instructions:

Prof le Roux: Feel free to discuss your feelings openly as this is a research environment. All the 14 April 2003 discussions will be confidential.

The discussions are being recorded on video tape for research administration purposes. May we continue with the recording? Yes

May the researcher refer to the comments made on the tape in her research? Yes

Request to interview and to ask questions which was granted.

INTERVIEW STARTS

Prof le Roux: Question 9: What did you want to ACHIEVE during the course development? Dit is die bereiking en ontwikkeling gedurende die kursus wat jy ondervind het.

Prof Wessels: Wat 'n mens op daardie stadium gedink het en wat ek nou weet is daar 'n baie groter perspektief op die goed kan kyk. Maar is dit seker ook voordelig want nou kan ek dit nie artikuleer nie, m.a.w. dit kan omsit. Ek wou eerstens wiskunde onderrig oordra maar in die proses was ek bewus van die totale tradisionele persepsie van wat bepaalde wiskunde is en ek wou verandering bewerkstellig na die positiewe toe en die positiewe beteken vir my dan probleemoplossings gerig, want in die verlede was dit gladnie so nie. Ons handboeke en gidse was dit gladnie so nie [volgens die probleemoplossingsmetode nie], so ons is eintlik in hierdie huidige handboeke vër voor die vraestelle. Die sillabus was nie beskikbaar nie. Ons is eintlik in hierdie handboeke [gidse] ver voor [die Suid Afrikaanse beweging]. En vraestelle deurgewerk. Ons wou [fokus op] interaktiwiteit tussen my en die student, maar veral dan ook die leerstof. Dit was die groot belangrike goed gewees.

Ek dink ek kan weer terugkom. Ek wil net konsentreer. Die student moes baie langer tyd spandeer aan wiskunde onderwys en dat hulle nie in drie dae se tyd 'n werkopdrag moes uitwerk nie. Daar was die gids en 'n handboek wat die student moes uitwerk. Daar was nie genoeg tyd nie. En ook wil bereik het saam met die verandering is die ontwikkeling van vaardighede wat hulle nog nooit gehad het nie. En wat ek wel glo wat nie in die HOD raamwerk aangebied word nie. Ek sou dit graag eendag wou vasstel. My aanvoeling is dat die studente skryf hulle het goed teëgekome wat hulle nog nooit gedoen het nie, of wat van hulle verwag was nie. Die proses van verandering was vir my nogal baie goed en positief. Omdat jy moet maar die paragrawe 'n bietjie goed skommel en skud voordat jy 'n ding verander. Sy het gesê jy het 14 dae se intensiewe onderrig nodig en al hierdie middels ens. voordat jy dink jy 'n verandering gaan doen. Of 'n kortpad.

Prof le Roux: Goed ons gaan maar nou aan dan kan jy intussen invul soos jy kan.

Question 10: What factors in the LEARNING ENVIRONMENT influenced learners' ACTIONS and UNDERSTANDING OF STUDY MATERIAL?

Prof Wessels: Hierdie vraag van studiemateriaal is 'n algemene vraag en nie op myne spesifiek nie maar ek gaan net op beide spesifiek praat maar ek gaan net maar meer oor myne praat, en hoe die studiemateriaal die studente se aksies beïnvloed het. Ek dink die aard van die studiemateriaal wat ek gestudeer het, is ongelooflik belangrik - ek het dit ook ondervind uit die Nederlandse onderwys agtergrond wat ek bestudeer het waar die probleem is een of ander benadering en absoluut daarop gebou is oor die regte seleksie van probleme en die sekwensie van probleme en om uit te kom by die kern van wiskunde. Wat dit betref is die aard van die studiemateriaal vir my ongelooflik belangrik - en vir studente sou ek sê dat van die probleme en sekwens van probleme om by die wiskunde uit te kom.

Die aard van die studiemateriaal is vir my baie belangrik. Ek sou sê dat ek dink die interaktiwiteit, die lesers

vriendelikheid, die oopheid van vrae en aktiwiteite wat gestel word, is 'n kernmerk van hierdie projek. Omtrent 171 aktiwiteite uit 'n 110 bladsye en dit was baie gekompakteer en was natuurlik wrap-around ... en op 'n baie goeie handboek gerig. Die handboek opsigself sou nie iets beteken het nie as ek nie vir hom 'n opdrag gegee het om 'n werkopdrag te voltooi nie. Dit geld vir ander handboeke en het jy so 'n gids nodig om daardie ding te omsluit. Die kommentaar was ook - ek dink dit kom later.

Prof le Roux: So dus was die klem baie sterk op die aktiwiteite.

Prof Wessels: Ja die klem was op aktiwiteite en uit die aard van die aktiwiteite in terme van waar ek die student erken het as 'n onafhanklike volwasse leerder en die aktiwiteite en vrae was baie gebaseer op sy eie ervarings, eie siening en eie interpretasie. Ek het vir hom van die begin af gesê die tradisionele benadering is 'n gevestigde benadering in ons land is nodig. Ons kan deur 'n proses gaan en die kommentaar van die student het dit toe bevestig.

Prof le Roux: Dit het navore getree dat hulle het besef dat dit was eers so gedoen en nou is dit verander.

Prof Wessels: Hulle moes dit voltooi om die Diploma te kry. Die omvang van die aktiwiteite en die aard van die werkopdragte omdat hulle ook gedwing word om met behulp van die gids deur die hele boek te werk - nie net sekere dele van die boek nie - hulle moes die boek woord vir woord lees.

Dit was vir my belangrik om daardie intensiewe tydrawende proses te gaan en die studente het gesê dit was vir hulle 'daunting'. En wat ook interessant was hulle moes dit slaag om 'n diploma te kry.

Die aksies wat hulle beïnvloed het en so sê hierdie dame [read from the letters] "due to the fact that I had never done something like this before and the tasks seem daunting. The way I was taught maths in the school ... however it was with great enthusiasm that I finished this assignment.

Prof le Roux: Daar kry jy dit in die opskrif.

Prof Wessels: Ek dink dit sal werk dat as ek by die woord kom moenie vir my vertel hoe moeilik dit was nie want ek weet dit - maar ek het net soveel briewe daarvan dat ten spyte daarvan wat dit vir my beteken het.

Prof Wessels: Een van die faktore was dat hulle goed moes kan lees. Maar ons het hulle ook deur 'n proses gevat van hoe om te lees, bv. 'n 'mind-map' En van die knapste studente het gesê dat die 'mind-map' vir haar die beste was. Dit het vir haar beslis gewerk. Van die studente het ook gesê dat dit was eintlik woes om hulself te leer ken.

Prof le Roux: Soort van 'n mind-mender gewees.

Prof Wessels: Ja, van hulle het ook gesê dat hulle so onderrig en so opgelei was en so klas gegee.

Prof le Roux: Die nuwe benadering.

Prof Wessels: Ja, die nuwe benadering. Ek sou dit in ander terme ook wou gemeet het. Ek sou 'n baie meer intensiewe vraelys opstel. Van hoe om akademies te lees en die kere wat hulle gesê het - dit het vir haar gewerk maar van die moeilikste goed wat sy eintlik moes doen. Dit was woes om hulleself te leer ken.

Prof Wessels: Hulle sê dat hulle so opgelei en so gaan hulle klas gee en nou voel hulle weer anders oor die nuwe benadering. Ek sou wou hulle besoek het om baie intensiewe vrae te vra.

Prof le Roux: Bevestiging daarvan te kry. Dirk baie dankie. Baie dankie nou gaan ons aan na vraag 11. Hy lees dit voor:

Question 11: In your opinion, which LEARNING THEORIES that you employed in the design of the course had a DECISIVE INFLUENCE on the ACTIONS of the students?

Prof Wessels: Ek dink wat hier gesê kan word, is in die leer teoretiese benadering van wiskunde baie bewus geword van die behandeling van die HOD -. en almal praat daarvoor en min weet hulle wat daarvoor gaan. In Vista onderwys is dit aanvaarbaar. Dit was baie moeilik aanvaar deur die onderwysers, maar ek het regtig probeer om hierdie konstruktiewe siening te laat gaan in die materiaal.

Die boek is nie baie alhoewel hy baie interaktief en meer leer-gesentreerd is. Ek sou dit nie anders kon bepaal as die leerteorie. Ek dink dat die groter openheid en my eie erkenning wat ek in die gids gee, is ek het nie die antwoorde op alles het nie. Ek het die studente genooi en van hulle het vir my gesê wat hulle voel en ek dink dit het terwyl almal praat - dit het 'n sterk rol gespeel. Van hulle het ook vir my beskryf in watter dieptes hulle was.

Prof le Roux: So hulle het tot 'n punt gekom wt hulle laat 'despair' het.

Prof Wessels:: Maar tenminste die openheid en die gesentreerdheid en die feit dat jy kan wiskunde deurbring as 'n menslike aktiwiteit en nie net iets wat êrens staan en jy gaan haal dit maar finale idees het. Hulle het seker vir hulle klaarheid gekry oor sekere dinge. Dalk het die konstruktiewe aanslag gehelp.

Prof le Roux: Dit is dan nou vraag 12. Question 12: What ACTIVE LEARNING STRATEGIES did you EMPLOY in the design of the course?

Prof Wessels:: Ek verstaan dat ek bepaalde goed gedoen het wat die student aktief laat leer het. En aktief sien ek dat hy sy kop gebruik het. Die feit dat dit probleme oplossingsgerig was dat dit 'n wye spektrum gedek het, nie net waar dit 'n oop aktiwiteit gedek het en nie net uit die boek moet lees en die kern moet uithaal maar ook hulle eie idees kry en dan ook onderhoude met hulle kollegas bewerkstellig het.

Hulle moes bespreek en ook ouers en kinders onderhoude voer. Hierdie soort aktiwiteit weet ek nie of - ook met ouers en kinders onderhoude voer - ek het hulle ook gevra hulle moet studie groepe vorm, en dat hulle nie moet praat met 'n student nie, maar met 'n ander onderwyser uit 'n ander vak ook benader.

Die aktiwiteite is ook geklassifiseer, ek kan ook nie hier presies bewoord nie, maar daar is basiese goed wat op lae vlak inkom wat die student baie moeilik gevind het. Wat ook intellektuele inkom..... verskeidenheid van spektrum maar ook ... die feit dat daar 'n verskeidenheid in die spektrum wasen die feit dat daar was 'n redelike verandering wat plaasgevind het, en dit vertel my dat dit redelik suksesvol sal wees.

Prof le Roux: Ek dink learning strategy and development
Question 13: What ACTIVE LEARNING STRATEGIES had a DECISIVE INFLUENCE on the development of competencies, skills and knowledge of the students? Dit wil vir my voorkom asof vraag 12 en 13 nou aan mekaar is.

Prof Wessels:: Die studente het getuig hulle siening en aard van die kennis heelwat verander het. Die feit dat hulle op 'n bepaalde manier opgelei is en klas gegee het op hierdie handboeke en die probleem-oplossingsbeandering wat praktyk gerig is, is dit eintlik 'n totaal nuwe ding vir hulle gewees. Hulle eie kennis en dan wat die skills betref, het beslis verbeter.

Dan wat die 'skills' betref is daar heelwat dinge wat navore gekom het. Hulle vermoë om vir hulle self te dink en self op te tree. Dit is veral sterk na vore gekom. In die klas is daar met die metodologiese varieteite in terme van onderwys metodes in die wiskunde klaskamer want die handboek klassifiseer bepaalde en refleksie van hoe om op te tree. Die wiskunde inhoud bepaalde a, b, c, en elkeen van die het 'n eiesoortige raamwerk, aanpassing en ommeswaai veroorsaak. Daardie soort vaardighede het ook sterk ontwikkel. Dan ook die skills om groot klasse te hanteer. Die algemene didaktiese goed wat die handboeke aangespreek word, is sterk en kragtig weergegee. Van hulle het ook gesê die ander didaktiek opleiding wat hulle gehad het, dit was lig gewees.

Prof le Roux: Dit was 'n pynige proses?

Prof Wessels:: Ongelukkig ja, maar dit het ook sy foute gehad. Dit was 'n bydraende faktor was om hierdie geheel van my aanslag op hulle, effektiewer te maak.

Prof le Roux: Ja, afstandsonderrig is nogal 'n probleem. Nou na vraag 14:
Question 14: What course DESIGN FACTORS had a *positive* affect the learning and understanding of students? Motivate your answer.

Prof Wessels:: In die gids was dit hoofsaaklik oor die lees en studie strategieë wat ons in die begin van elke hoofstuk ingevoer het om die student in staat te stel om die moeiliker inhoud en formaat te bemeester. So hulle is taal matig in staat gestel om makliker toegang te kry tot die moontlikhede.

Dan die groot klem geplaas op waarde van beplanning en voorbereiding en die proses daaraan verbonde, en die interaktiwiteit, leser vriendelikheid van die materiaal, lokalisering van die materiaal - dan die konteks wat 'n mens probeer uitlig. En dan die student met homself konfronteer en met die werklikheid konfronteer. En dan die assesering daarvan in terme van logistief, konstruktief en ook om homself in 'n groepsituasie te stel.

Ek kon werklik sien in studente wat geïsoleerd was dat hulle baie swaar gekry het. Dan was daar andere soos huisvrouens wat hulle rigting wou verander het. Uit die aard van die saak, studente is huisvrouens en wat nou 'n ander pad wil volg.

Prof le Roux: So die omstandighede was vir hulle moeilik.

Prof Wessels: Dit was nogal vir hulle moeilik. So daardie omstandighede wat ek vir hulle gestel het - vir party nadelig gewees.

Prof le Roux: Gaan dit positiewe. Gee net vir my kans ek wil sien wat gebeur daar - MET DIE OPNAME-BAND. Vraag 15 dan nou.

Question 15: What course DESIGN ASPECTS had a *negative affect* the learning and understanding of students? Motivate your answer.

Prof Wessels: Dit wat ek toegepas het is die feit dat hulle daardie boek moes lees en vir die tweede derde taal Engels gebruiker was dit moeilik.

Dat hulle moes meer neerskryf. Dit was vir hulle moeilik. Dit was dinge wat ek sien daar swak formulering is en min geskryf. As ek vir hulle punte moet toeken. Van hulle sê hulle kon die vraag nie verstaan nie en dit was vir my aanleiding dat hulle nie in-diepte en diversiteit van hierdie proses nie so goed deurgewerk is nie. Maar ek dink tog die relatief bietjie wat gedoen is, op hulle leer en verstaan, tog 'n voordeel was.

'n Ander aspek was dat ons het begin met studiegidses en studiebriewe op 1992 uitgawe van hierdie boek moes skryf en toe skielik is die boek nie meer beskikbaar nie. Toe moes ek baie vinnig die bladsyverwysings op die nuwe boek - die 1996 uitgawe - aanbring/pas.

TAPE B:

Prof Wessels: So die feit dat die eerste boek vir 2 jaar geloop het en daarna onverwags en sonder my medewete verander het moes ek, op daardie stadium in die min tyd wat ek gehad het, moes ek toe nou, die nuwe boek kry - en toe het ek nou die aanpassings gemaak op die bladsye maar met die ordening van die uitgawe en die aktiwiteite se nommering - daar was nogal taamlik veranderinge wat moes kom. Om dit in 'n gidsvorm gegee is, was die blad-verwysings verskillend en die Afrikaanse en Engels het verskil van die handboek so die studente wat die 240 aktiwiteite moes doen het 'n rukkies gevat voordat hulle hierdie foute besef het. M.a.w. daar was 'n ontwerp wat in die gids gewerk het maar studente het gesukkel net omdat dit hulle lank gevat het om "in" te kom en verwysings te kry.

Die ander ding was dat daar heelwat voorbeelde van die Amerikaanse handboek - van hulle verskuiwings wat hulle voor 1998 en na 1998 deurgegaan het. Hulle het gefokus op aspekte daarvan wat vir hulle belangrik was. Ek het die taak gehad om ons leerplanne te vat en vergelyk met wat moontlik is in ons nuwe landwye verskuiwing. Maar die Std 5 to 10 sillabus is 'n baie dik dokument wat baie kos om te versprei en wat op die ou ent nie aan die studente uitgestuur is nie. Probleme was daar beslis a.g.v. ons besluit. Hulle het nie die salabus nie, of hulle het, of hulle kan nie kry nie.

Prof le Roux: Goed baie dankie. Dan vraag 16.

Question 16: How would you describe the ability of your course to promote DIALOGUE between participants?

Prof Wessels: Ek sou sê uitstekend omdat dit baie vrae was en aktiwiteite was wat nuut was vir die studente. 'n Student moes homself eers vind, dan 'n mede-student as dit bespreek moes word met iemand anders. Dit was tog 'n baie sterk punt van die kursus gewees. Die studente het mekaar gekontak en hulle het baie moeite gedoen en 'n maat tevind op langafstand en die faksfasiliteite te gebruik.

Ek het nêrens maar nêrens gevind wat studente on-etiese goed ingestuur het nie. Dit was vir my totaal nuut omdat ek skielik die gevoel gekry het dat hierdie studente 'n totaal ander taak moes verrig.

In terme van die veranderinge, dit het fantasties gewerk. Hierdie kursus is driekeer die volume van 'n HOD-kursus. Ek wil dit nie afskaal nie omdat dit die kwaliteit sal verlaag. Ek doen wat ander kursusse nie doen nie.

Prof le Roux: So die projefeule is amper soos 'n verhandeling.

Prof Wessels: Ek dink dit is baie goeie oefening vir die student om te skryf en te lees en nie net te memoriseer nie. Hulle het in briewe geskryf dat hierdie kursus se benadering so belangrik is en dat hulle tyd daaraan spandeer. Ek het naderhand sleg gevoel daarvoor. Foute is daar tog, maar as jy so iets optel dan is dit te laat om reg te stel agv die eienskappe van afstandsonderrig.

Prof le Roux: Vraag 17 nou.

Question 17: How did your course assist your distance education students to learn INDEPENDENTLY?

Prof Wessels: 'n Voleldige pakket wat hulle ontvang het met geweldige riglyne het hulle in staat gestel. Ek weet hoe hy voel, ek dink dit het hom vertrouwe gegee om te waag en vryheid gegee om sy eie skills soort van te artikuleer. Daar was natuurlik baie vrae wat hy [die student] alleen vir homself moes uitklaar. Hierdie was 'n deel van die sukses van die onafhanklike leer. In die jare wat ek in die fakulteit is was dit gebruik om drie take op te stel vir die student waar die student moes weergee wat hy weet. Hulle het nie so opgetree in daardie kursusse nie en dit was vir my 'n totale bewys van die onaktiwiteit van die stelsel. Ek het net besluit dit sal met my nooit weer so wees nie.

Prof le Roux: Dankie. Vraag 18.

Question 18: How did particular course ASSESSMENT STRATEGIES contribute to getting students actively involved in the learning process?

Prof Wessels: Ek dink die begeleiding wat ek hulle gegee het om die materiaal te bemeester was belangrik om hulle in staat te stel om dit te doen. Die pad wat dan gekies is, het hom in staat gestel om self die evaluering, wat 'n baie belangrike element is, self te doen. Die kwaliteit is ingebou deur die ontwikkeling van die materiaal en voortdurende kontrolering van die materiaal oor die tydperk.

Ek het hulle uitgenooi om niks uit te vee of iets van die aard nie. Ek wil graag sien as hy goed regmaak en groei [a criterium for portfolios]. 'n Voorbeeld is om 'n vraag weer na drie hoostukke te stel, dan sien jy hulle skryf aan die kantlyn hoe hulle sieninge verander het. Ek dink die aard van hierdie samestelling het gehelp om hierdie studente werklik betrokke te kry.

Prof le Roux: Vraag 19.

Question 19: How did you as the lecturer MANAGE the particular course ASSESSMENT STRATEGIES?

Prof Wessels: Ek het dit so ingebou dat en die toepassing en bestuur op 'n bepaalde wys. Eerstens dis

Tweedens is die aktiwiteite wat vir my belangrik was. Ek blaai bladsy vir bladsy en soek na bepaalde dinge in die portfeuille. En dan lees jy al meer en meer. Ons het 'n evaluerings instrument ontwerp vir die portfeuille sodat ons hulle op vlakke kan plaas van level 0 tot 4 en wissel tot 90% aan die hand van bepaalde kriteria. Hy moet homself ook evalueer. Maar dis interessant om te sien dat die beter student huiwer om te veel punte te gee - ek moes hulle lig van 80% lig na 90%, omdat ek weet hoeveel tyd daaraan gegee is en hoe belangrik dit vir die student is.

Ek en Hentie het begin met 'n artikel om die kwalitatiewe navorsing en sy het vir die eerstekeer gehoor van probleem-gebaseerde benadering. Ek het van die projufeljes getrek en vir haar gegee en sy het dit in 'n stadium op haar lessenaar geplaas. Dit was soek maar toe het ons agtergekom hoe teleurgesteld die student was. In hierdie tyd hier kom die goed toe uit. Ek het agtergekom hoe belangrik dit was.

Prof le Roux: Vraag 20:

Question 20: How did the TEXTUAL LAYOUT contribute to promoting active learning? Which textual layout aspects were incorporated in the study material?

Prof Wessels: Ek dink die aktiwiteite is so 'n integrale deel van die hele werk. Ek het eintlik tussen die aktiwiteite om die kontinuiteit met die boek te behou gesukkel en moes in die aktiwiteite verwys na sekere bladsye, so daardie soort van uitleg het eintlik die kontinuiteit bevorder.

Die handboek en benadering is totaal Amerikaans georiënteerd en ek moes verander van die Amerikaansheid en die teks en die bydraes en my swaai na ons situasie. Dit is 'n belangrike uitweg. Ek het vreeslik voorskrytelik gewees en dan antwoord ek maar in terme van my eie ervaring en die tradisionele siening en waarheen ons beweeg.

Prof le Roux: En die vakleerling daartoe.

Prof Wessels: Natuurlik sit ons met 'n groot deel van die bevolking en hulle het nie kennis en vaardighede nie. Dit was maklik om hulle te antwoord ook.

Prof Wessels: [vertel van sy ervaring in Amerika]

Question 21: Is there any OTHER aspects that you would like to add?

Prof Wessels: Ek het niks om te sê oor ander aspekte nie. Om terug te kom na punt 9 is dit vir my belangrik om te sê dat met my eerste oorsese besoek in 1994 - hoe lyk die wiskunde onderwys in die wêreld. Ek het ook 'n kursus bygewoon juis met die skryf van materiaal, dit het die regte tyd gekom en ek was gereed daarvoor.

Prof le Roux: Baie dankie Dirk.

Analysis of the data

Validation of the questions against the thematic concerns and questions according to the nominal group technique principles.

1.	Aim of the project: Questions 1 and 6 - Focus Question (FQ) 1.1, 1.2, 2.1
2.	Aspects that have an effect on the learning and understanding of the students: positive, negative and environmental including meta-cognition, study strategies, problem-solving strategies, reflection, motivation, self-confidence and attitudes: Questions 8, 12 and 13 - FQ 1.3-1.9
3.	Textual layout and structure: Question 15 and 16 - FQ 1.2
4.	The dialogue between participants; Question 11 - FQ 1.1
5.	Course development stages: Question 2 - FQ 2.1
6.	Aspects that have an effects on the course planning and development: Question 4 - FQ 2.2 -2.3
7.	The student profile: Question 3 - FQ 2.2-2.3
8.	The assessment strategies: Question 13 and 14 - FQ 2.2-2.3
9.	Active learning strategies: Question 10 - FQ 2.2-2.3
10.	The team approach: Question 5 - FQ 2.2-2.3
11.	Independent learning: Question 12 - FQ 2.2-2.3
12.	Learning theories: Question 7 and 9 - FQ 2.2-2.3