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**DIFFERENTIATED COMPUTER SCIENCE SYLLABUSES :**  
**A FUNDAMENTAL PEDAGOGIC PERSPECTIVE**

by

**JOAN PAMELA VAN HEERDEN**

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## **SUMMARY**

South Africans are confronted by social and economic problems of magnitude and complexity that cannot be ignored by curriculum planners. Increasing population statistics, plummeting gold prices, disinvestment, unemployment and political uncertainty continue to make economic and social ventures hazardous in their undertaking. Man accesses his world through education, and curriculum planners should, therefore, anticipate the future socio-economic structures of this country, and beyond, thereby providing meaningful school curricula that will prepare learners for the technology-intensive workplaces of modern times. Curriculating wisdom would include the:

- \* needs of the learner as he prepares for adulthood;
- \* demands of society for utilitarian citizens; and
- \* structuring of knowledge that encourages learning rather than discourages it.

The secondary school adolescent is career oriented and progresses towards a state of independent thought and behaviour. The school is obliged to address the situation of the adolescent and provide learning opportunities that will prepare him for a meaningful place in society. Selected themes from the discipline of computer science have been evaluated according to the essences of the pedagogic school structure. Differentiation of the subject content has been indicated so that pupils of all academic abilities can benefit from the learning experiences offered by the content.

A questionnaire, sent to Education Departments in South Africa, determined that computer science was available to a very small percentage of pupils for matriculation creditation. A sample of these pupils completed a questionnaire designed to determine their regard for the subject and the influence it had on their choice of career. Three pupils were interviewed to assess, primarily, the rôle that computers played in their family and peer relationships.

All investigations confirmed that computer science is a highly desired subject, skilfully able to fulfil the needs of the adolescent as he prepares for his place in society in the most meaningful, contemporaneous and dignified manner.

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## **CHAPTER ONE**

### **1.1 INTRODUCTION**

The present era is one of transition, perhaps even turbulence. In recent years, society has been subjected to major changes in attitudes, values and aspirations, dictated primarily by changes effected by developments in the technological sciences. An awareness of a variety of issues such as the population explosion, pollution of the environment, the energy crisis and the more turbulent aspects of political change has come about. Looking to the future, the modern-day prophets (or scenario-planners) cannot avoid predicting the profound impact that continued developments in the computer field will have on task-efficiency, home-life and leisure activities. The ability to deal effectively with information technologies in business, industry, medicine, government and the home, has created a need for a computer-literate populace. Evidence of this is clearly provided by the Council for Scientific and Industrial Research (CSIR) publication "Technology Impact 1990". A perusal of this report illustrates that there are few (if any) activities within the sciences, ranging from Earth science to Aeronautical science, that do not incorporate the use of a computer in their fields. Children, adults, students and teachers will live, work and consume goods and services in the technological world; a world becoming increasingly dependent on the use of computers. WHEELER (1983:7) urges that:

"... we need to understand what is happening and be very careful about the options that are selected ... we must harness the potential offered by the new technology to feasibly construct a future which is exciting and challenging".

The following statement, made in the 15th century by Francis Bacon, confirms that the attitude of man towards the utilization of "instruments" has spanned society for many years in history.

"The unassisted hand and the understanding left to itself possesses but little power. Effects are produced by means of instruments and helps (aids), which the understanding requires less than the hand" (in: Kinzer et al., 1986:4).

Both Bacon's and Wheeler's pronouncements have relevance in today's technological world. Bacon emphasizes that man's performance of physical feats is limited, and to improve these performances, aids are utilized. Similarly, man's mental abilities are also limited and, to achieve his goals, he must also employ "instruments" and "helps". There has been almost 400 years progress from Bacon's era to today, when life would seem unfeasible without the daily incorporation of mechanical aid to improve the execution of the demands of some physical task. The impact of the computer on human lives, to assist with, not only the mental tasks that seem humanly insurmountable, but also the physical tasks, has certainly been revolutionary. The computer, however, contrary to the industrial road-grader or domestic coffee-grinder, has the ability to change the nature of its output to suit the user-situation, and this requires far more than an instruction leaflet to make it effective. Its utilization requires insight and training on the part of the user. It would not be far-fetched to say that in the future man's ability to realize his full

potentialities may be very closely linked to his competency in the field of technology, to his being comfortable with making use of the assistance which the computer can afford him. The man of the future is the child of today. To ensure that the child of today can uphold his own self-sufficiency, self-respect and human dignity in the world which is envisaged, serious thought must be given to the means of helping him to cope with the realities of the future. The first step in this direction is to ascertain the current state of affairs concerning the guidance and assistance obtainable to pupils.

In South Africa, over a number of years, beginning in the early eighties, several instructional computer projects, such as PLATO and TOAM, have been operational in schools and industries in selected areas across the country. In other schools, computer centres funded mainly by funds raised by parent-bodies, have been established. While there is no doubt that, within these endeavours learning took place, the type of instruction received has resulted in the computer being viewed as an expensive toy that lacked the sophistication required for serious instruction. Hence, the "formal" instruction tended to cease at the end of the junior-secondary phase of schooling and only the "boffins" continued to dabble at home with their personal computers, or had the privilege of being selected to study computer science as an extra-mural seventh subject.

There are those, however, who have come to appreciate the use of the microcomputer as a powerful tool that can change, not only the control of information and communication, but also the course of educative teaching. Using the computer for computer-aided instruction (CAI) has far-reaching considerations for the education situation, but these are not pertinent to this study. It is the situation that surrounds the

adolescent who studies computer science as a subject at school, that is relevant to this study. The adolescent's world is dominated by thoughts of peers, careers, power, control and independence. The question arises as to how the specific subject, computer science, can facilitate the adolescent's realization of the goals of adulthood. As early as 1980, the idea of computer literacy as a "social force" was addressed by MOLNAR (in: Kinzer et al., 1986:47) of the National Science Foundation in the USA who stated that:

"Access to information and communications may turn out to be the most significant social force in the information society... . Information can be transformed into power".

MOLNAR wrote that the next great crisis in education would be "computer literacy", and he also stressed that educators have an obligation to make today's pupils computer literate. School-leavers must have an understanding of the relationship between the computer and society and how this relationship affects their lives. Pupils should be taught to use the computer in ways that they may be expected to use it in their work, home and leisure environments. In this way, the feeling of being a useful member of the family, peer group and society could be heightened, and the adolescent could envisage an opening to adulthood and independence through mastery of the computer. One possible way of achieving this successfully is to infuse the computer into all academic areas at every level of education.

The obvious question that now arises is: "How successful is the current system in South Africa in making South African pupils computer literate?" Details of the answers are not encouraging, but will be dealt with later in Chapter Four (4.2). It would appear, from the data available, that computers are not being infused into a major portion of the

curriculum, and that pupils are not being provided with training in the use of computers in scientific, business and mathematical applications. The disciplines that an information society demands are apparently being ignored by the curriculum designers in South Africa.

When examining the technological advances of the last 25 years, one cannot help being awe-struck. A simultaneous examination of the advances made in the school in the instruction in computer use over the same period in South Africa, generates cause for concern. Indications are that educators are not keeping pace, even getting off the mark in an attempt to keep up with the strides in technological progress. If today's pupils are to be prepared for the proliferating information age, the author is of the opinion that the micro-computer ought to be permitted to infiltrate the school curriculum as a major force. Only by taking heed of the demands of the future can pupils be helped, through the implementation of carefully considered curricula, to progress to adulthood where they will be able to fulfil the demands of responsible, capable and well-adjusted adults. This aspect will be more fully examined in Chapter Two (2.5) and Chapter Three (3.2).

The preceding outline of the importance of using computers to relate school education to the demands of a technological society, always keeping in mind the human needs of the adolescent in his quest for adulthood, provides a point of departure for analysing the situation pertinent to computer education.

## **1.2 SITUATION ANALYSIS**

There are primarily three types of schools today which offer secondary education with

a bearing on a future career: the general academic, technical and commercial schools. The technical and commercial courses are offered in exclusively technical (for boys) or commercial (mainly for girls) colleges, or such specialized departments may be part of a comprehensive-type school. DUMINY (n.d. : 259) urges a renewal of pedagogic didactical reflection. A traditional school is described as a modern-day school based on the outdated psychology of the nineteenth century. DUMINY is against a traditional education because of the

"... one sided accentuation of intellectual forming, the ease with which pupils are allowed to mechanise work, the exaggerated accent on memorization and the dependence on working habits ... . This intellectualism is one of the most important defects which we have inherited from the old system".

The education system at present nurtures the traditional education, wherein subjects may constitute a pot-pourri from the languages, the natural sciences, the social sciences or the economic sciences. It is believed that such a general education allows a child a wider choice of career on leaving school. All three types of schools offer pupils the opportunity to gain entrance to a tertiary institution such as a university, a technikon or a teacher-training college.

A careful consideration does not appear to reveal a problem with the present education profile, and if computer science were to be introduced, it could comfortably be incorporated into any one of the general, technical or commercial curricula. However, according to POURIS (1989:27) there is a major problem in South Africa in that:

"... the country is at risk. South Africa's once unchallenged wealth and prosperity is vanishing gradually ... one of the many causes of the problem is ... the erosion of the scientific and technological education

and the diminishing of the attainment level of the people in this country".

This opinion is sustained in the article by HOFMEYR & SPENCE, "Bridges to the Future", which appeared in the Anglo American Corporation's publication "ULTIMA" (1989:37). The following features of education in South Africa are some that are identified by the authors of the article:

- \* a small pool of black matriculants with mathematics and science
- \* a shortage of high-level manpower
- \* underprovision of vocational and technical education
- \* rote memorization and dependence on a teacher or a textbook is the dominant learning strategy in schools
- \* the inability of pupils to solve problems because teachers are bound by the content of subjects to prepare pupils for external examinations.

NYAKA (in: The Sunday Star, 1989:2) confirms that these crises are particularly evident in Black schools under the control of the Department of Education and Training (D.E.T.).

These factors point to pupils being coached at schools for dependence and non-adulthood. Adulthood implies a career, a feeling of being of use to society, independence and the ability to solve problems successfully. Subject knowledge must be established in schools, but the emphasis is increasingly being placed on subject-related skills of which problem-solving is paramount. Language, thinking and problem-solving skills must be integrated within subject areas and specific disciplines and not taught in a subject-free way. The author will attempt to reveal in this study how computer science, as a subject, may

contribute towards preparing a learner for adulthood.

It would appear that the present education system (supply) meets neither the needs of the economic system (demand) nor the needs of the pupils in order to progress adequately towards becoming a responsible workforce with their human dignity inviolate because they are aware of their own worth and competence. A thorough re-evaluation of the present subject-course structure is necessary. Barlow Rand's human resource executive ALAN TONKIN (in: Hersch, 1990:9) describes it as unfortunate that matriculation does not prepare people for work. The way in which such irrelevance may affect the young adult when he, having completed his secondary school career, tries to gain meaningful employment, may be far reaching and this may lead to a permanent sense of incompetence and unworthiness. TONKIN makes an urgent plea for change and that "... school education be re-focused and made more relevant".

A number of factors which have been identified by the author as being important in implementing this shift in the emphasis on education, need to be examined.

### **1.2.1 THE HUMAN DIMENSION OF THE ADOLESCENT PUPIL**

Phenomenology defines the essence of being human as man living out his relationship with the world. Being-in-the-world is concised in the German word "Dasein", representing man's human situatedness in the world. Man finds himself in situations arising from the world about him and it is his ability to co-exist, co-ordinate and cope with these situations, that creates his own personal world, to which he attaches his own personal meaning. Man wishes to obtain a grip on the world; to control that which

affects him so that his place of habitation is safer and more secure. The child and adolescent (not-yet-adult) observes the adult as having achieved this control, and they desire and yearn for the same. They strive for adulthood, and the security it appears to bring, by appealing to the adult for guidance.

The adult (the educator in the education situation) is obliged to guide the non-adult (educand) along a path that prepares him for the world that he (the educand) will encounter. This may not be the exact path followed previously by the educator; it may be completely different. The educator, as the knowing, informed partner, is commissioned in the pedagogic situation, to anticipate the world to be encountered by the learner, and to guide, advise and act accordingly. The educator must research reality and acknowledge the reality facing his ward. If he fails to anticipate and acknowledge the truth of the world facing the adult-in-making, then he will certainly fail in his task as pedagogue. Without an awareness of the inevitable differences that result from perpetuity, the educator may prepare his ward for a non-real world and the outcome will be that the educand will be hopelessly unprepared for the demands of adulthood.

Adulthood, as a general and universal aim of education, ought to conform to certain fundamental aspects and to these further attention will be given in Chapter Two (2.3).

The next factor which is seen to effect a demand for a change in the content and nature of education in secondary schools, is the phenomenal growth in population.

### **1.2.2 THE PHENOMENAL GROWTH IN POPULATION**

People are the most valuable and versatile resource in any community. They are the

source and the perpetuation of all progress. However, population growth may be a blessing or a curse. Wealth producers are productive participants in a country's economic activity, while the unskilled, unemployed people are a burden to the social system. Statistics issued by the DEPARTMENT OF EDUCATION AND TRAINING (1989:7) show the projected increase in population over the period from 1980 to 2020 as 20 million, 19 million of whom will be Black citizens. These facts translate into equally massive numbers of learners and learning needs to ensure that those completing the minimum required number of schooling years, join the ranks of at least the "employable-citizens", to afford them an opportunity of leading a meaningful existence.

The emphasis of the academic curriculum at schools has to shift from the general to the specific, therefore, specific courses must be incorporated into high school syllabuses to equip a school-leaver for employment. The traditional school certificate, reflecting a general education with no specific skills or knowledge as required by the business and industrial sectors of the community, no longer guarantees a school-leaver employment opportunities. Tertiary education for all school leavers is an economically prohibitive thought for any country exhibiting a population expansion such as South Africa is experiencing at present.

Computer skills and expertise, gained as part of the school academic program is one specific subject that may contribute towards improved employment opportunities for school-leavers. Another factor which illustrates the need for a shift in the emphasis in education is the revolution in communication.

### **1.2.3 THE REVOLUTION IN COMMUNICATION**

Before the technological revolution in data-communication became a reality in the latter part of the twentieth century, pupils were taught the "three Rs" : Reading, wRiting and aRithmetic. The media of communication emphasized in all walks of life was the book which was used to transfer knowledge from person to person. It is difficult to envisage the book ever being replaced, but as the population of the world continues to proliferate, so too, do knowledge and data. Books are large and storage of information therein takes up space. Space in an overpopulated world is optimum. The computer and its secondary storage devices are rapidly being recognized as the answer to communication and data storage. As the three Rs were considered to be the basis of education before the communication revolution, computer literacy is being considered by a growing number of people concerned with education as essentially an integral part of modern education, which is substantiated by VAN DER STOEP & LOUW (1987:207) when they contend that:

"Even at this stage computer literacy is as important an educational aim as learning to read, write and do arithmetic".

The next factor to be considered which highlights the need for a refurbishing of the existing education emphasis is the present economic situation in South Africa.

### **1.2.4 SOUTH AFRICA'S DIMINISHING ECONOMIC VITALITY**

"Sanctions" is the rod that has beaten the economy of South Africa for more than a decade. It is not within the scope of this dissertation to discuss the reasons for the call

for sanctions or the details for adhering to such calls, but it is relevant to address the effects that sanctions have had, indirectly, on the education structure.

#### **1.2.4.1 Limited Funding for Post-school Education and Training**

International companies which had previously invested in South Africa but have since disinvested, had offered bursaries to promising students for tertiary study. With these bursaries no longer being available, many of the would-be recipients have now to end their formal education at matriculation level. Those companies which have endured the stormy economic climate of the past decade, have had to limit the in-service-training opportunities offered to their staff and now demand adequately trained school-leavers. It is becoming paramount that school-leavers should have a marketable expertise, such as computer literacy, to bridge the gap between school and employment.

#### **1.2.4.2 Limited Employment Opportunities**

While many international companies were disinvesting in the South African economy, there were only limited possibilities of new investments becoming available in the immediate future. Parallel this unfortunate scenario with a rapidly-expanding school-leaving population, and the scene appears dismal. Only those seeking employment with desirable and marketable skills to offer, would be likely to succeed in obtaining employment on leaving school.

The image of South Africa from the perspective of overseas and African countries has improved dramatically since February 1990. The channels for international trade are still littered with hurdles and problems but the gateways are, nevertheless, opening and this

has provided hope for new growth and development potential for all aspects of life in South Africa. Positive outcomes in the political and financial fields must certainly be felt in the social and educational realms of society as well.

The impact that technology has had on society is undoubtedly a factor that is affecting, and will increasingly continue to affect, the nature of the curricula offered in schools. This will now receive attention.

#### **1.2.5 THE INCREASED DEMAND FOR TECHNOLOGICAL MANPOWER**

South Africa has an inordinately small number of technologically and scientifically trained personnel. Assuming that the average conditions prevailing in developed countries abroad, indicate a minimal desired state of affairs for South Africa, the country would have to increase its scientific and technological manpower by at least four-fold (Pouris, 1989:36).

Assuming that this increase in scientific and technological manpower demands a similar increase in all of the industrial, the commercial and the research components associated with such a technological/scientific development, the demand for adequately trained computer personnel would increase on a similar, if not greater, scale.

Having established that the demand for computer personnel can no longer be ignored, it becomes necessary to determine what the present possibilities are for education and training. The neglect in schools of attending to the requirements for computer skilled citizens has resulted in costly courses being offered by computer training centres. These will now be discussed.

### **1.2.6 "COMPUTER ACADEMY" TRAINING CENTRES**

A plethora of computer training academies have sprung up in the commercial and industrial centres of South Africa. One has merely to open any national or local newspaper or magazine to be confronted with a selection of "colleges" offering courses in computer skills, over periods ranging from one week to six months, generally at prohibitive prices. The courses offered by these colleges usually train participants in the skills required for the three typical business packages: a wordprocessor, a spreadsheet and a data base. The efficient utilization of a commercially-developed package is only one component of a large and diverse field of computer education. As will be described in Chapter Three (3.5.2) and Chapter Four (4.3.3), the thought processes required for the range of topics in a computer science syllabus extend from remembering what key to engage on the keyboard, to the most insight-demanding cognitive exercises associated with programming and Boolean algebra. The "computer academies" do, however, have their use in bringing adults into touch with the modern practical skills of data communication required for a specific task in an office situation.

Computer literacy today requires that the participant be educated with the knowledge and skills to design and, thereafter, tap a continuously changing information base, sort it, analyze it, change it, synthesize it and use it effectively for work, leisure, personal and community activities. These characteristics of the subject require that it be taught within a formal education situation by suitably qualified and proficient educators. Some of the computer training academies make use of video-type instruction material. This is clearly not an education situation, as it is without an educator. Anyone who claims to be an

educator is required to have an understanding of the various fields of study embracing the science of Education. He is to understand, for example, what might be considered as educationally valuable and what might be distinctive about a person's rôle as an educator. GAUTHIER (in: Harnett & Naish, 1978:85) pointed out that a clear statement of educational aims is required for the justification of any program as being educational. When educational aims are not clear, then a good many questions about curriculum content and methods arise.

The computer academies have their functions outlined for the inculcation of certain basic skills concerning the computer, but the events taking place in them are far removed from education. The situation may be compared to a doctor who treats his patients for an illness but has no concept of what health is.

The reasons stated above (the humanness of the adolescent, the population explosion, the communication revolution, economic factors, limited employment opportunities, technological demands and the non-education ethos of computer academies) illustrate the need to incorporate computer science as a subject in the formal, academic curriculum at secondary schools. To substantiate this KELLY (1984:xiii) is quoted as saying:

"... there is great educational potential in the microcomputer ... (but) ... its present use leaves much to be desired".

With this attempt at a description of the situation which motivated this investigation now completed, it is appropriate to formulate the problem recognized as arising from this situation.

### 1.3 PROBLEM FORMULATION

South Africa's economic, social and education situations are in a state of turbulence, each being dependent on the other two. The country is in a financial recession, unemployment has reached critical dimensions and the education system does not seem to satisfy the requirements of the industrial and commercial sectors, resulting in thousands of matriculants each year realizing that they are unemployable. Dreams and expectations are shattered, as is enthusiasm and motivation on the part of the adolescent to strive to become a valuable member of society. The school has the responsibility to prepare the school-leaver for a meaningful existence by equipping him with knowledge and skills to take his place as a contributor to society so that the community may benefit socially and economically and he may benefit personally. The author intends to investigate the potential of computer science as a true discipline, suitable for inclusion in a senior secondary-school curriculum, which may be able to fulfil the needs and desires of the adolescent as he contemplates, tests and enacts his

- \* relationship with his parents
- \* relationships with his peers
- \* future career
- \* place in society
- \* intellectual abilities
- \* potential as an employee
- \* independent status at home, at school and in society.

The author will proceed to utilize the essences of the pedagogic school structure as

described by LANDMAN et al., (1982 : Scheme G) to investigate the potential of computer science as a means of assisting the adolescent to actualize these adulthood goals.

It is now necessary to define the concepts to be used in the course of this study.

#### **1.4 DEFINITION OF CONCEPTS**

Before an in-depth investigation of a theme can proceed, it is necessary to clarify the meaning of terms and phrases to be used in the context of the investigation. As the problem is to be approached from a Fundamental Pedagogical perspective, it is of particular importance that this perspective be clearly defined.

##### **1.4.1 FUNDAMENTAL PEDAGOGICS AND THE PEDAGOGICIAN**

Fundamental has its origin in the Latin words *fundamentum* (ground, basis, foundation) and *fundare* (essential, perennial, innermost, constantly and universally present). Pedagogics is derived from the Greek words *pais* (child) and *agogos* (leader). (Van Rensburg & Landman, 1988:354 and 436).

Pedagogics owes its existence to the study of people in the world (Kilian, 1976:73). The pedagogician's search is for the essential characteristics of the phenomenon that interests him; namely, Education. The pedagogician's involvement with education begins with an observation of the education situation and proceeds with a progressive and systematic revelation of the nature of its manifestations in the universal situation. A number of prominent pedagogicians, among them KOHNSTAMM and WATERINK, through

purposeful study, evolved the science of education (Pedagogics). The pedagogician is involved with the study of this science of education, in contrast to the pedagogue who is involved with the actual task of educating. The task of the pedagogician is to expose the fundamental structures that underlie the phenomenon of education. It is for this fundamental or basic reason that the discipline is called Fundamental Pedagogics.

The theme in Pedagogics is concerned with "child leading" (Du Plooy & Kilian, 1985:4). Pedagogicians study and verbalize the path taken by an educator and an educand, with the educand's adulthood as ultimate goal, up to a stage when the ward can find his own way independently in life. The educand is led out of his present situation of dependence into another which he ought to achieve, and in which he will be able to take responsibility for his own choices and actions.

It must be made clear why the term "Pedagogics" is not interchangeable with the term "education" or "pedagogy". DU PLOOY & KILIAN (1985:30) explain that "Pedagogics" is the scientific investigation of the phenomenon of education, whereas "education" means to accompany a child to a higher level (niveau) than his present one, therefore the educative practice is implied.

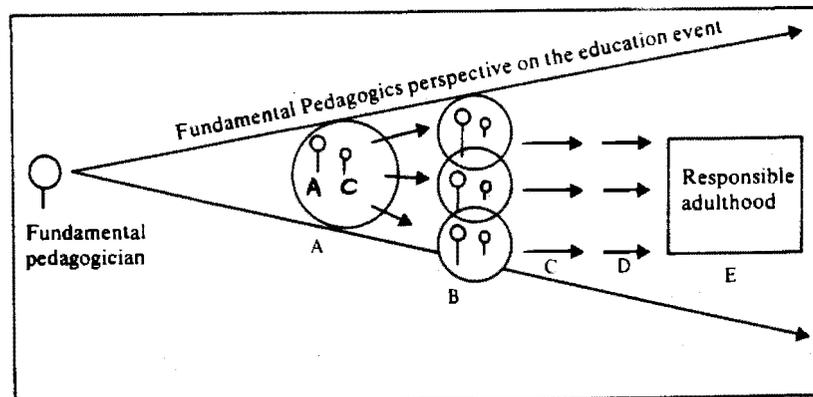
LANGEVELD in his "Beknopte Theoretische Pedagogiek" (1944) (in: Du Plooy & Kilian, 1985:41) revealed that in order to practice Pedagogics as a science, the pedagogician must reflect deeply on the phenomenon of education as it reveals itself in the original experience of man. He must, of necessity, structure the phenomenon of education where it reveals itself and then analyze it critically. To practice Pedagogics as a science is one of the many ways, according to DU PLOOY & KILIAN (1985:49), of

gaining a refined grip on reality. Man's being in the world (Dasein) encompasses an infinite number of smaller realities, and each is revealed by its own language usage. The realities must be seen in their basic structures in order to distinguish what is particular only to the human being (in contrast to what is characteristic of animal, plant or machine).

Fundamental Pedagogics is the study of the event of the pedagogic reality in its interhuman context. Education is not the result of a scientific investigation - it is "simply always there!" (Du Plooy & Kilian 1985:49); in fact it is as old as mankind itself (cf. Van Vuuren ed., 1976:17). Education has an ontological nature and because it is confined to humans, it has an anthropological nature as well. Clearly the pedagogician may not be merely an empiricist, a psychologist, a sociologist, a didactician, an historian or a philosopher. He must interpret his data pedagogically, that is, he must decide whether they are important for pedagogically accountable educative events. He must study and describe all his data systematically in order to make a meaningful and relevant contribution to Pedagogics.

The perspective of Fundamental Pedagogics on the reality of education can be represented simply and systematically so that it illustrates the structure of the education event (Van Vuuren ed., 1976:18).

FIGURE 1: FUNDAMENTAL PEDAGOGICS PERSPECTIVE ON EDUCATION



- A. The fundamental Pedagogician examines the "education situation" where an adult (A) and child (C) are in one of the basic relationships of human existence.
- B. Adult and child are in a certain relation to each other. They are therefore related. In this relational structure three closely interrelated relations show up clearly: the trust relation, the understanding relation and the authority relation, which together form the relationship structure.
- C. The education events take a given course. Pedagogic effort is marked by actions such as association, encounter, intervention or interaction. These actions form part of the progression structure.
- D. The education event is a dynamic event which takes a particular course because educator (adult) and educand (child) are actively engaged in characteristic activities; the educator instructs and the educand learns. This is only one

example of many pedagogic activities. The word 'event' is used rather than 'process', as 'process' implies a fixed, automated set of machine-like movements, in contrast to 'event', which is coloured by the participants, their circumstances and their personal inputs.

- E. The full education event is aimed at a special goal. All pedagogic acts are goal-oriented, otherwise it would be aimless and meaningless for an adult to concern himself with a not yet adult. Education is oriented to the ultimate adulthood of the adult in the making. Education ought, therefore, to aim at adulthood as its ultimate purpose and this goal should be describable in terms of a special goal structure, of which some of the components are responsibility, significance of existence, human dignity, self-evaluation and self-knowledge. Fundamental Pedagogics, on the other hand, seeks to reveal the essences that underlie the education event; those scientifically validated, unchanging essentials that are valid and reliable norms of any education event.

Having mentioned both the pedagogic situation and the education situation in this section, it appears as if these situations may exhibit both similarities and differences. It becomes necessary to distinguish between these concepts in order to reveal the true characteristics of each.

#### **1.4.2 THE PEDAGOGIC SITUATION AND THE EDUCATION SITUATION**

The Fundamental requirement for education is the presence of not less than two persons:

the educator and the educand. Either of these may be more than one in number in relation to the other. A situation or set of circumstances must confront them, in which the educator is obviously able to render aid to the educand because of his (the educator's) greater maturity, dependability, experience and knowledge, therefore, the educator's being an adult. Any associative relationship between adult and child is not necessarily pedagogic in nature, as the influence of the educator may not be normative in nature. However, a pedagogic relationship will always be:

"... one of trust, cognisance and authority, demanding from the educator an assumption of responsibility towards the educand" (Kilian, 1973:29).

Some pedagogicians prefer to differentiate between these two situations, namely the education situation and the pedagogic situation. According to KILIAN & VILJOEN (1974:33) the original situation of adult and child is called the EDUCATION situation. That which is created in the mind of the pedagogician, that on which he reflects, is known as the PEDAGOGIC situation. The pedagogic situation also refers to the post-scientific or school situation where the educator is a pedagogue having undergone specific training to become a teacher at a formal education institution.

A distinction must also be drawn between the pedagogic situation as a re-constituted education situation in the consciousness of the pedagogician, and the pedagogical situation as a researched scientific situation (Kilian & Viljoen, 1974:45). In the pedagogical situation the education and the pedagogic situations are scientifically researched, justified and accounted for with regard to the fundamental structures and essences of the pedagogic. Hence these situations pass via the consciousness of the pedagogician to the

scientifically accountable fundamental pedagogic situation.

### 1.4.3 THE CHANGING NATURE OF THE EDUCATION SITUATION

A time will arrive in any education situation, when the ward (child) will oppose the authority of his mentor (adult). The discrepancy in their niveaux of authority no longer requires perpetuation of the relationship which initially arose because of the situation confronting them. At the start of the relationship, the educand saw the educator as a symbol of power and knowledge, but gradually the educand matures to independence and greater self-respect, confidence and responsibility. Gradually both educand and educator will accept the other as fellow human-being and companion.

Because the human-being enters the world as a new arrival, the world addresses man for perpetuation of his survival. Man is thus primordially situated within the world. His origin is temporally and spatially related to the world. (Kilian & Viljoen, 1974:242 and Van Vuuren ed. 1976:14-21). It appears that man finds himself in a situation of being cast into the world, and a situation is constituted whereby, because of the surrounding circumstances, an awareness is created of an "opposite"; an opposition or confrontation which must be addressed by man in order for him to live as a responsible person in the world. In the scientific situation (pedagogical situation) such an "opposite" is called the question mark or problem which is placed over and against the pedagogician. (M.O. Oberholzer ed., 1978:13). The possibility may even exist that the ingratiation of the computer into society may be observed as such an opposite. Man is confronted by the computer in the world and it is the task of a pedagogician to attempt to justify or reject the computer's practical implementation in the phenomenon of education.

The concept of education as human activity, by means of which the phenomenon of education is actualized in the human situation, needs further clarification in order to determine the need for accountability of computer instruction in the education situation.

#### **1.4.4 EDUCATION**

"Education is a purposeful aid to the non-adult to fit him for independent fulfilment in his appointed rôle in life; a conscious effort to promote the act of maturation" (Kilian, 1973:11).

KILIAN stresses that education is the positive influencing of a non-adult by an adult with the specific purpose of effecting changes of significant value. Fundamentally, all education concerns itself with the character and spiritual values of the educand; to arouse in him a consciousness of, and appreciation for, the true significance of his existence in the world. There are as many activities bearing the title "education" as there are institutions offering them and disciplines describing them. It is important at this stage to clarify the meaning of terms often encountered within the context of education and also to describe the meaning to be attached to "education" for the remainder of this study.

##### **1.4.4.1 Forming (Moulding)**

The impact of all the environmental influences on human beings, both children and adults, represents formation and moulding. It is a continuous occurrence from birth to death, according to KILIAN (1973:16) but never completed to perfection. Not all influences are conducive to the elevation of character, and the evolving adult voluntarily takes possession of what he chooses and assigns his own meaning to it. Two people may

be influenced by identical environmental circumstances but, because of their individual, personal internalization of these influences, and their normative framework, respond in their own individual way, which may differ significantly from others. Moulding differs from education primarily because adult intervention in the actualization of the non-adult is not a prerequisite for the moulding situation. Moulding, although it is affected by education, does not necessarily have as its goal leading a child to adulthood.

#### **1.4.4.2 Teaching**

According to KILIAN (1973:17), teaching is a means of educating but not all teaching is educative. He suggests that education is chiefly concerned with moral formation (affective, spiritual domains), while teaching concentrates on intellectual development involving bodies of knowledge and skills useful for communal existence. Teaching is not confined to a school, and similarly a school does not exist purely for teaching; education occurs also through the medium of teaching. Teaching does not depend on the mutual interaction of adults and children as both adult and child can teach another child or adult or be taught by them.

#### **1.4.4.3 Training**

According to KILIAN (1973:18), training is reserved purely for animals. By repeated application of the same stimulus, an animal can be trained to perform a desired act. A reward (or punishment) usually accompanies the successful (or unsuccessful) execution of the act. Training has no significance for the animal performing the act, except that it pleases the trainer. This view of KILIAN may not be upheld by people who regard

training for athletic events a purely human occurrence. An athlete will confirm the mental preparation, the dedication and commitment that are integral components of training for a prestigious athletic event. It is, however, the body that is ultimately trained to perform the final physical feat, so for definition purposes, thus far, it may seem appropriate to confine training to activities associated with the physical, and not the mental, capacities of humans or animals.

Academics associated with "teacher training" and the "training of nursing staff" may well object to the execution of the training of their students being referred to as a non-mental activity. According to VAN HEERDEN (1987:18) there can be no practical training without the association of theoretical knowledge. The author therefore formulates the definition of "training" for purposes of this study as:

The progress towards the mastery of a manual or physical skill accompanied by the inculcation of the necessary theoretical knowledge required to enhance the acquisition and performance of said skill.

#### **1.4.4.4 Habit-formation**

Habit formation can be described as the subject adopting a mode of conduct without considering any innate preference for it. If an adolescent is guided along a pedagogically designed course, aimed at improving his independent status in life, then it is the educator's intention that he systematically acquire the necessary faculties needed to distinguish between the virtues and vices of habit formation. Adopting a habit may have a positive or negative influence on the person subjected to that habit, as habits may be termed good or bad. Similarly, a habit may persist in one's life without any due

consideration for its advantage or disadvantage. Education is an intentional event with a predetermined goal (adulthood). Habit formation, therefore, cannot be classified as an educative event, as habit formation is an activity adopted with little or no consideration for future implications or intentions. It may, however, influence the education event.

#### **1.4.4.5 The Pedagogical Understanding of Education**

Education is concerned with considerably more than the child's intellectual activities; it penetrates into his inner spiritual and moral existence. The term "education" will be used to describe the purposeful influencing of the educand, with the definite goal of eventually enabling him to formulate, for himself, a code of moral and spiritual ethics, along with a body of intellectual knowledge that will assist him to fulfil his own desires in life, as well as enabling him to contribute meaningfully to his communal existence. The educand initiates the event of education by addressing an appeal for support to the adult (Van Vuuren *ed.*, 1976:71). The adult then strives to lead the educand in a way which enables him (the educand) to bring to fruition a desired and approved change in behaviour. If the experiences and events that occur are normative and pedagogic in nature, a gradual equality between adult and adult-in-making may be attained.

#### **1.4.4.6 Education and Technology**

Education reveals to a young adult his needs for existence and the rôle he must play in a technologically dominated world. Unfortunately, not all the influences emanating from modern society are helpful to the youth in shouldering their responsibilities. It is for this reason that the young people of today, far more than at any other time, require more than

merely being taught; they need an education which has been scientifically and pedagogically investigated, structured and formulated, in order for them to be able to meet all societal and intellectual problems with courage and competence. The possibilities provided by the world of technology for the enrichment of life are infinite, but they also contain an innate threat of depersonalization, by reducing man to a number to be filed on a computer. It is here that pedagogics must intervene to ensure that the education of today provides the youth with:

"... the support, the 'point d'appui', of values transcending time as a bulwark against eroding perils" (Forester, in: Kilian, 1973:14).

This opinion is consolidated by ATHERTON (in: Terblanche, 1987:140):

"The task of education in helping our kind to make the transition to a new lifestyle is one which will demand all our skills, insights, flexibility".

#### **1.4.4.7 Education According to its Nature**

Three main types of education will be described here according to the nature of the educative occurrence (in: Van Heerden, 1987:22).

##### **\* Formal Education**

This occurs within the constraints of a formal education institution, such as a school, a university, a technikon, or a teacher training college. Education has, on previous occasions in this study, been described as the intervention of an adult in the life of an adolescent (or child, non-adult, adult in making) to lead

him to adulthood. Although this study is not concerned directly with tertiary education, it may be relevant to discuss, here, the educative activities at tertiary institutions. Many students may be adults but the fact that they are studying further, indicates that they wish to improve their status as adults. Students at tertiary institutions may thus be engaged in an educative event that leads them to a more desired state of adulthood, an enhanced adulthood. All tertiary students are being guided by adults (the lecturers) although, chronologically, the student may sometimes be more senior than the lecturer. There is no such concept as "perfect adulthood" and neither is there an alpha and omega of education. One adult may assume the rôle of educator in one situation, while simultaneously, in a different situation, he may be led by another adult to enhance his own adult status.

\* Non-formal Education

This occurs in organized "classroom" situations, but the outcome is not a nationally/internationally recognized certificate, diploma or degree as in the case of formal education. Secretarial courses, catering courses, creative-art courses, computer courses, brick-laying courses and welding courses are examples of non-formal education activities. For many, such courses are for self-enrichment, but for others it means greater expertise for enhanced employment opportunities.

\* Informal Education

Everyday experiences, including conversations, travel, discussions, theatre attendances, successes and failures at various mental or physical challenges, all

contribute to an informal education. The experiences are usually spontaneous and not institution or content bound. A mother and child experiencing singing, playing and stories together, constitute an important part of the informal education of the child and possibly also of the mother. Negative experiences, as well as positive experiences contribute to one's informal education.

Only when the educand understands a specific normative concept and voluntarily internalizes it with meaning for himself, does education really take place. Education is aid given to facilitate a choice, to impose judgement of values and to show strength of will and perseverance for beliefs and moral standards. The mentor must not continue, unrelentingly, to prescribe conduct or a mode of thought. The educand must, by degrees, shoulder the responsibility for which education has equipped him.

"The finest reward of education is responsibility dictated by inner morality" (Kilian, 1973:13).

#### **1.4.5 THE SECONDARY SCHOOL CHILD AS ADOLESCENT**

The secondary school spans standards six to ten, and the respective ages range from expected averages of thirteen to eighteen years. A scholar enters secondary school as a child; he leaves it as a youth on the threshold of adulthood. This period witnesses great physical transformations, but it is the psychological development, according to VREY (1979:165), which is the key to the level of adulthood that has been attained. Adolescence is the term which describes these transitional years. The Concise Oxford Dictionary (1964:17) defines adolescence as "... the time between childhood and manhood".

INLOW (1963:200) describes adolescence as:

"... that interim period in life when childhood is behind, adulthood is ahead and ambivalence is the intervening legacy".

The same author (1963:201) identifies four noteworthy features of any group of adolescents. They are their:

- \* search for conformity (in dress, language, achievements);
- \* discovery of a new world of interests and knowledge;
- \* heterosexual interests; and
- \* rebellion against adults and adult restraints.

The feature that is particularly relevant to this study is the second-mentioned: the new world of interests and knowledge that the adolescent finds is within his reach because of his increasing physical abilities, social independence and mental skills. A basic tenet of psychoanalysis is stated by INLOW (1963:203):

"The psychic energy in man will flow into positive channels if not influenced adversely by environmental conditioners".

Man, after all, is made in the image of God and is, therefore, created "good". However, it is the environmental conditioners present in the world, such as drugs, money, possessions, television, media and politics, that may influence man to become unlike the image of God. Man, being in the world, cannot escape these influences. It is essential for those who know better and have more experience, to guide those of lesser knowledge and experience so that environmental influences detour as little psychic energy as possible

from its flow into positive channels.

The adolescent is eager to learn. A faulty curriculum, a disturbed individual or a culture that is in turmoil may nevertheless be instrumental in causing him to resist knowledge. Educators, as policy makers, can control the curriculum. An up-to-date, challenging curriculum will enhance pupil response leading to the curriculum outcomes of greater knowledge, keener understanding, wholesome attitudes and greater aptitudes for the skills required to become a valuable member of the community.

If a pupil poses the question (usually with an appropriately complaining tone): "Why do I have to learn this?", the educator must certainly have a sound answer for such a justifiable question. Failing a plausible response, the educator may find that the adolescent will resist any further knowledge offered on the topic, and consider it to be (yet another) adult imposition.

DU PLOOY & KILIAN (1985:34) describe the child as:

"... a human being who is very strongly orientated towards the future".

The child longs for a meaningful future and will eagerly avail himself of the opportunities prevailing in his pedagogic milieu to move in the direction of his future destination, provided that he sees these opportunities as meaningful. GRIESSEL (in: Van Vuuren ed., 1976:116) expresses the same opinion, adding to this the importance of the teacher's task, namely:

"... the directing of the child's full course of development as a movement in the direction of his future destination, [is one of] the most important tasks demanded of the educator". (The phrase in parentheses has been included by the author to accommodate the use of only one task mentioned by Griessel.)

Worthy of mention here is the adolescent's degree of personal awareness - the ideas he has of himself and the world around him. The implications and significance of these ideas for his self-actualization depend on his cognitive development. According to PIAGET (in: Ausubel, 1978:317), the adolescent is in the period of formal operations. His powers of logical thought enable him to move beyond the concrete, the personal experiences, to a more abstract, speculative, analytical mode of reasoning. This mode of thinking, according to VREY (1979:178) enables the adolescent to formulate a hypothesis to an incumbent problem and compare the possible solution he proposes with the practical situation. If he is not satisfied with the relationship between his thoughts and reality, he is able to try out other possibilities. The adolescent should have developed a cognitive domain that facilitates problem solving, involving abstract and analytical exercises. He should be challenged with problems relating to the reality of the world around him, and the future ahead of him.

#### **1.4.6 SELF ACTUALIZATION OF THE ADOLESCENT**

VREY (1979:13) defines the individual's self as the totality (Gestalt) of what he can call his own. It includes his system of ideas, attitudes, values and whatever he commits himself to.

"The self is the individual's total subjective environment; the centre of experience and of meaning". (Vrey, 1979:13).

BINSWANGER (in: Vrey, 1979:14) describes the concept of the Gestalt of the child's world in which he must orientate himself as:

- \* The Umwelt: the environment - a world of physical objects which must be understood to be of use to him.
- \* The Mitwelt: the world of interpersonal relationships.
- \* The Eigenwelt: the world of the self - one's relationships with oneself.

In his progression towards adulthood, the child will initiate relationships with the objects in his Umwelt, with the people important (to him) in his Mitwelt, thereby establishing an Eigenwelt or a self-concept.

One becomes strongly aware of the progress achieved with the help of education when one considers the physical growth, the increasing ability to solve problems and the improved control of emotions of the adolescent. VREY (1979:13) speaks of this progress as self-actualization. It is in the company of people, important to him and with whom he can positively identify, that the adolescent creates and discovers meaning. It is usually during the middle (15 to 18 years) and the late (18 to 22 years) adolescent years that the previous generation feels the subconscious need to hand over the "torch of civilization" to the adolescent to perpetuate values, norms and development of the culture. Tension and friction between the two generations often arises because of the sentiments of both parties; the younger does not seem to nurture the same interpretations of the pending responsibility as does the older, while the older feels that the younger is not quite equipped for the task. Self-actualizing is a comprehensive task in the development of the child to adulthood and VREY (1979:166) identifies three aims of self-actualization:

- \* Meaningfulness as the will to understand: he must understand and orientate himself with respect to objects and situations that arise in his world. He must attribute meaning to situations and in so doing, "make them his own".
- \* Adequate self as the will to be somebody: he must experience personal adequacy and this will encourage him to achieve the goals that he sets for himself.
- \* Belonging to the people he esteems: he must be accepted by the people he values. During his adolescent period the peer group, the parents and the educators are important and valuable people with whom the adolescent needs to form relationships of acceptance.

During the final year of the secondary school phase, the adolescent's self-concept reaches a high level of permanence. Not only does his relationships with parents and peers show new characteristics, but the underlying motivation of a pending career drives him to achieve goals that will ensure his acceptance at his chosen career.

"... a career is chosen as a matter of self-actualization. The career is seen as the area within which self actualization can take place" (Vrey, 1979:186).

The adolescent's life-world is always expanding, partly because of the broadness of his interests and his acquaintance with ideas. The relationships that he enters into are an expression of the life-world of the secondary school child.

#### 1.4.7 THE SYLLABUS

According to AARTS (in: Castelyn et al., 1978:99) a syllabus includes:

"... de concrete omschrijving alsmede de systematische ordening van de leerstof over de verschillende leerjaren voor een bepaalde school".

("... the concrete description as well as the systematic arrangement of the learning content over the different years of study for one particular school" - translated by Castelyn et al.).

In South Africa there exists no less than twenty-two education departments which all fall under the National Education Department. A core syllabus exists at National level for each subject taught at schools. Each Department of Education may construct its own course content within the constraints of the National core syllabus. This core syllabus is an attempt at maintaining academic standards amongst the various Departments and also enabling inter-Departmental co-operation and exchanges. Thus, where AARTS refers to "... voor een bepaalde school", it would be more appropriate to substitute "... for a specific Department", as the syllabuses are designed at Department level, not school level. The tutorial matter for each subject is arranged according to a syllabus. A syllabus is designed for each standard and will thus contain course material suitable for the average pupil-age of that standard. Syllabuses are further differentiated within a standard, to cater for the cognitive and/or psycho-motor development levels expected of pupils in that standard. A subject may thus have syllabuses for standards six to ten, and within each standard, three different syllabuses may be available: higher grade, standard grade and lower grade. The syllabus contents should be arranged in a progressive order which ensures that the knowledge and skills required in one section have been dealt with in a previous section.

The format of the syllabus is entirely at the discretion of the particular syllabus committee

appointed by each Department. Within each Department there is usually a large variation amongst teachers with respect to their qualifications, their expertise and their experience in teaching the subject. For this reason the different Departments of Education may choose to list the syllabus contents as a set of detailed learning objectives for pupils, or the topics may appear briefly in point form leaving the detailed interpretation to the school educators, under the guidance of subject inspectors or subject advisors.

#### **1.4.8 THE SYLLABUS IN RELATION TO THE CURRICULUM**

The term curriculum is of Latin origin and, in late and medieval Latin, had the meaning of "course", "period" or "annually". It became the word for the selection and ordering of subject matter with the sense of repetition or annual repetition. This definition is according to DOLCH (*in*: Castelyn *et al.*, 1978:100), who then continues to illustrate the ambiguity of this word, by referring to NOVAL who collected 98 definitions in 1960 and REISSE who presented 27 definitions in 1972.

As the Curriculum Cycle will be discussed in greater detail in Chapter Three (3.3), a definition of the curriculum according to FREY (*in*: Castelyn *et al.*, 1978:101) will suffice for the purpose of this study to clarify the importance of the syllabus in the curriculum.

"The field of the curriculum includes all the processes of selection in order to create a learning situation with the intention of actualizing the learning process and evaluating its results".

FREY stipulates that there are three themes which must be reflected upon when curricula are being conceived:

- \* The goals of moulding.
- \* Subject matter (Syllabus).
- \* Organisation of Learning (The ways of using the syllabus to achieve the goals of moulding).

The conclusion which may be arrived at is that the curriculum has a much broader perspective than the syllabus on its own. Moreover, the concept of curriculum emphasizes aspects of the learning situation which receive little attention when specifying the syllabus. This is referred to as the "hidden curriculum" (Pratt, 1980:108).

When selecting learning or tutorial matter for a syllabus, the selection criteria cannot be purely academic; the overall scenario as proposed by the curriculum must be taken into consideration. The choice of syllabus-content must not ignore the goals of moulding (see 1.4.4.1) but it should be selected to facilitate and enhance these goals. Furthermore, the syllabus ought to be designed so that the actualization of knowledge and selection of learning experiences are feasible for the envisaged learning situations.

#### **1.4.9 THE COMPUTER**

In the words of REAL (1981:161):

"Computers, those blinking boxes of magic, are performing a greater variety of tasks for a greater number of countries, institutions and individuals each year".

This popular notion of a computer, as a magic box, is upheld by most people who suffer from technophobia; who view a computer with awe from a safe distance. The computer

is able to inspire and impress only to the extent that man has programmed it to do so, "... otherwise it is merely lights and wires in a box" (Real, 1981:161). Real's idea of a computer is somewhat outdated as "wires and lights" are, nowadays, replaced by superconductors and lead-crystal displays. The computer has evolved through four generations, each generation being typical of a "device" central to its development.

These generations are:

- \* The 1st generation, characterized by the vacuum tube.
- \* The 2nd generation, characterized by the transistor.
- \* The 3rd generation, characterized by the microchip.
- \* The 4th generation, characterized by the superchip and laser technology.

(Gough-Jones et al., 1989a:198-202; Raymont, 1984:211).

The components peculiar to their generation, show a progressive decrease in size, which is one of the main reasons why the physical size of a computer has decreased while its performance capacities have increased. Current attempts to develop a 5th generation computer for the 1990s are being hotly pursued by both Japan and the United States of America. The computer of the future is envisaged as operating intelligently in a manner similar to that of the human brain (Raymont, 1984:211). Present-day computers do what they are programmed to do; no more - no less. The social turbulence that a 5th generation computer will cause is too excessive to contemplate. If such a computer design comes to fruition:

"Silicon (the building block of the microchip) will in effect take over from carbon - the current building block of human evolution" (Davies & Shane, in: Culbertson & Cunningham eds., 1986:6).

The fears that man may harbour about the pending appearance of this man-created mental giant are mainly centred about the threat of dehumanization. Man fears the unknown: that which he is unable to explain or reason away. The great leap, effected by the artificial intelligence of this envisaged 5th generation computer, will demand more, rather than less, knowledge and wisdom of man.

DAVIES & SHANE (in: Culbertson & Cunningham eds., 1986:8), emphasize that man is now living in an epoch in which "... humans can never only do one thing". They refer to now as a period of hyperturbulence: one single action is certain to have consequences greater than the one(s) intended. The technological changes that have occurred in the various stages of computer development have had intended, as well as largely unexpected and unintended, consequences. The microchip industry, the light-current industry, the software design industry and the totally undesirable virus and computer-fraud industries, are but five multi-million dollar enterprises that were not contemplated when Charles Babbage and Ada Lovelace designed the first counting machine at the turn of the 19th century.

A computer may be utilized as a freestanding isolated unit for instruction, home study or administration. Several computers (and several may mean anything from five computers, as in a small office environment, to thousands of computers, as in a banking network) may be adequately networked to become part of a total information-knowledge communication system at local, regional, national and international level. A computerized information communication system is, according to DAVIES & SHANE (in: Culbertson & Cunningham eds., 1986:19), neither good nor bad, but it is

POWERFUL. What makes it good or bad is how we learn to use it and how intelligently we apply our skills as thinking people. PLATT as quoted by DAVIES & SHANE (in: Culbertson & Cunningham eds., 1986:8) contends that:

"The convergency of today's technological forces has produced a waterfall of change. It leads onwards to a great sea of new evolutionary possibilities on the earth and reaching into space. But right now we are in the torrent and our only hope is to work together with energy and intelligence if we are to come through successfully into that boundless ocean".

DAVIES & SHANE (in: Culbertson & Cunningham eds., 1986:18) also quote both TURKLE and THOMPSON in an attempt to establish the significance of the association of today's man with the computer reality:

"Individuals can use computer systems to establish personal identity, to gain self-awareness, to achieve a feeling of mastery over their present lives, and to direct their alternative futures" (Turkle),

and

"All the computers in the world won't help you if your unexamined and unconscious assumptions on the nature of reality are simply wrong in their basic conception. All the computer will do is help you to be stupid in an expensive fashion" (Thompson).

#### **1.4.10 LEVELS OF EXPERTISE IN COMPUTER EDUCATION**

A plethora of terms embracing familiarity with a computer and the use of a computer, has developed along with the fairly comprehensive vocabulary of computer-jargon. "Computer Awareness", "Computer Studies", "Computer Literacy" and "Computer Science" are widely used phrases, but none of them is being used with a uniquely defined meaning. Computer Literacy, for example, is used to describe a course similar in aims

to the subject Computer Science, currently being offered in most provinces as a seventh subject for matriculation exemption in secondary schools. It is, therefore, necessary to define the meaning of the terms to be used, as a point of departure for further discussion.

#### **1.4.10.1 Computer Awareness**

Computer awareness refers to a very rudimentary understanding of computers including basic definitions such as hardware and software, computer components, getting the computer to function, history of computer development, installations that utilize computers and what computers have done for civilization. It is simply a theoretical knowledge of the computer, but it should precede any further computer education program.

#### **1.4.10.2 Computer Literacy**

A claim to computer literacy demands knowledge of a higher level of understanding, derived from the combination of a philosophical and social understanding of the computer, together with a significant amount of hands-on experience with computers and computer programs. Computer awareness may be arrived at by means of books, lectures, films and introductory training sessions, while computer literacy can be reached only through practice. PANTIEL & PETERSEN (1985:11) list four main areas of competence required to become computer literate:

- \* Knowledge of the architecture of the computer without emphasis on electronic technology.
- \* Efficient interaction with computers using commercially designed software

packages.

- \* Knowledge of the effects of the computer revolution of the past, the present and the future.
- \* Ability to create and write computer programs to facilitate solving problems with respect to business, homes and education.

Computer literacy cannot single out theoretical knowledge, software applications or computer programming to be studied in isolation or to be disregarded. All three categories are necessary as a means to becoming computer literate.

### **1.4.10.3 Computer Science**

Computer Science is described by the working committee, assembled by the HUMAN SCIENCES RESEARCH COUNCIL (HSRC) (1983:Part I:29) as follows:

"Computer Science, and its related specialized subject-areas, are reserved for the fairly limited number of individuals specially concerned with furthering their interest and careers in the computer field".

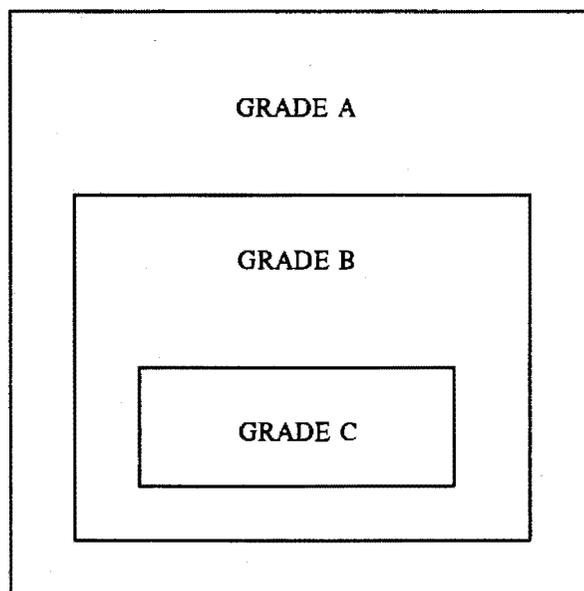
This has been the aura created about Computer Science in the White Education Departments in South Africa today. The subject has been offered to an elite group of pupils, carefully selected on performances in mathematics and language, and sometimes on results of an admission test as well. From the author's personal experience gained over a period of eighteen years, while teaching computer science as a seventh subject to this group, only a small percentage of the pupils who complete the course, lasting three years, elects to enter the computer field of study on leaving school.

According to DENNING et al., (1989:11) computer science is at the crossroads of applied mathematics, science, mathematics and engineering. The four processes are of equal and fundamental importance to the discipline, which is a unique blend of interaction amongst theory, abstraction, design and practical. These latter four applications of computer science, appropriately managed and incorporated into a core curriculum, would justify the subject as a scientific discipline (see Chapter Three 3.4.4). DENNING et al., (1989:11) continue to seek a definition of the subject computer science. The following is considered to be the most comprehensive:

"Computer science is the body of knowledge concerned with computers and computation. It has theoretical, experimental and design components and includes (1) theories for understanding computing devices, programs and systems; (2) experimentation for the development and testing of concepts; (3) design methodology, algorithms and tools for practical realization and (4) methods of analysis for verifying that these realizations meet requirements".

The field of computer science would embrace all that is included in computer literacy, but the level of problem solving, depth of theoretical knowledge and degree of difficulty of tasks set, would demand a higher cognitive level of reasoning than would computer literacy. In addition, aspects of electronics and abstract numerical analysis are examples of additional material for computer science courses. Computer science, for the remainder of this study, will refer to a subject designed for the school curriculum, available for all pupils in a school, because of the proposed grading of the course content into three graded courses. The structure of the courses may be represented as follows:

**FIGURE 2: COURSE GRADE STRUCTURE**



The level of difficulty of the contents for each grade, and the emphasis placed on themes within each grade, will be further illuminated in Chapter Three (3.5.3).

#### **1.4.10.4 Computer Education**

Many schools in the White, Coloured and Asian Education Departments do offer their pupils opportunities to become computer-aware or computer-literate, without following formal Departmental syllabuses for Computer Science. These courses usually end their formal-education nature by standard six or seven, whereupon pupils with any further interest in computers join the school's computer club, or apply to be admitted to the official computer science class of that region. Both alternatives depend on availability of such facilities.

The learning situations that exist within the school's formal classroom situation, where a well-informed, computer-proficient educator is available to guide the proceedings,

directed towards achieving pre-planned aims and objectives, will be termed Computer Education. The pupils may be becoming computer-aware, computer-literate or computer-scientists within a formal education situation. The nature of the guidance in such classes will be more than training as it will also address the cognitive, affective, aesthetic, social and conative aspects of the adolescent's progression as he strives to attain a meaningful rôle as an adult.

#### **1.4.11 THE DESIGN OF SYLLABUSES**

"To design" is defined in the Concise Oxford Dictionary (1964:233) as:

"... to formulate the plan of (something) in the mind or on paper as a pattern ... outline or sketch or groundwork or pattern for a work of different scale or material or elaboration".

The meaning of the word "design" in this study will adhere to the implications of the definition above for the following reasons:

- \* The syllabuses will be structured so that a pattern evolves clearly demarcating differentiations in pupil-age, cognitive skills and psycho-motor skills demanded of pupils by the different themes of the syllabuses.
- \* The design of the syllabuses will represent the groundwork for a document containing new ideas for computer science syllabuses since no such document exists, or is in use at the moment, for computer studies at secondary schools that cater for the career opportunities of pupils choosing to study the subject. Up until 1991, the subject has been available only to those few pupils who are chosen to study the subject, and in some education departments, the subject is

not available at all. Efforts are being made to encourage schools with qualified staff to introduce the subject as part of a full-time curriculum. The author is of the opinion that the present syllabus has been designed for limited post-school applications and it is therefore necessary to consider new syllabus material that will facilitate meaningful differentiation. (See Chapter Four (4.2).)

Having clarified the terminology surrounding computers in schools it is now possible to attempt the formulation of a hypothesis.

### **1.5 HYPOTHESIS FORMATION**

Reflecting on the problem formulation as unfolded above, the following hypotheses may be formulated:

- \* Computer science syllabuses can be designed to accommodate all pupils at secondary-school level. Aspects of the syllabuses may involve thought processes ranging from pure rote-learning to intricate, high-level cognitive exercises, thus promoting the self-respect and self-realization of all pupils.
- \* Computer science courses in schools can bridge the gap between school and employment, eradicating the need, on leaving school, to enrol for expensive computer-skill courses at computer academies, and in this way promoting the actualization of adulthood and self-sufficiency.
- \* Computer science course content and learning experiences are of the nature that a professionally-trained educator is required to accompany the child as he endeavours to achieve the syllabus objectives. A pedagogically meaningful

relationship can develop within the learning situation.

- \* Computer science syllabuses can be designed so as to encourage pupils to continue with tertiary studies in computer science, or to assist potential tertiary students with demands that other courses may make for computer proficiency. Syllabuses can, therefore, prepare learners for future academic studies.
- \* The fundamental-pedagogical structures and essences are basic to all pedagogic thinking and may provide accountable scientific certainty about the changing styles, changing subjects, changing contents and changing conditions of the education event.
- \* Computer science has ample intellectual substance to be classified as a discipline (Chapter Three (3.4.4).) It has an interdisciplinary nature and its application spans theoretical, practical, design and experimental activities.

Now that the hypotheses have been formulated, it is necessary to describe the methods that will be used to investigate the situations and criteria described or implied by the hypotheses.

## **1.6 METHODOLOGICAL JUSTIFICATION**

It is a basic requirement for scientific practice to make use of suitable methods to reveal the actualities surrounding the field of investigation, so that the conclusions reached that accept or reject the hypotheses, are honest, pragmatic and empirically based. The methods employed are determined by the nature of the topic or phenomenon being investigated. The author has decided on a number of methods to reveal the essences of

this study of computer science from a fundamental pedagogic perspective.

### 1.6.1 THE PHENOMENOLOGICAL METHOD

The following explication of phenomenology is based on the guidance of DU PLOOY & KILIAN (1985:36). *Phainomenon* (appearance) is derived from Greek *phainesta* meaning "to reveal itself". The end syllable "-logy" is derived from *logos*, meaning "word", which implies that there is structure or method in the expression or revelation of the occurrence (the phenomenon or appearance) as its intrinsicality is revealed. Phenomenology is a method which aims to reveal a phenomenon as it actually is; to reveal the heart and soul, the *sine qua non* of that phenomenon, therefore, its true essence.

The phenomenologist must ask penetrating and radical questions to disclose the essence of the phenomenon. He accepts, as a starting point, that the phenomenon is an actuality of existence. The procedure is based on fact and reveals the significance of the phenomenon according to man's ontic disposition, as education is part of the reality of life from the beginning of human existence.

DU PLOOY & KILIAN (1985:36) affirm that no one has ever experienced education as such, only its associate property, educative activity, in which education as an appearance (phenomenon) reveals itself to the consciousness of the pedagogician. The claim "to be educated" can impart as many meanings as there are people claiming it; its boundaries are infinite. There are, however, specific educative activities that are distinct for subjects, institutions, age-groups, sexes, cognitive exercises, skills and so on, which can

be researched and described within the limits of a scientific investigation. One such method of investigation which ensures a structured arrival at the essential truth is the phenomenological method which includes:

- \* careful observation (which is abstract in nature; conceived in the mind of the pedagogican);
- \* radical reflection on the phenomenon;
- \* an unambiguous description of the essences of the phenomenon, to ensure radical accountability. (The researcher attempts to get to the roots (eidos) or essences of an existing phenomenon and describe these essences as categories.)

To employ the phenomenological method in investigating a phenomenon, a series of steps must be carried out. These steps are clearly described in VAN VUUREN ed., (1976:36-42), BODENSTEIN (1977:29), DU PLOOY & KILIAN (1985:37-42) and VAN RENSBURG & LANDMAN (1988:444). The reader is referred to any one of these references for further clarification of the phenomenological method. Employment of the phenomenological method as a research approach spontaneously leads the researcher to ontological reflection, which will be discussed next.

### **1.6.2 ONTOLOGICAL REFLECTION**

To understand what is meant by onticity it is necessary to examine the word etymologically. The Greek word *oun* is the present participle of the verb "to be", which would translate in English as "being". (Kilian, 1973:2). In Philosophy, when the word ontic describes a state, it means that it came into being with man; it has been there from the beginning and cannot be ignored, overlooked or destroyed. "Absolute condition" and

"walk of life" are synonyms provided in ROGET'S Thesaurus (Kirkpatrick ed., 1987:7) for "state". One such state is education; man has never been without it. The specific discipline which has to do with the discovery of the ontic grounds of a science is known as Ontology. GOUWS et al., (1982:208) describe Ontology as the study of being, with the fixed purpose of establishing the basic nature of things, of that which is.

It is proposed in this investigation to employ ontological thought to seek the essences that are concealed in a possible four-cornered pedagogic situation encompassing the educator, educand, computer-science tuition material and computer. The latter three constitute a relatively modern-day triangle to be verified as an onticity by means of the phenomenological approach. Concepts such as "technological revolution", "ever-changing", "thinking-machine", "computer - child interaction" and "artificial intelligence" tend to cloud the path to the ontic truth and essences of computer education. There is an affluent dictionary of computer-related jargon that belies the perennial onticities prevalent in the field of computer education. These essences will be reflected upon, exposed and described as they have manifested themselves in the life-world of the author.

Another method which is of inestimable value to most investigations is the study of relevant literature. This investigation is no exception and this method will be discussed next.

### **1.6.3 LITERARY REVIEW**

"The researcher has to take upon himself the task of conducting an exhaustive literary-availability survey" (Davey, 1990:12).

A thorough literary review enables a revealing evaluation of past, present and predicted perspectives on the specific theme under investigation. The researcher must strive to achieve a state of objectivity and non-prejudice throughout the literary encounter, and in so doing may be directed by, become critical of and/or appreciative of the views and ideas expressed in another's writings. The literary review should focus the research goal in the light of its expositions. The researcher should avail himself, not only of the most up-to-date announcements relating to his topic, but also of situations prevailing in the past. An orderly analysis and synthesis of relevant material will provide a pedagogical framework within which the new terrain suggested by the researcher's own hypotheses may be explored. Another method which the author considers as having significance for this investigation is the idiographic method.

#### **1.6.4 THE IDIOGRAPHIC METHOD**

Idiographic research attempts to evaluate and understand the human condition and the human being as he presents himself in his own private world. An etymological examination of the word "idiographic" reveals its derivation from the Greek prefix *idio* meaning "... own, personal, private" and the Latin-Greek suffix *-graphicus* meaning drawing or writing. (Onions, *in*: Davey, 1990:15).

The idiographic approach embraces a study of the feelings of the interviewee as an individual (not the general feeling of a group of individuals). The lived and personal experiences of the individual are reflected on, possibly theorized about, and expressed as a valuable contribution to the whole theatre of the topic being researched. There is, of course, more than one interviewee contributing to this totality, but each interviewee's

contribution must remain distinctly apart and personal.

The author will embark on an idiographic search into the life-worlds of three ex-pupils with whom she had been educatively involved since the start of their computer science education. All interviewees have matriculated. The interviews will be conducted by means of a set of carefully formulated questions posed during a conversation with each subject. Interpretation of their responses must involve an unprejudiced, objective stance on the part of the author.

Total detachment from the actual pedagogic relationship must occur before determining the significance of the data and processing it into qualitative (not quantitative) information. An evaluation of the interviews will be presented in Chapter Four (4.5). Another method of research which is to be employed in this investigation is that of nomothetic research.

### **1.6.5 NOMOTHETIC RESEARCH**

Idiographic research is qualitative in nature while cognate, nomothetic (statistical) research, is quantitative in nature. Research, according to TUCKMAN (1978:1) is:

"... a systematic attempt to provide answers to questions. Such answers may be abstract and general, as is often the case in basic research, or they may be highly concrete and specific as in the case of demonstration or applied research".

In both kinds of research, the investigator uncovers facts and then formulates a generalization based on the interpretation of those facts. A clear differentiation between the two approaches needs to be drawn.

\* Basic Research.

The term basic research is concerned with the relationship between two or more variables. A problem is identified; variables are revealed; relevant variables are selected; variables are examined through a literature review; a hypothesis is constructed; a research design is created to investigate the problem; data is collected and analysed and, finally, conclusions are drawn about the relationships amongst the variables.

"The purpose of basic research is to develop a model or theory, that identifies all the relevant variables in a particular environment and hypothesize about their relationship" (Tuckman, 1978:1).

\* Applied Research.

Applied research is a test or tryout of a program or a model. A "before" and "after" situation is systematically evaluated.

The procedures followed by the author in this investigation could more appropriately be classified as basic research.

Once data has been processed and the information obtained has facilitated a directive for the researcher, it is possible to develop a field of study which, in this research, is to be a computer science program for secondary schools, designed to improve the attainment of meaningful adulthood satisfying the criteria for adulthood.

In order to arrive at convincing conclusions it was necessary to design two research instruments (questionnaires) which can briefly be described as:

- \* a questionnaire (Appendix A) that was sent to six Departments of Education

requesting information to assess the importance of, the popularity of, the demand for and the progress of the subject Computer Science in the four provinces of South Africa. The responses to this questionnaire have been evaluated in Chapter Four (4.2).

\* a questionnaire (Appendix B) that was completed by thirty-one pupils who were at different stages in their study of computer science at school. Some pupils were in standard nine, others in standard ten while the remainder had already completed standard ten. All pupils pursued the subject as an additional subject for matriculation purposes. This questionnaire was designed to assess the influence that computer science has on the academic, social, family and career aspects of the adolescent. Comments were also requested concerning the content of the subject. The responses to this questionnaire have been evaluated in Chapter Four (4.4), using specifically designed computer programs (Appendix E).

The research designs used in this study are what TUCKMAN (1978:9) refers to as "survey research". The variables will be analysed using a simple counting procedure. It was not relevant to this study to arrive at a relationship amongst variables in either questionnaire, but rather to arrive at figures that would assist in assessing the extent of the progress and development of pedagogically accountable computer education, as it exists in the country at this time and the influence it has had on the various tenets of adulthood of the adolescents studying the subject. Furthermore it was not pertinent to compare the situations existing in the various Departments. Both research designs did, however, aid the formation of the overall canvas of computer-education development in

South Africa, as well as the subject's effect on the self-realization of the adolescent. The penultimate method relevant to this investigation requiring clarification is the process of systemization.

#### **1.6.6 SYSTEMATIZATION**

The word system is derived from the Greek words *syn* (together) and *histemi* (to set).

System is defined, in Webster's Encyclopedic Dictionary (1944: 735) as:

"... a plan or scheme according to which things are connected as a whole".

Systemization is thereafter clarified as being the act or process of reducing to a system.

BEERLING (in: Hugo, 1987:52) asserts that scientific knowledge is well-grounded, systematic and intersubjective and that a fundamental relationship exists between these three. Throughout this study, the material researched during the literary study, the theories deduced from the questionnaires, the essences revealed through phenomenological and ontological deliberation and the essences already apparent to the author through Computer Education experience, will be related into a systematism of meanings and relationships, hopefully to be of use to other educators, educationalists and policy-makers in future. The final method used in this investigation requiring clarification is Collective Consideration.

### **1.6.7 COLLECTIVE CONSIDERATION**

The author considered it relevant to examine the computer science syllabuses of schools, technikons and universities to assess the scope and degree of difficulty of the relevant syllabuses. Each Department of Education, several technikons and most universities were sent letters (Appendix C), requesting copies of available syllabuses. The response was most favourable and several institutions provided additional information regarding their experiences in particular areas of study, as well as valuable and pertinent articles from magazines concerning the field of computer science. The syllabuses were scrutinized, compared and utilized to assist in the compilation of course content for graded syllabuses in secondary schools.

The author attended the Association of Science Educators' conference in Lancaster in the United Kingdom in January 1990. It was possible to obtain copies of several county's computer science syllabuses at this conference. The City Council Education Department in Manchester arranged a tour of two schools in the city as well as a visit to the Micro Electronics Development Unit. (Appendix D). These visits were specifically to gain insight into the achievements in computer education and information technology in the city of Manchester. A morning was also spent at Bolton High School in the same city, where the author was invited to assist with a lesson in the computer science A-level class. All schools provided valuable information regarding this study and the documentation and literature assembled proved immensely useful.

## **1.7 SUMMARY AND ANNOUNCEMENT OF FURTHER PROGRAM**

### **1.7.1 SUMMARY**

In Chapter One the problem has been formulated, accompanied by a revelation of the factors giving rise to the problem. The concepts essential to lucid understanding throughout the investigation have been defined with unrestricted completeness. These concepts include fundamental pedagogics and the pedagogician, the pedagogic situation and the education situation, education, the self-actualizing adolescent, the syllabus, the syllabus and the curriculum, the computer, computer education and the designing of syllabuses. The methods used to achieve the aims of this investigation have also been described in Chapter One. An outline of the contents of the remaining chapters will now be undertaken.

### **1.7.2 FURTHER PROGRAM**

The adolescent will be investigated in detail in Chapter Two but he will share this investigation with the school, the syllabus and the subject computer science. The adolescent and his self-actualization will be portrayed within the framework of aspects of adulthood, the status to which he aspires through being in the world in general and being educated in particular. The school as a creator of reality and the part played by the syllabus in creating this reality will be highlighted. The syllabus will be viewed from a fundamental pedagogical perspective as related to the Pedagogic School Structure. Computer Science as a secondary-school subject, will receive attention in Chapter Two. The subject's intrinsicality with the adolescent and the pedagogic school structure will be

exposed.

Attention will be granted in Chapter Three to the curriculum-cycle and its implementation in formulating a school syllabus. Claims that are made on the curriculum will be presented and evaluated. A thorough investigation will be conducted into the structuring of knowledge as the author considers familiarity with this, essential for the selection of content for syllabuses. The ultimate theme in Chapter Three discloses criteria for the selection of learning content so that the requirements of the pedagogic school structure can be fulfilled.

The present status of computer science as a formal subject in schools for tertiary education creditation, will be evaluated in Chapter Four against the background of the author's personal experience and from data extracted from questionnaires sent to various Departments of Education in South Africa. The syllabus content selected, will be emphasized as a reflection of the lived experiences in the life-world of the adolescent. With this in cognisance, components of computer science syllabuses will be designed with attention being paid to the level of cognitive skills, the affective skills and the psychomotor skills required for each topic. According to these skills and always with due regard for the needs and human dignity of the child in mind, a model for computer science syllabuses will be delineated for standard seven to standard ten in the secondary school. The writings of Chapter Four will develop the synthesis (the relationship) between a computer science syllabus and the:

- \* dictates of the needs of the adolescent;
- \* dictates of society for mature adolescents and vocational training in the school;

and

\* essences of the pedagogic school structure.

Pupil responses, regarding their lived-experiences with the existing computer science syllabus, will be evaluated and discussed to ascertain if the subject **has meaning for the educand comparable to that theoretically formulated, through intensive reflection, in the mind of the author.**

A summary of the findings of each chapter will be accounted for in Chapter Five, followed by a prognosis of the implications that these findings may have on the education of the secondary school adolescent in the future. An empirically-pedagogically based justification for the inclusion or exclusion of a differentiated computer science syllabus in the school curriculum for all secondary school pupils will be manifest throughout the summary. The findings will, through the recapitulation, constantly relate to the hypotheses proposed in Chapter One (1.5) to ascertain whether the stated hypotheses may be accepted or should be rejected. Problems that are anticipated with the implementation of such syllabuses will be disclosed as situations to be addressed by curricularators and policy makers. The shortcomings of this study will be suggested as areas for further research and investigation by scholars of pedagogics.

## **CHAPTER TWO**

### **2.1 INTRODUCTION**

In Chapter One the importance of being a competent computer practitioner, in almost every type of employment environment, was outlined. Employment implies skills and knowledge, which in turn demands education. Formal education is a costly endeavour and available funds depend on the country's economic situation. The present unfavourable economic situation in South Africa is predicted to remain with us for at least the next decade.

"Political and economic issues in South Africa in the 1990s are likely to be complex and there will be no quick fixes" (Maasdorp, 1992:126).

The need for a shift in the content of the school curricula towards a more vocational or career orientated matriculation certificate has been validated. These are factors which are extrinsic to the adolescent's motivation to study and succeed at school. The adolescent remains a human being with intrinsic motivations that affect his choices and actions as he approaches the complex, yet inviting, world of the adult. He is experiencing an era of flux in most aspects of his life, wherein relationships and situations are viewed from a perspective which demands that he make choices and decisions based on his own experience and knowledge.

Curriculators must design curricula for schools so that the school-leavers, who may be regarded as the products of the curricula, may meet the demand of the society, who may be termed the consumers of the products. Curriculating may not occur with society as the only perspective; the learner with his needs and his demands must be integrated into all stages of syllabus planning so that a harmonious plait of the adolescent, subject-content and society can be created.

This chapter concentrates on the adolescent. He is discussed from various perspectives essential to his being human and typical of his status of being neither child nor adult. Adulthood is described as a state of being, sought after by the adolescent. Thereafter, the pedagogic school structure is discussed with particular emphasis on those aspects that can successfully be realized by learners of computer science. The specific essentials of the pedagogic structure are exposed relative to the life world of the adolescent. As this study is concerned with the relevance of computer studies for the actualization of adulthood by the adolescent, it is pertinent in this chapter, to relate the synchronization of computer studies with the essentials of the pedagogic school structure. Finally, the syllabus as a reflection of the adolescent's life world as he strives for adulthood, is discussed.

## **2.2        THE ADOLESCENT AS BEING**

### **2.2.1        INTRODUCTION**

Although the actualization of being human is one continuous progression, there is, in the life of every individual, a significant period where he is no longer child and not yet an

adult. The young person thus finds himself in a transition period between two modes of being; the mode of being of the child and that of the adult. This transition period requires tremendous social adaptations, especially concerning relationships with parents, family, peers and teachers. The young person experiences constant inner conflict effected by his increased ability to reason for himself, to question the actions of others and to formulate his own solutions to problems, albeit sometimes with unsuccessful results.

Since adolescence is a gradual period of growth and development, it has no fixed beginning and ending. The age-limits assigned to this period are arbitrary, but, according to DREYER & DUMINY (1983:29):

"... the adolescent period lasts approximately from the 12th year to somewhere after the 18th year ...".

Hence the secondary school child is journeying the somewhat troubled path of adolescence during the secondary school period. DREYER & DUMINY (1983:30) quote MORSE & WINGO on this adolescent period:

"Adolescence has been called a variety of things, from a disease to a miracle. People look back on the years from twelve to eighteen as some of the happiest years of their life - and also the most distressing. It is the age of awakening of emotions and newly discovered capabilities, but it is also an age of moodiness and anxiety".

What, then, are the characteristics intrinsic to this juvenescent era preceding adulthood? In Western society, there are pointers which target the adolescent era and identify typical physical, emotional, social, spiritual, affective and mental traits of anticipated behaviour. The characteristics considered to be relevant to this study will be discussed hence.

### 2.2.2 THE ADOLESCENT AS SOCIAL BEING

Man is not man-in-isolation, but rather "... man-in-community". (Van Vuuren ed., 1976:93). Only as an individual within a community can man respond to his being human. The adolescent on the brink of adulthood, must become aware of his individual and personal aspirations within the milieu of the community.

"A community indicates human ties, human co-existence and co-existing self realization" (Van Vuuren ed., 1976:93).

Adolescence is marked by increased social awareness. The peer group becomes a major influence in selecting and establishing the general rules of behaviour, often in contrast to what the parents consider appropriate. In the junior secondary school phase (standards six and seven) pupils feel the need to conform; they want to be part of ..., look exactly like each member of ..., utilize typical jargon of ..., and do precisely the same as ...

THE CROWD. Towards the end of the adolescent period, however, the standards and activities of the peer group exercise less influence on the individual and he begins to detach himself from the influence of the group and contemplate his own personal destiny. He may cogitate (for many hours at a time!) on one specific member of the opposite sex, the career he envisages to ensure his arrival with status on the social scene, and the changes he would make to eradicate the domestic, communal, regional, provincial, national and international problems. It is during the adolescent period that the human being has the most unrealistic view of the world; the time before he meets the real world of the independent adult. It is the obligation of the education planners to curriculate so as to confront the school-going adolescent with challenges and complexities that will

diminish his naïvety, and better equip him to face the world of the adult as he arrives at the crossroads of adolescence and adulthood. The syllabuses of the high-school curriculum should facilitate, for example, a knowledge of politics and current affairs, economics and current trends in the international stock markets, science as it effects his everyday existence, language(s) for better communication, mathematics for all round logic and an unindoctrinated study of people of the world, their beliefs, customs and international relations.

The adult in the making should be adequately prepared for his personal future within a social system.

"The child has to be educated, moulded, taught or even adjusted to be able to live according to some definite human pattern" (Kilian, 1973:91).

Society makes demands on its members. There are laws initiated from circumstances: laws of paying taxes, laws of social behaviour, laws of attendance at work and school, laws of driving vehicles, laws of maintaining healthy modes of existence, laws of dress and laws of moral behaviour. Man as a social being is embraced by laws which govern his thoughts and movements every day. Demands are made on man to maintain the societal structure and all its branches. It is during the adolescent years that the presence of these demands begins to have impact and assume significance. A perusal through the employment-opportunity section of a newspaper will indicate what society is demanding in terms of qualifications and experience on the labour market. By-laws and regulations regarding social and communal behaviour are visible on notices everywhere: pay here, do not smoke, do not touch, queue here, males only, pay within 30 days, exit only, cards

accepted, wait for green light ... . Society makes demands on man and these demands arise from prevailing circumstances. However, man and society are symbiotically related and man, too, may demand the necessities of existence from within his society. Man, together with the man-made social infrastructures created by man, is society. The most basic, but most important need that man has within his society is the need for human dignity. This arises from the assurance that society needs what he has to offer and society can provide for his needs. Human dignity is a feeling of worth within one's society. Man must be taught and educated so that he can contribute meaningfully to the needs of his society. VANDENBERG (1971:56) warns of the dangers of socialism that prepare a child purely for the needs of society:

"... to conceive of schooling as a preparation for society is to alienate the child from the world, himself, others, the school and society, and necessarily fails to be preparatory".

For this reason it is essential that curriculum developers have a thorough understanding of the nature, abilities, needs and aspirations of the target group for which they are curriculum developing.

### **2.2.3 THE ADOLESCENT AS PHYSICAL BEING**

Man is his intellect within his body; the intellect and the body form a unit facilitating his existence within the world. As an infant, he observes an object which he interprets as desirable and his body must get him to that object. If the child is not yet able to crawl or walk or grasp, then a wave of frustration is emitted in the form of a cry for help. This intellect interpretation followed by physical action is what is demanded of man

throughout his life; life makes demands on man's physical and intellectual skills - and seldom are they separated.

During early and middle adolescence, at secondary school, important bodily changes take place that profoundly affect the adolescent's relationships with others. Concern about physical changes that occur during adolescence, such as growth spurts in the legs, arms and neck, can result in tension caused by embarrassment, ridicule or criticism. Feelings of physical inadequacy can directly affect his psychological and social interactions, resulting in a lowered self-concept and poor social relationships (Vrey, 1979:167).

The physical-self (body-image) is more important during adolescence than in any other stage of a person's life, except possibly old age (Vrey, 1979:167). The body becomes a symbol of experience; the response of others (especially the peer group) is characterized by the way he feels about himself - the way he sees himself. The parents usually are critical of the adolescent; not of his God-given physical inheritance, but rather of his apparent exaggerated concern about his appearance. This is, however, according to VREY (1979:168), part of his intense experience of his own corporeality.

The body-image, the body as experienced by its owner, is the medium through which relationships with people and objects are formed. Often the objects, such as sporting equipment and musical instruments tend to amplify or expose the body-image, creating enhanced anxiety. An object such as a computer can relate to an adolescent without any concern for his appearance or physical performance. A computer has infinite patience with repetition and has no equivalent of the critical, human eye. If correctly utilized in education, it can serve as a tension-reliever for an anxious adolescent.

#### 2.2.4 THE ADOLESCENT AS INTELLECTUAL (COGNITIVE) BEING

Throughout the period of adolescence, there is noteworthy progress towards intellectual maturity, characterized by a heightened "sensitivity", which results in an increase in the ability to think in general terms, to apply abstract ideas, to comprehend and assign meaning to situations, to apply judgement and to reason clearly with the purpose of achieving insight into increasingly complex situation (Dreyer, 1980:32). Towards the end of the adolescent period, most young people have come close to achieving maximum intellectual efficiency, but lack of experience limits their ability to utilize what they know.

VANDENBERG (1971:47) describes the youth's *gaucherie* as:

"The power of ideas and character become overrated because youth lacks both the concrete involvement and the disinterestedness that are requisite to the formation of adequate value judgements".

It may appear that the adolescent does not have the mental (intellectual) faculties to arrive at solutions to problems without following a heroic intrepid path fraught with youthful idealism and misjudgments. The intellect is certainly as well developed as it will ever be; the experience that gives quality to decisions is absent.

The adolescent's cognitive powers function on an intellectual plane which PIAGET (In: Vrey, 1979:177) calls the period of formal operations. This will be dealt with in greater detail in Chapter Three (3.5.4), but it is relevant to mention that the extent of these cognitive powers is dependent on three factors:

- \* The maturity of the nervous system.

This factor is not in the direct control of man: God designs the original system and man then sets it in operation. God programs the package, but the output depends on the user.

\* The experiences with objects in his life-world.

From the infant in his cradle, fascinated with the different colours of the mobile above him, to the executive at his desk, fascinated with the computer's ability to output production figures at the touch-of-a-button, man is constantly assigning his own meaning to the superabundance of objects in his life-world. It is the way he interprets, appreciates and utilizes these objects that affords quality to his cognitive domain.

\* The experiences with people he esteems.

HIRST & PETERS (1979:80) state that extrinsic motivation is neither necessary nor sufficient for learning to take place, but they do agree that these are valuable aids to learning. Man is a social being and, as clarified in 2.2.1, the adolescent is particularly aware of what others think of him. To the extent that the adolescent can open-up to his educators in a trusting and relaxed atmosphere, the richer the learning experience will be, and the greater the scope will be for enhancement of the cognitive domain.

The importance of the three abovementioned factors as contributing to the development of the cognitive powers are restated by VAN VUUREN ed., (1976:91).

"His intellectual forming should be part of the wider challenge to design a personal world and should therefore involve more than the absorption of a certain quantity of knowledge".

During the adolescent period, the development of the intellect should particularly help the youth to acquire insight into his choice of career. Subject choice and content should be such that the adolescent has a spring-board to the career that would offer him optimum personal gratification and human dignity. Included in the secondary school curriculum should be an up to date, on-going, career guidance course offering realistic views of the employment sector. If school activities are reduced merely to acquisition of knowledge in preparation for the final examination, then such an education is pedagogically unjustifiable. The youth will enter the world with no real intellectual moulding, for insight and coherence will be lacking (Van Vuuren ed., 1976:93).

There are several modern-day attractions which may, on research and reflection, prove to hinder the youth's maturation. Suggested examples are television instead of newspapers and books, discotheques instead of live theatre, videos instead of conversation and debate, visual impact of television instead of the intellectual imagery of radio, and there may be many more intrusions into the world of the young which may or may not be conducive to his cognitive development. Mass media imparts to its observers the glitz and gymnastics of the rich and famous in the fashionable world: evening wear for gala occasions and sometimes for home-use too, restaurants for the elite, million-dollar money-making manoeuvres, sporting idealisms, entertainment idols and bounteous mansions of abode. The adolescent is an idealist; a covetous being. He has not yet experienced the real-world of survival and may quickly become disillusioned with his own family status if presentations of the above nature reach him on a repetitive basis. This state of affairs places great responsibility on the curriculumators and educators to balance the scales of adolescent-fantasy and life-reality. Education must integrate today's

influences and inventions with classroom activities so that the adolescent can evaluate for himself what is good and true and what is bad and misleading (cf. Du Plooy & Kilian, 1985:110).

### **2.2.5 THE ADOLESCENT AS EMOTIONAL (AFFECTIVE) BEING**

According to FRANZSEN (in: Du Plooy & Kilian, 1985:108) the actualization of affectivity is integrated in all the activities of a person:

"This means that emotions determine the personality of a man, mould it, change it, positively or negatively, towards the world in which he finds himself".

FRANZSEN elaborates further by stating that some affective quality (emotion) is inseparable from every perception, conscious or unconscious, physical or intimately personal. The affective life of the educand is inseparable from his other modes of existence, as it affects his intellectual, moral, social and religious existence. However, according to VAN VUUREN ed. (1976:90), the affective life needs the least intervention if the education situation is one that spontaneously elicits love, security and being-accepted. A feeling of safety and security gives a human being that self-confidence and courage to tackle and conquer the problems he encounters, with dedication and perseverance.

DREYER & DREYER (1983:30) outline the behavioural consequences that the adolescent may portray when faced with new situations which he is not able to control because of lack of experience and self-confidence. He may

- \* develop feelings of inadequacy, become embarrassed, be over-sensitive to criticism;
- \* behave boisterously to conceal his lack of self confidence; and
- \* become overly aggressive, in defiance, in a show of apparent indifference and in outward bravado, in an attempt to bolster his self-esteem.

Self-consciousness, moodiness and unpredictable behaviour may materialize during the early and/or late adolescent periods because of biological changes associated with physical maturation and also because of their own confusion about being neither child nor adult. Many of the crises facing the adolescent may also arise from friction within his family circle because of the emphasis that the adolescent places on the norms of the peer groups. It is of paramount importance that there is a concerted effort from the school-milieu and the home-front to convey the hand of acceptance to the adolescent, despite many prevailing contradictory issues. If father is computer-dependant at work, if mother is knowledgeable about the wordprocessor, banking by modem and shopping with beltel, if brothers and sisters are computer-game fanatics and if the adolescent's computer science curriculum permits him to advise on all these activities, then the computer can surge a great communication link between the family and adolescent. It (the computer) could be an aid to establishing a harmonious network around the home.

"... the so essential feeling of security and being accepted can best be done in the family" (Van Vuuren ed., 1976:90).

### 2.2.6 THE ADOLESCENT AS AESTHETIC BEING

"Aesthetic experience is one of the many ways man learns to know the world; the creation of beauty is one of the many ways man gives meaning to his being-in-the-world" (Van Vuuren ed., 1976:96).

The secondary school years are the period of formal operational thought (Vrey, 1979:178), facilitating the movement from literal to metaphorical meaning. The adolescent can thus read a poem and appreciate and discover relevant concepts therein, not apparent in the literal arrangement. He can reason his approval or disapproval of art, politics, viewpoints, music and behaviour. His choices and decisions may seem bizarre to parents and teachers, but often the adolescent's expressions are merely a passion for his need to oppose or be different from the adults he knows.

The youth is preoccupied with his appearance (does he conform to peer-standards?) and the urgent desire to rectify and normalize the confused world (as he sees it) that he has congenitally inherited. He does not, of his own accord, reserve time for appreciation of the bounty of nature about him. Neglect of this aspect leaves his education poorer, whereas a thoroughly roused aesthetic sense contributes to a better unfolding of his total being. The aim of aesthetic education is to encourage appreciation of the beautiful and, as a more discreet aim, to develop the inherent creativity of the educand.

The emphasis on education content today is being centred around the sciences and technology. Although there are those who would argue the beauty possessed by a piece of machinery, the aesthetic development of the pupils could suffer neglect if curricula are designed to exclude dabbling in a pot of paint, visits to the theatre, participation in play-

festivals and such activities that nurture a love of the creative and aesthetic. Science and technology are survival, but one must question the quality of life without beauty.

### **2.2.7 THE ADOLESCENT AS FUTURISTIC (CONATIVE) BEING**

Western civilization has created new problems for the adolescent en route to adulthood. The modern world is radically different from that of a generation ago. Mass production, automation, materialism, over-population and star wars are but a few dominating factors which adults have produced, with which the future generation has to cope. The adolescent may find that he can no longer borrow knowledge from the previous generation, and adapting to this complex society puts great demands on him to reach maturity as soon as possible. There is, however, a paradox here: the youth finds himself dependent at home for a longer period because of the needs of today's society for tertiary education and training and also because of the still prevailing compulsory period of military training for some sections of the nation. Technological developments and subsequent increased education demands have, in many ways, aggravated the problems of the adolescent. He is on his way to adulthood; almost there, but he must still conform to rules and regulations at home, which often reduce him to a child-like state.

The adolescent has needs for physical security, sexual satisfaction, love and acceptance, status and recognition, intellectuality and creativity and, above all, realization and improvement of the self (Dreyer & Duminy, 1983:36). He dwells on what he is going to do on leaving school, what he wants to become in the career-world of his choice and simultaneously declares war against all the aspects of his own life that have so far proved irksome to his inner self. The need to work towards a goal is supported by his urgent

desire to be independent. He is futuristically orientated; he sees the golden sun on the horizon, often without any contemplation of the labour and obstacles to be encountered en route.

Curriculators, planners, educators and parents have a daunting task to pave a road for the youth to travel so that goals can be attained, dreams can become reality and disillusionment can be avoided. The fluctuating norms and standards of the world of today, technological, financial, spiritual, political and moral, do little to provide a stable foundation for arriving at fulfilment of dreams of adulthood. The school curriculum content should be designed to provide a secure and stable foundation for future plans to be built on. Its content ought to provide the adolescent with a realistic vision of the world of the independent adult. The school experience should be the training arena for anticipated encounters in the real world and the harmonious transition between these two phases in life can be facilitated by suitably selected curriculum content.

#### **2.2.8 SUMMARY**

The aspects of the adolescent's existentiality described in the preceding theme are not always obvious during personal encounters with an adolescent. What does become obvious is a character irregularity or unacceptability when one of the aspects is constantly neglected or emphasized with respect to the others. For this reason, it is essential that educators and educationalists who exert control over or an influence on the progress of the adolescent's development, have a comprehensive understanding of the whole persona of the adolescent.

With the ethos of the adolescent clarified and understood as far as is possible for this period of human existence, it is now appropriate to define the state of adulthood to which the adolescent strives.

## **2.3        THE GESTALT OF ADULTHOOD**

### **2.3.1        INTRODUCTION**

Adulthood is described as the main aim of education. Man is in the world by means of his body but his liaison with the world is via his multifaceted spirit, constituted by the domains of intelligence, emotion, religion, aestheticism and sociality. The adolescent as pre-adult, is striving to be recognized in the adult world as having satisfied the conditions for adulthood within each of these domains. Neglect of any one aspect adversely affects advancement in the others. The gestalt of these aspects as mutually dependent determinants of adulthood will now be discussed.

### **2.3.2        THE SOCIAL ASPECT (SOCIALITY)**

"Social education is supporting the adult in the making in an independent realization of his personal objectives in life in the community ... . He must be taught to retain the good but also to contribute his share to the creation of the new - particularly in the technical and cultural field" (Van Vuuren ed., 1976:93).

Man's social commitments arise from three aspects of community involvement: work, worship and recreation. All three imply an integration with other members of society. School education is committed to preparing the pupil to appreciate the importance of his personal contribution to the maintenance, propagation and improvement of all three

aspects.

A very important characteristic of society is its changeability; it is never static. The work environment becomes automated and computerized. Traditional-type places of worship compete for worshippers with many "new" charismatic-type churches. Recreation for adolescents varies amongst playing sport, meeting at music scenes, dancing, video watching and aerobic workouts. There are many social options available to teenagers today, and it is of utmost importance that their school education prepares them for the choices to be made on leaving school. A matriculation certificate no longer guarantees a harmonious integration into society. There is an explosive increase in the number of people in most communities today, especially in the urban, industrialized areas. Therefore, what society has to offer, is competed for by many aspirant competitors. Educators have to prepare their wards honestly and competently, to be in a position to compete for a dignified place in society. Inadequate preparation will present society with a generation of frustrated and disillusioned youngsters, termed "dropouts", who will seek consolation by repaying society in ways that would be considered socially unacceptable.

### **2.3.3 THE PHYSICAL ASPECT**

Man is a union of the body, the mind (the will and the intellect) and the spirit. The body makes it possible for man to be in the world. As an infant, man relates to the world because of, and by means of, his body. As time progresses, he increases the use of his will and his intellect to assign meaning to the world around him, but, throughout, his body remains an important means of mediation with the world. As he assigns meaning to his encounters, he develops in spirit which may be of a religious or a philosophical

nature, but these encounters always contribute towards his own personal spirit.

Life makes demands on the young human being's physical strength and stamina. The responsibilities of adulthood, physical, intellectual and emotional, can tap the body's energy and it is extremely difficult for the young adult to fulfil his adult task in society if he is not physically able to cope.

Life also demands certain basic skills from its participants. Adulthood may demand more specialized skills which could relate to an occupation or, perhaps, to interpersonal relationships. Man uses his body to execute these skills and he therefore desires that his body be able to actualize his potential to the maximum level.

Man's body is not always able to meet the demands made of it because of some physical handicap. The adolescent, particularly, would need to be supported to accept his own disability so that he may still feel he has a meaningful contribution to make to society and his own independence. The computer has a particularly important role to play in the lives of the physically disabled, but the exposition of this would require a thesis in itself.

The adolescent must be educated to accept his own physical-being, with its possibilities, defects and limitations, as an opportunity to become, in a humanly dignified way, what he can and ought to become.

#### **2.3.4 THE INTELLECTUAL ASPECT**

The intellectual forming of the adolescent should be seen as one aspect of the ultimate aim of education: dignified adulthood. It should involve more than the mere absorption

of facts or the acquisition of manual skills. It must improve the feeling of worth of the adolescent amongst family, peers and within society and have a favourable effect on his development as a person. In particular, the intellectual aspect of human development should help with the acquisition of insight into a life task and result in preparedness and ability to carry out this life task. VAN VUUREN ed., (1976:92) mention the idea of knowledge that predominates in modern times:

"... knowledge of natural sciences threatens to be raised to the only form of knowledge. Of course this is not pedagogically justifiable because it could result in the neglect of the other aspects of development to adulthood".

Yet, equally sinister would be a neglect of knowledge of the natural sciences. Pupils who matriculate with three languages, history, biblical studies and business economics, would hardly be able to compete in the adult world which demands problem-solving abilities related to technological environments. One is not able to deny the impact and importance of science and technology in society; it has been conceived by the population explosion and is an inherent part of modern life irrespective of the views of human beings.

If knowledge is presented to the adolescent merely for the sake of an examination, the result will be an ill-prepared, non-adult entering the adult world as a stranger. Only if there is real understanding and insight into the meaning and use of the knowledge, will the adolescent be prepared to confront the challenges of adulthood.

### **2.3.5 THE EMOTIONAL ASPECT**

If the adolescent lives in an environment of love, security and acceptance, then the

emotional aspect of his life is the one that needs the least intervention. His emotional being will open itself to the good and beautiful in life if

- \* within his family he is accepted and praised for whom and what he is and the good that he does;
- \* amongst his peers he feels he belongs and has a contribution to make towards their unity;
- \* at school his ideas are encouraged, his talents are recognized, accepted and appreciated and his abilities are perceived, approved and further developed; and
- \* within the community he feels he can benefit its progress and perpetuity.

If the emotional development of the adolescent is at the mercy of indoctrination, corruption, immorality or religious indifference, then it will assume similar characteristics. If the educator assumes his rôle as a giver of rules and prescriptions for a predetermined mode of living for the educand, then there is no longer an education situation but rather a domination situation. As the child becomes an adolescent, the need and desire to make choices, based on his own knowledge, experience and self-confidence, is increasingly important for sound emotional development.

### **2.3.6 THE AESTHETIC ASPECT**

The aim of aesthetic education is to develop in the learner an appreciation of that which is God-given and beautiful. The emphasis today is on the study of science and technology. It would be a foolish educator who would permit an educand to omit from his studies the negative effects of science and technology on the environment. Deprived,

too, would be the learner who did not include in his curriculum a study of the beauty of creation in some form, be it art, nature, theatre, language, dance or music. Neglect of the aesthetic aspect of adulthood causes impoverishment of the knowledge of the world and the beauty it has to offer.

### **2.3.7 THE ETHICAL ASPECT (MORALITY)**

"... we can say that no human being can want anything or make it the objective of his action if he does not consider it meaningful or valuable in one way or another" (VAN VUUREN ed., 1976:96).

Man-given rules are not necessarily logical choices but often moral (ethical) choices. The educator would wish to arouse in the educand a sense of the moral good and the benefit of obeying the norms associated with it. While at school, the adolescent must obey school rules, sport rules and also rules associated with different subjects. Transgression of such rules results in disciplinary action or subject failure. Appreciation of the reasons for the existence of rules and the resolution to uphold the rules is a step forward towards self-reliance.

Pupils who choose a subject at school because they appreciate what it has to offer them and their fellow beings, will surely relate to the rules of that subject far more positively than if they had the subject imposed on them without any choice at all. An understanding of the impact of the subject on the life of the individual and on the progress of society, will contribute much to the adolescent's attitude to learning. It is in the small everyday actions that man reveals and develops his moral consciousness. Within the classroom-subject constraints, the adolescent can be assisted in his ethical development by pupil-

pupil, pupil-teacher and pupil-subject interaction. These encounters set the stage for those pending encounters of the adult-world.

### **2.3.8 THE RELIGIOUS ASPECT**

As man conceives the most amazing ideas and gives birth to astounding technological wonders, the omnipotence of a Divine Creator may fade into the background as man's genius is applauded. Without the comfort of a Divine Force in life that influences the choices offered to man, the adolescent may find his adulthood strivings fraught with confusion and disappointment. It may appear to a student of science and technology, that man's intellectual achievements are all that is needed to survive in this world of today. It is the duty of the educator to remind the adolescent that discoveries are by the grace of the Divine Creator only and all that is discovered, was initially created by a power far superior to man.

### **2.3.9 THE PRAGMATIC ASPECT**

The historian, the philosopher, the social worker, the physiologist, the psychologist, the anthropologist and the educationalist each contribute thoughts and hypotheses about what the adolescent is striving for when he approaches the culmination of his school days. Sophisticated, empirically founded theories are presented to the student of education who, in his more sophisticated and experienced state of being, perceives the truth and reality in these theories. The young adolescent, however, would adopt a far more pragmatic stance on his expectations of adulthood and would probably outline some of the following goals:

\* Financial Independence.

To have one's own money, to spend it whenever and on whatever one desires, would be a major contribution towards total freedom and independence.

\* Social Independence.

To be free to make one's own choice about where to be, when to be there and at what time to leave there, would consolidate the status of adulthood. The freedom to choose one's own friends and to integrate and socialize within the boundaries set by personal limitations would be preferable to those dictated by parental constraints.

\* Social Status.

Status can mean many things to many different adolescents, but status afforded by the material possessions of life are generally coveted by all adolescents. A well-paying career with promotion prospects would be the bottom-line of most material gains and for this reason, the adolescent is career orientated, albeit impatient in its establishment.

\* Social Acceptance.

To be popular amongst working colleagues or fellow students is of prime concern in the adolescent's life. This concern is perpetuated into the phase of young adulthood wherein membership of sporting, academic, social and cultural clubs is common.

\* Creation of Family.

The adolescent sees himself as a procreator in the adult world. He removes himself from his family bonds and establishes a position of "new growth" in

society. The effect that this instinct may have on society depends on the responsibility with which it is handled.

The adolescent appears, then, to have a more worldly and materialistic vision of adulthood. His approach is filled with demands and expectations which, often, are difficult or impossible to fulfil. The rôle of the educator in the sequel of adolescence is to prevent disillusionment and disappointment by revealing the truth of what is to be encountered in the world as it is and not as the theorist would like it to be.

### **2.3.10 SUMMARY**

The multifaceted nature of the adolescent and the goal of all his efforts and endeavours, namely adulthood, have been dealt with. The next aspect requiring clarification is the rôle that the school should play in achieving the pedagogic aim of adulthood.

## **2.4 THE PEDAGOGIC SCHOOL STRUCTURE**

### **2.4.1 INTRODUCTION**

The significance of the being of the adolescent for educating and the significance of educating for the being of the adolescent, rely on the knowledge that the teacher has of the being of the adolescent en route to adulthood and the potentialities of the subject-matter at hand to clear the way for the pedagogic encounter.

"The problematic of the teacher concerns ways to let being emerge within the relationship; how to let the being of the teacher, the being of the pupil and the being of the world shine forth" (Vandenberg, 1971:147).

These three elements of the encounter: the pupil, the teacher, and the world, indicate the aspects of the pedagogic relation. The teacher must lead the pupil to an encounter with the subject-matter so that he may explore the world and become more orientated in the world. The teacher must also lead the pupil to an encounter with himself (the teacher) so that the world is disclosed to the pupil in the regions constituted by the particular subject matter. These two encounters form the encounter between pupil, world and teacher; they are interrelated and ongoing throughout the pedagogic encounter.

Man is constantly in relation to someone or something else. Man, in a state of isolation, may relate to his inanimate surroundings or he may relate to persons by means of pleasant or unpleasant thoughts. Within a crowded situation, man may choose to relate to the crowd in general, to the person alongside him or to a situation far removed from his own immediate surroundings. Teachers, as educators, are interested in the relations of the children entrusted to them. This interest is specifically in those relations wherein the child becomes involved under the supervision of the educator: the relations of authority, understanding and trust. It is the task of the educator to guide the educand to a point where these relations will be performed in an independent and responsible way, characteristic of adulthood. LANDMAN et al., (1982:1) define education as being precisely what is implied by the previous statement:

"This then, is exactly what education means; education is to assist the child in doing in education situations what he eventually should do independently and responsibly". (The author has underlined.)

LANDMAN et al., (1982:3) stress that education cannot be regarded only by definition

as an occurrence between an adult and a non-adult, but rather that, in practice, most certainly, education requires the presence of a non-adult under the supervision of an adult who is familiar with, can anticipate and can reason the problems encountered by the non-adult. The problem now arises: can persons who have not made a study of pedagogics, and therefore have no theoretical knowledge of the relations of trust, understanding and authority, still execute authentic educative intervention? LANDMAN et al., (1982:5) contend that:

"To execute this educative event, in other words to have events of educating occur, requires no scientifically vested knowledge of the mentioned structures, but it does require a willingness to constitute education relations in such a way that the non-adult ... consistently moves closer towards adulthood".

To execute this education event, therefore, does not always require theoretical knowledge of the described structures, essences and relations of the phenomenon of education, but what is required is willingness to order and organize the encounters between adult and non-adult in such a way that the non-adult will have the opportunity progressively to relate his experiences to the adult-world as it increasingly reveals itself through educative occurrences. To be an "expert" educator, a teacher must have knowledge of the theory of education. It is the work of the experts (educationalists) in the various disciplines of study (social, commercial, cultural, historical, scientific, technical, sporting etc.) to investigate the particular education situations relevant to their designations and subsequently describe the methods, approaches, styles (didactics) and content that could best be utilized to ensure the realization, within the classroom, of the pedagogic structures, essences and relations of education. These structures, essences and relations

are described in detail in LANDMAN et al., 1982: Chapters 1, 3, 5. Subject-experts who have scientifically vested knowledge of education, would appear to be best suited to circumscribe and demarcate the fields of subject-study in schools, so that the subject-content is richly exposed to the child within an education-situation that is pedagogically accountable and didactically appropriate, organized and intent on revealing the path to adulthood.

It is with this in mind that the pedagogic school structure will be discussed and, ultimately, later in this study, utilized to validate the selection of subject content for Computer Studies in secondary schools.

A new born child exists in a state of helplessness. From the moment of birth he begins a sequence of changes that continue to occur throughout his life (C.K. Oberholzer, 1979:162). Initially these changes aim at the acquisition of independence and self-realization of adulthood. The search for knowledge is an ontic human feature; the human being is the only creature that seeks knowledge (Landman et al., 1982:17) and, since a major part of the period of the life of an adolescent, preceding adulthood, is spent in a classroom supervised by an educator, it is essential that the time spent together in this education situation, is characterized by meaningful pedagogic-didactic experiences. LANDMAN et al., (1982 : Scheme G) outline seventeen aspects intrinsic to the pedagogic school structure. The following seven intentions or expectations of this structure have been identified as particularly worthy of discussion because of their relevance to the computer-science pedagogic situation. Later in this study these seven

aspects will be used to validate the selection of content for computer science syllabuses in schools.

#### **2.4.2 THE EXECUTION OF PURPOSEFUL ACTIVITIES**

Activities within a classroom cannot always be regarded as educative. Pupils may become bored with the proceedings and subsequently lose interest in the subject. The methods of exposing the subject matter may result in rote-learning of facts, without any self-expression or creativity on the part of the pupil being encouraged. The content of the subject may be such that it is selected and structured to reflect the views and philosophy of another person or group of persons, with no inherent possibilities for the self-actualization of the individual learner. Activities in a classroom are considered to be educative if they expose realities of the world to the pupils, offer occasions for self-expression and actualization and provide a space for social interaction within the discipline of the subject. For activities to result in purposeful education, the teaching and the learning activities have to be appropriately structured.

##### **2.4.2.1 Teaching Activities**

Expert teachers have to supervise activities in the classroom. The action verb is not "teach", but rather "supervise". The classroom situation which displays passive learners listening to a verbally-active teacher, has become a scene desired only as a replay of school-days of yesteryear. Today's classroom is an active area of pupils asking questions, thinking, listening, testing, trying and contributing. The teacher is required to supervise and advise these events by imparting knowledge, correcting misconceptions,

listening to ideas, controlling activities and, above all, understanding the physical, emotional, social and intellectual needs of the non-adults before him. The classroom must be alive with creative thinking guided by a degree of discipline determined by the contributing circumstances. The traditional 3Rs of learning could be increased to the 4Rs of Reading, wRiting, aRithmetic and Reasoning.

#### **2.4.2.2 Learning Activities**

Human learning implies the involvement of people and, more specifically, the involvement of the child as a person. Learning does not imply facts but rather personal abilities. These learning abilities or potentials, can be activated. LANDMAN et al., (1982:97) refer to "learning orientation" as the activation of learning potentialities by the implementation of appropriate learning material within a stimulating environment under the supervision of an expert teacher. Perpetuation of learning is stimulated by evaluation of efforts and the reinforcement of successful outcomes of the input made by pupils in response to the requirements set by the teacher.

Learning activities are directly related to the thought processes that underlie them. For the purposes of this discussion, learning activities can be grouped into three main areas. The reader is referred to Chapter Three (3.5.2) for further information. Examples of types of learning activities are provided to justify the groupings. They are:

- \* Knowledge
  - Memorization of facts, definitions and rules.
  - Memorization of a sequence of activities to effect a result.

- Development of techniques to ensure neatness and accuracy.

\* Application and Comprehension

- Using rules and laws to solve problems.
- Use of language to apply meaning to and explain situations.
- Relating to the "Real World".
- Development of accuracy by repeated practice.
- Physical co-ordination acquisition by repeated practice.
- Organization of thought patterns.
- Manipulation of numbers according to prescription.

\* Insight

- Thinking in steps.
- Manipulation of numbers to arrive at a conclusion.
- Being creative.
- Designing solutions to problems.
- Formulating hypotheses.
- Interpreting results.
- Classifying information.
- Analysing results.

Emphasis must be placed on the different learning activities according to the individuals' abilities. Learning orientation, which implies education, is an activity in which a child is influenced by an adult to seek solutions to problems. In this way, responsibility and independence can be nurtured and self-confidence established.

"A person who has been orientated through learning, is a person who has certainty about his position in the world ... a person who can state his opinion with great prudence and accuracy ... with regard to the world about him" (Landman et al., 1982:18).

Such self-confidence can be kindled only in a person who has been exposed to learning activities that foster the development of knowledge, comprehension and insight. According to the various abilities of pupils, the emphasis on activities can be varied, provided that each type receives appropriately proportionate attention.

If classroom activities are such that the learner is expected to listen intently while absorbing facts and, thereafter, reproduce what has been absorbed at a later stage, there can be no hope of self-actualization of individuals. A nation of stereotyped, non-thinking citizens will result, leading to tyrannical rule in an authoratitive, non-democratic state. A criterion of adulthood is the ability to make decisions based on the learning and experience of the individual. If learners are guided in school to experience and test all faculties of their intellect, the confidence thus created in their own abilities will have far reaching effects on society. Thinking, non-indoctrinated adults will propagate a democratic society of lucid thinkers, creative inventors and competitive citizens, tolerant of individual differences and abilities. The way in which educators guide educands to learn ultimately creates the ethos of the nation.

### **2.4.3 ORGANIZED AND SYSTEMATIC EXERCISE ON THE FUTURE**

The reader is reminded of the definition of education by LANDMAN et al., (1982:1):

"... education is to assist the child in doing in education situations what he eventually should do independently and responsibly".

Learning orientation is closely related to the teacher's sensitive understanding of the child who is in need of, and expects, his assistance, as well as a comprehensive understanding of the child's increasing awareness of what the future means. There ought to be an exposition of the future to the child. The life-world of the adult with its incumbent demands and expectations must progressively be revealed in the school situation. Simulated experiences from the "real world" can be created within the secure space of the school, providing the adult-in-training with opportunities to find solutions, manage the moments and challenge his creativity. The expert teacher must know what exists beyond the confines of the classroom; he must know what challenges, expectations, confrontations and demands await the child as he leaves the security of the school. Similarly, the teacher must be aware of the personal hopes, fears and aspirations of each child under his supervision.

This appears to be a monumental task for a single teacher but as teachers in the secondary school environment are generally single-subject specialists, the task of familiarizing pupils with the social, economic and political realities of life is confined to the potential of the specific subject of which he is a master. He must reveal the subject matter with due consideration for the often harsh, unyielding demands of the world beyond the classroom on the one hand, and the human needs aspirations and abilities of his wards on the other hand. The question the teacher must ask is: "How can I present this subject to the child so that he will be prepared for a meaningful mode of existence?" If the subject content has been designed by subject experts with a sound knowledge of the theory and practice of education and its societal implications, then the answers should be inherent in the

choice and design of the subject-content.

The learning activities within the school should be goal-orientated; the preparation of the child for the adult-world being the goal. If the child understands the "why" of the learning experience and not just the "what", the teaching and the learning will progress with an inherent momentum. Man is ontically a futuristic being. He is motivated and stimulated by the future.

"Though the future is an uncertainty, man plans today what he aims toward doing later ... . He who does not plan for the future can be compared with a plant or an animal; both are not 'concerned' with a futuristic outlook" (Du Plooy & Kilian, 1984:148).

It is the task of the school to present the future to the child so that the transition from school to the "real world" is an anticipated and manageable experience.

#### **2.4.4 CREATING A SPACE IN WHICH LEARNING OPPORTUNITIES MAY BE ACTUALIZED**

Creating a space in which an individual can effectively learn, is a relatively simple matter. The individual may discard from his environment that which is not to his liking and create a surround that satisfies his personal needs for learning. To perform such a task for a school situation is hardly as simple an undertaking as this, for as many as 300 different pupils may pass the threshold of one classroom during one school day, each having his own unique composition with respect to age, sex, sociality, emotionality, culturality and ability. It is thus the task of the educator to determine, with respect to his subject, what the motivating factors are, both intrinsic and extrinsic, that will create an

atmosphere for learning for a group which is homogeneous possibly only with respect to age.

The adolescent is approaching adulthood and is anticipating the privileges of independence and responsibility. His vision of life after school is mainly centred around his career and possibly the financial implications thereof. Motivation for learning may thus be achieved by fostering a link between the classroom activities and their relevance to life after school. Tasks, exercises and assignments should regularly relate to business, industry, technology, the home, the society, the environment and the community. Media reports relevant to the subject should be brought to the attention of learners and the latest developments pertaining to the subject should take their place in classroom discussions.

A classroom may become conducive to learning when an individual child feels that he is able to cope with the subject content. To be made aware of the importance of a subject, both during and after school-life, is a form of extrinsic motivation, but it is the intrinsic motivation, gained from the individual's ability to achieve and succeed at the subject, that provides him with a perpetuating desire to learn more. It is for this reason that subject-content should be differentiated to cater for the varying levels of ability amongst pupils and, also, the varying intensity of interest that pupils may show in the subject.

Within a classroom, discipline and control contribute towards creating a space in which learning opportunities can be realized. Discipline is usually considered to be acted out by the pupils, while control is the part played by the teacher. Both control and discipline are behaviours intrinsic to an atmosphere conducive to learning; if the motivation, both intrinsic and extrinsic, exists to learn, then there should be rare moments when discipline

and control cease to apply. Discipline does not involve only the personal behaviour of the pupils, but it includes the execution of duties within the class by both pupils and teachers, the correct care and use of classroom apparatus, the consideration amongst individuals for one another, adhering to time schedules for execution of tasks and general attitudes adopted by teacher and pupils to prevailing circumstances. LANDMAN et al., (1982:6.7 Scheme G) refers to:

"... the regard for the demands of propriety as demands of proper human existence..."

as a need for creating a space in which learning opportunities can be actualized. The implication is that promotion of the appropriate and correct behaviour amongst pupils in the classroom, should prepare them for what will be expected of them outside the classroom, throughout their human existence.

#### **2.4.5 EXERCISING MEANINGFUL MODES OF BEING HUMAN IN SECURED TOGETHERNESS**

This aspect of the pedagogic school structure circumscribes three inherent components of the adolescent path towards adulthood: meaningful modes, being human and secured togetherness. Each aspect will now be discussed in relation to the adolescent and the school.

##### **2.4.5.1 Meaningful Modes**

"Exercising meaningful modes" implies that there should be daily, purposeful exercises performed in the school with which the child can identify and to which he, as a human

being with expectations, can relate. The selected exercises should take into account the life-world of the child: his interests, his community, his school and his family. His knowledge should relate to the Real World; that which is established and waiting to confront him as he gradually progresses from being an adolescent to becoming an adult. It is not always possible for a child to learn only that in which he is interested, but it is possible for subject content to be selected and designed so that the presentation thereof can awaken an appreciation and an interest in the field. Subject matter that can link up with a hobby or a favourite subject of a learner, will surely, in time, become an appreciated and interesting subject itself. Learning will be integral to class attendance if the learner feels that the knowledge is useable, pertinent to life and a step towards the future. Knowledge should not be a means to obtaining a qualification or passing an examination, but rather the path towards what ought to be for the learner and the world in which he is to exist. According to VILJOEN & PIENAAR (1971:171) education is also qualified as "... the formation of character". Man is a moral being and the choices he makes, the norms he accepts and the values he lives by, are all dependent on education. Education may, therefore, be regarded as the formation of the conscience. The conscience is that entity of man that persuades him to act according to his deepest convictions of what is right. To form a conscience is not the same as succumbing to an indoctrinated body of information. A conscience is established by exposing the child to circumstances, simulated or real, and requiring that he make a choice. Indoctrination tells the child that only one option is available and therefore he has no choice. Being examination orientated when dealing with subject matter is a form of indoctrination, but allowing the child to make mistakes, create and test his intuition in dealing with

classroom material, is a way of encouraging him to make choices and find out what is right. The child who has been tutored to sit for an examination, may have confidence for the examination but little else to offer beyond the examination. On the other hand, the child who has been taught to confront a problem and design a means to solve it, will acquire the ability to extend this special, meaningful type of knowledge to a wider field of life-situations. Basic education should centre around reading, writing and reasoning, to become a pedagogically accountable means to attaining this goal.

#### **2.4.5.2 Being Human**

Being human implies sharing in the successes, failures, frustrations, joys, disappointments, fears, elations and angers of human existence. Pupils should experience these emotions within the academic and social structure of their school-life, subsequently learning to deal with their experiences and simultaneously gathering knowledge for Life. The school and the classroom should be a microcosm of social reality, providing a training centre for an independent existence later on in life.

Being human, according to VAN RENSBURG et al. (1981:289), stems from the philosophy of life regarding man as the measure of all things: there is no existence and truth outside man and his abilities - his needs alone should be satisfied. To define what man's needs are in the modern world, is an incomprehensible task for pragmatist or philosopher. Man's basic needs, however, could be described as love, acceptance, security, food, clothing and shelter. Acquisition of these afford him the human dignity he deserves. These needs may be further refined into vital needs; those of food, clothing and shelter. There are people who receive these vital needs as a birthright or as a right

of matrimony, but for most people they are provided for by employment. Some form of marketable skill for employment should be initiated in the schools, in the form of performance skills such as typing, computer or technical skills, and attitude skills concerning human relationships, self-discipline, loyalty, ambition and perseverance.

Being human implies being an individual in the over-populated arena of encounters with other people, animals and things in society. Man will constantly, as a human, find himself in relation to someone or something else. It is the meaning that he attaches to these encounters and the nature of the encounters themselves that make him a unique individual, and establishes his self-image. The school has an obligation to expose the child to many different encounters that will prepare him for his individual experiences in the Real World.

#### **2.4.5.3 Secured Togetherness**

"Secured togetherness" implies acceptance, belonging, security and loyalty. Such feelings can prevail amongst pupils in a school if learning orientation is such that individual abilities are provided for, cultural differences are respected, failures are tolerated, successes are encouraged, talents are fostered and interests are promoted.

VILJOEN & PIENAAR (1971:171) claim that a child will feel at home in a world that has been prepared for him if the constituents of expectation, encounter, acceptance and dialogue are established in the educator-educand relationship. The learner and the teacher impose expectations on each other as they enter the pedagogic situation. The non-adult appeals for help and the adult reciprocates with the offer of knowledge and help which

the pupil accepts and utilizes to investigate the unknown. The teacher accepts him with his limitations, his talents, his failures and his successes. The encounter is realized through mutual dialogue as the teacher encourages the learner to constitute this encounter as part of his life-world. The family and the community form an extension of the school and vice versa. Pupils must feel that attendance at school is a vital part of citizenship and that what is learnt at school is in preparation for a meaningful community life. The school, the family and the community should interact to introduce and reflect the norms of the society. The school has the obligation to reflect a social order and not reinforce it. Co-ordination between social expectations and expectations of pupils should at all times be observed. An exposition of the needs and demands of society should encourage and entice pupils (and not force them) to pursue certain career directions because of financial rewards and employment security. They should not feel pressurized into pursuing a career for which they have neither aptitude nor interest. VANDENBERG (1971:165) discusses the "pedagogic paradox" of educating to restore both "identity" and "community". However he says:

"This paradox is not really paradoxical because authentic individual existence and authentic coexistence are equiprimordial".

Claiming that individual existence and coexistence are equiprimordial not only refuses to elevate one of these above the other, but also asserts the ontological fact that the child can actualize his own possibilities only within the genuine coexistence with, and dependence on, another human being. Those pupils who choose more unconventional fields of study should be allowed the freedom to follow their interests, while still being part of the "secured togetherness of family, school and society". VANDENBERG

(1971:165) warns of existing only as an individual with no authentic co-existence, because everything slips into the "grey of inauthentic everydayness" where people are neither themselves nor with one another in any meaningful sense.

#### **2.4.6 MUTUAL INTERESTS BETWEEN SCHOOL AND HOME**

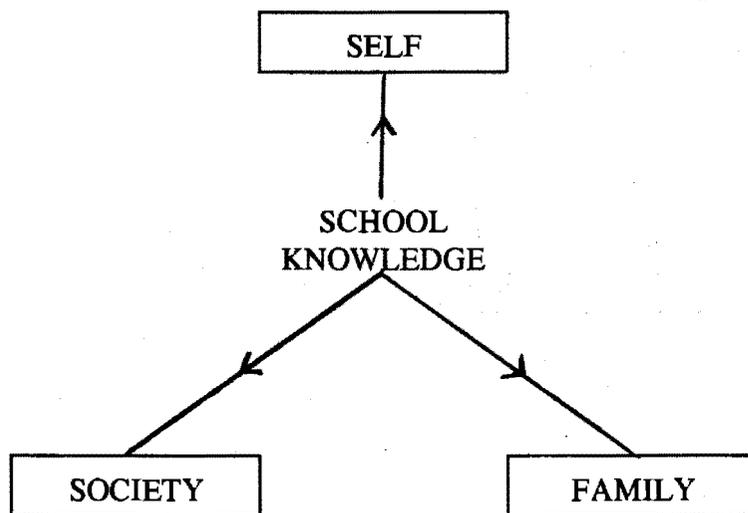
Parents colloquially refer to the desired state of behaviour of their adolescent family members as "grown up". "He has grown up into ..." or "I wish he would grow up" or "He has started to grow up". "Grown up" implies a state of maturity; a state of recognized responsibility. The adolescent period is thwarted by strained relationships between parents and adolescents as the not-yet-adult strives for adulthood (to become "grown up"). Common areas of discourse between parents and adolescents appear to be rare, and the youth seeks solace in the company of peers.

The school, as a true pedagogic-didactic situation, should strive to achieve a transfer of knowledge to pupils to supplement the home-school relationship and, simultaneously, decrease the tension in the parent-adolescent relationship. Pedagogic-didactic principles can guide the child to adulthood but it is not only the way in which knowledge is transferred in the didactic situation, but also the nature of the knowledge that can purposefully fulfil the expectations of both the adolescent and his parents. The knowledge can be such that it provides a link between a parent and a child; knowledge that they can both share in and discuss. Knowledge that is gained in school should not polarize parents and their children, but rather provide opportunities for conversation and sharing. Ideally, knowledge transferred in the pedagogic situation should be selected and designed so that it satisfies what:

- \* the child desires;
- \* the society needs; and
- \* the family can share in.

This relationship can be diagrammatically represented as:

FIGURE 3: THE SCHOOL-KNOWLEDGE LINK



#### 2.4.7 OPPORTUNITIES TO EXERCISE ACQUIRED FREEDOM IN SECURITY

Many aspects of the school curriculum restrict the learner to specific facts and inflexible methods of presentation of these facts, with little scope for creativity and initiative. Tuition becomes "examination orientated" and "text-book bound". This unfortunate scenario has repercussions in tertiary institutions and the employment sector. School-

leavers are not adequately prepared for demands made on their intellect and initiative. Failure-rates amongst first year tertiary students are alarmingly high and employers are questioning the preparation for employment that pupils receive at school. The following statistics are provided by HOFMEYR & SPENCE (1989:37) and represent a sample of 3 698 students who had a matriculation aggregate of less than 80 percent, and who registered for a three-year degree at a South African university in 1980:

Degree	Number of students	% of students who graduated in	
		3 years	4 years
BSc	1 012	15	18
BCom	918	23	18
BA	1 768	36	15
Total	3 698	27	17

These figures confirm that there is something drastically wrong with the preparation that pupils receive at school for tertiary studies, as just more than a quarter of the sample (27%) completed the degree in the prescribed period of three years. The questions which arise are:

- \* do the pupils know how to put their acquired skills and knowledge to work, and
- \* are they taught skills and knowledge that they can put to work on leaving school?

Adolescents, as they acquire greater responsibility through academic success in the school, should be afforded an increasing period of breaking away from the rigours and

requirements or preparing for the year-end examinations. Independent exercises on the meaning of the content, skills and conduct acquired in the classroom can be introduced into tuition programs that will facilitate a freedom to put the school-knowledge to task. Senior pupils could be given the opportunity to spend a few days in a commercial, industrial, medical, technical, conservational or artistic centre, where they could see their acquired knowledge in action. While this can be seen as a "breaking away" of the pupils from the confines of the classroom, it is also a means of interaction between school and community, an actualization of acquired insights. There are other types of breaking away that can release the tension arising from constant courting of the demands of the syllabus. Spontaneous discussions of topics initiated by the pupils, should be permitted at the right time, as should any activity, classified as relaxing rather than demanding, that can periodically reinforce the pedagogic relationship in the classroom in a more sociable, but meaningful, way. The setting of assignments which require pupils to research and simulate situations outside of the school environment, is another means of exercising skills, creativity and conduct, while simultaneously satisfying the yearning of the non-adult to associate with adults on the level of adulthood.

#### **2.4.8 FORMALIZED EDUCATIVE OCCURRENCES**

Within a multi-cultured society, a mutual commitment is required from parents, teachers and pupils to maintain the identity of the school. Within South Africa's rich and diverse cultural heritage is the new 1990's concept of "open schools" and "open areas". A school's identity based on culture will have to give way to an identity based primarily on the academic content of the school and the personal performances of both pupils and

teachers of the school. The technical, artistic, commercial, scientific or humanistic nature, the standards of tuition and academic performances, and the extra-mural participation and achievements of the pupils of the school are factors influencing the identity of the school.

An educative occurrence is characterized by an educator, an educand and a goal towards which the educand, assisted by the educator, is striving. The path towards the goal is often distributed with problems and difficulties and it is the experience and knowledge of the educator that permits him to assume a position of authority in guiding the educand along the less hazardous path towards the goal. Within the classroom situation, a commitment is required from the teacher to nurture in the pupils a regard for certain norms and particular rules which will ensure a harmonious and profitable path towards achieving the goals of the subject content. The rules and regulations of school and home are the laws in force in the pupil's existence. These represent the prescribed order belonging to this life-phase of the child and youth.

"For the pupil to be in the truth of the rules and regulations of schooling, is for him to be committed to the moral facticity of the society within his horizon, to the truth of his coexistence with other pupils and with teachers ..." (Vandenberg, 1971:201).

The intent is not to force the pupils to conform to rules, but rather to be committed to the moral facticity of coexistence. Adherence to rules should occur within the pedagogic situation through the use of request, appeal, explanation and admonition. It is essential to disclose the reason for the rule rather than to promulgate the rule. The majority of school rules can be consolidated in the classroom by using the subject matter as a means

of effecting personal discipline and desired behaviour amongst pupils. The educational task is to take the inner being of the pupil into account by encouraging him to express his views, and, in so doing, appeal for assistance to clarify the task of determining for himself who he is and to accept responsibility for his being and for being there with others.

Obeying rules may appear to conflict with the concepts of developing creativity and allowing freedom for personal expression. This, however, is not the case as, once again, the old adage of "freedom through authority" applies. The learner may be afforded freedom to create within the rules and laws of the subject matter. Transgression of these rules should illustrate that the outcome of the exercise is not what was desired nor anticipated. To find out for himself who he is, requires scope for disobedience that is prohibited (or later avoided) through reward and punishment, praise and blame (Vandenberg, 1971:153). Admonition does, however, allow room for disobedience.

Selection of the subject content should ensure a proportionate balance between keeping to the rules and experimenting with ideas. A successful author of essays or books allows himself freedom of expression within the confines of correct use of language. Subject matter should be selected and structured so that its inherent discipline presupposes all creative action.

A subject which demands accuracy, neatness, attention to detail and logical thought processes throughout its execution, can ensure the development of similar character traits in its learners. Such qualities are also required by employers and parents alike, and can, therefore, supplement paternal and societal tuition and education.

#### **2.4.9 SUMMARY**

The previous seven principles of the pedagogic (school) structure have been extracted from LANDMAN et al., (1982 : Scheme G). Seventeen principles, as listed by LANDMAN et al., have been confined to seven principles, as groups of more than one of the listed seventeen have been, on several occasions, combined into one principle. Consideration of the seven principles (or essences) reveals the intricate synchronization of educator, educand and subject matter within the small confines of the classroom, the larger terrain of the school and the unlimited dimensions of society. LANDMAN et al. have contemplated the school situation and in so doing, have excluded the idea that the school is primarily an institution that provides classrooms wherein a learner consumes knowledge. The school has a much greater task and within the school structure, the design and selection of subject content assumes a major rôle in assisting the school to actualize its mandate. The rôle of the subject computer science within the pedagogic school structure, in helping to actualize the school's mandate, deserves investigation and discussion.

### **2.5 COMPUTER SCIENCE WITHIN THE PEDAGOGIC SCHOOL STRUCTURE**

#### **2.5.1 INTRODUCTION**

When the phrase "technological world" is used, it brings to mind flashes, beeps and messages from either a cybernetic voice or a flashing, luminous screen. To many people, these images are synonymous with a computer which itself tends to be attributed to an

intelligence superior to that of a human being. It is, in fact, a high-tech, plastic capsule, hiding a complicated network of circuits (designed by man) enabling it to perform whatever man programs it to do. It has no "brain" but it is a means to an end, in the same way that the subject-matter in the curriculum, essentially inanimate but with its own latent "life", is a means of bringing the learner into a relationship with the world. The computer could thus be grouped with the subject matter as a link between the three components of the pedagogic encounter: the pupil the teacher and the world.

DAVIES & SHANE (1986:14) quote POSTMAN who pointed out that by 1980 students who had graduated from high schools in the United States, had spent some 16 thousand hours in front of an electronic screen, versus the 12 thousand hours they spent in elementary and secondary classrooms. The use of a computer in the home and the playing of video games is included in the discrepancy.

The United Kingdom alone boasted some two million computers resident in homes in 1984 (Kelly, 1984:22), and this figure was predicted to triple by 1989. Unfortunately the computer is used in the home primarily for playing computer games and for wordprocessing. Clearly, ways of actualizing the full potential of the computer must become a greater part of the preparation of pupils in schools. Education in the microelectronic context, training for and mastering lifelong skills on the computer, should be initiated in the schools.

Today's environment contains enough visible evidence to suggest that we must consider most seriously the inclusion in the school curriculum of the theoretical and practical applications of a rapidly developing information technology. Inevitable social changes

follow technological development. The kind of social changes that occur depend entirely on how the technology is used. Children who have not followed an organized education program on the uses of the computer, are likely to use a computer purely for entertainment purposes. The revelation of the computer as a means to design, create, solve problems and retrieve processed data, will result in recognition of the true intention and potential of the computer in the child world, the adolescent world and the pending adult world. KELLY (1984:19) talks of "good practice" in the field of computers. According to KELLY, principles ought to be set out and conclusions reached about these principles, so that they are relevant for the development of individual children, for education and for society itself.

To this end, an attempt will now be made to substantiate the value of computer science in reinforcing and consolidating the pedagogic school structure as discussed in 2.4.

### **2.5.2 COMPUTER SCIENCE ENSURES THE EXECUTION OF PURPOSEFUL ACTIVITIES**

Computer science as a subject, has a large practical "hands-on" component, but it also requires a comprehensive study of associated theory. The use of the computer in the practical part of the syllabus introduces a model of education described by KELLY (1984:xiv) as:

"... that of education as experience, as active learning, as a matter of challenging events rather than products".

The above is a symphony, not a sentence, heralding what education should be at all

times. The following is an attempt at outlining the teaching and learning activities of computer science as a school subject that promotes the execution of purposeful activities.

### **2.5.2.1 Teaching Activities**

The practical component of the computer science syllabus brings another relation to the education situation; that of computer-learner interaction. The software of all modern computer applications has a "HELP" facility, which tends to subdue the role of the teacher as the prime initiator and promoter of progress in the classroom. The pupil interacts (excitedly) with the computer and responds undauntingly to the messages it relays when compilation of a program is interrupted. The question now arises concerning the role of the teacher in the pupil-computer relation. It is that of supervisor, advisor, listener and assistant. While the learners are involved in using the computer to solve a problem posed by the teacher, as many different solutions are being designed as there are pupils in the classroom. Individuality is programmed and while misconceptions and errors often occur, individual creativity and genius enters the central processing unit of each computer. The error messages built into the software being utilized, can clearly indicate most syntax errors, but the logical errors are usually reflected in compilation interrupts or incorrect output. The teacher thus finds himself in great demand to identify individual errors and to crystallize similar errors into a chalkboard explanation. The teacher must understand the varying needs and abilities of each pupil and render different degrees of assistance as evaluated by the problem at hand and the pupil before him.

### 2.5.2.2 Learning Activities

KELLY (1984:XIV) quotes RHEINGOLD (1983):

"The teaching machines of computer-assisted instruction transferred declarative knowledge with assembly-line efficiency, but did nothing to upset the stale notion that learning is little more than the acquisition of facts. Software programs, on the other hand, teach process: not new skills per se, but how to learn new skills, even how to think. Indeed, modern Piagetians believe that computers allow children to conduct their research on a scale never before possible...".

This viewpoint supports the notion that the use of computers to teach, is merely another way of enhancing, and perhaps accelerating, learning of a traditional kind; the "learning" that promotes the retention of facts (cf. Duminy, n.d. : 259). The reader is reminded that this study is not concerned with using computers to teach, but rather with teaching to use computers.

When the teacher poses a problem for which the pupils have to design a solution using a computer, the following sequence of skills may be addressed by the pupils to achieve their goal:

- \* Planning and designing the steps to a solution.
- \* Arranging the steps in a logical sequence.
- \* Coding the solution into a computer language, recalling the rules of the language as well as the rules of good programming practice.
- \* Refining the program steps to effect the most efficient use of the computer's abilities.
- \* Bringing the computer into active mode.

- \* Entering the program into primary memory (typing skills).
- \* Seeking new methods or correcting syntax errors when compilation is interrupted.
- \* Reassessment of design of solution if an unacceptable solution or no solution is arrived at.
- \* Preparing an aesthetically pleasing arrangement of the acceptable output.
- \* Interpreting results of the program in relation to the problem posed.
- \* Comparing results with those of fellow learners.
- \* Accepting his own solution, or that of a fellow learner, as the most effective and efficient solution to the problem.

It is not an easy task to identify every skill and thought process that is exercised during a computer programming assignment. The reader is also reminded that the subject, computer science, has a theoretical component, which involves memory recall, the use of theorems to solve problems and manipulation of numbers according to prescribed rules. This brief account of the computer science lesson, illuminates the skills and thought processes demanded of learners of computer science. They are:

- \* memorization of facts and rules,
- \* use of language,
- \* development of neatness and accuracy,
- \* development of psycho-motor skills,
- \* organization of thought patterns,
- \* logical thinking in steps,
- \* manipulation of numbers,

- \* being creative,
- \* designing solutions to problems, and
- \* evaluating results.

The learner may be asked to deal with situations arising from the commercial, scientific, domestic, humanitarian, social or geographic worlds. He is, through interaction with his computer, his teacher and the subject structure, in contact with the real world.

The degree of difficulty of problems presented to pupils may be adapted to suit the individual abilities of pupils. Subject content may be grouped so that there is greater emphasis on theoretical aspects than on programming skills. Sections requiring expertise in mathematical skills can be simplified or replaced with more practical skills, should pupil performances demand it. Problems to be solved can be graded to suit the pupils' abilities. Impromptu adaptations to problems can be made, so that "that something extra" can be required from those high achievers who would otherwise solve the problem before others have formulated a strategy.

The opportunities for differentiation are multiple. An advantage arising from this differentiation is that pupils of all abilities can work side by side, as their main focus of interaction is the computer in front of them and the feedback it so spontaneously offers.

### **2.5.3 COMPUTER SCIENCE AS AN ORGANIZED AND SYSTEMATIC EXERCISE ON THE FUTURE**

The computer has been described as having a function similar to that of the subject matter; as a link between the learner and the world. The computer is, however, also part

of the world of today. It is used to launch and control space vehicles. Executives and their secretaries depend on it for fast and efficient execution of tasks. It appears to be able to predict the weather. Library records are monitored on a computer, as are school records and banking account records. Hospitals use computers for administrative, diagnostic and prognostic purposes. Our purchases and personal movements appear to be monitored on a nationwide network of computers. The possibilities for computer use are endless. Every company, institution or person seems to depend on a computer printout for some or other reason.

The computer can be programmed to solve problems, process data, predict outcomes and evaluate permutations and combinations to provide information for decision making. The programming assignments may deal with problems from all walks of life. Pupils may be presented with a simulated problem or an actual problem relating to the home, the community or the school environment, which requires a decision to be made. Wordprocessing packages can be used to teach the writing of letters, compiling reports and designing of personal curriculum vitae. Spread sheets may be used to introduce the stock market to pupils or to follow the form of certain race horses. Desk-top Publishing packages can be utilized in conjunction with the language departments, history departments and school affairs committees. The material available for manipulation and processing using the computer is exciting, up to date, topical and reflective of the future. What the child learns in school is a presentation of the future; he can relate it to the world beyond school.

The subject content may be graded and classified to consider or anticipate the hopes and

expectations of the pupils with respect to the subject computer science. There are pupils who are not satisfied with what they can make the computer do (programming skills), nor with what the computer can do for them (skills associated with the use of application packages), but they also wish to know how it all happens along the complicated circuitry of the machine (scientific and mathematical skills).

The content can be differentiated into various courses that will meet the needs and expectations of the different learners as they plan for their responsibilities within the adult world.

#### **2.5.4 COMPUTER SCIENCE CREATES A SPACE IN WHICH LEARNING OPPORTUNITIES CAN BE REALIZED**

Creating a space in which the individual child can learn, is a task which requires insight into the features that determine both intrinsic and extrinsic motivation to learn, as well as establishing the physical space of the computer centre.

Extrinsic motivation to pursue the discipline of computer studies as a means to understand the potential of the computer in the world of employment, has already been discussed in 2.5.3. Intrinsic motivation is established when a child feels he can cope with the demands of the subject and is encouraged by his own successes to progress further. Computer science is presented to a group of academically elite pupils who are selected on grounds of one or more of mathematical skills, language proficiency and an aptitude test (see 4.2). There is extensive room for further differentiation of the subject to include skills demanded of the academic protégés as well as skills required by those pupils

wishing to enter employment on leaving school. In addition to differentiating and organizing the subject content to include topics to develop specific skills required for certain applications, a problem relating to a programming exercise may be augmented with challenges for some class members or it may be subdued in degrees to suit the different creative abilities of the rest of the class.

The best planned computer curriculum will not be effective unless careful planning has gone into the actual purchasing, placement and scheduling of the use of the computers. A wonderfully conceived computer curriculum - and no computers, or not enough computers, or inaccessible computers or computers inadequate to meet the demands of the syllabus, will all contribute to computer anxiety of both teachers and pupils. There are many alternatives to consider when adding a computer centre to a school, but all of them must make sense in terms of the curriculum that is undertaken.

There is no doubt that the computer centre will be used for computer aided instruction (CAI) as well as for the study of computer science. CAI can be effective with two or three pupils sharing a computer, but the "hands on" component of computer science demands one computer for every child in the class. An added aid for the teaching of application packages is a demonstration facility which links a computer to an overhead screen, which enables the whole class to observe on the screen, what the teacher is executing on his computer. At least one printer for every ten pupils in a class is also a requirement. Added to these costs are maintenance fees, software costs, costs for repairs, security and insurance premiums. A computer centre is a costly undertaking, and for this reason it is essential that it be scheduled for constant use, that the pupils be disciplined

to use the computers correctly and effectively and to appreciate and respect the investment. Equally important is the need for the computer syllabus to be such that pupils, parents, teachers and society are convinced of the return on the investment.

It would be impossible for a school to keep pace with the incessant developments in hardware and software of the computer industry. It is reasonable, however, to expect the teacher to bring to the pupils' attention what the state of the art is in the computer field. This can be done via the display of media cuttings on the noticeboard, subscribing to computer magazines and taking pupils to annual "computer fairs" if logistically possible.

The reinforcement that a pupil experiences when the program "works" and it is churned out of the printer to be admired (or criticized) by his classmates, is sufficient to encourage him to repeatedly "debug" his efforts, in a controlled way, until success is achieved. A computer has a further disciplinary action in the form of error messages; it demands specific syntax to which users must adhere without deviation. Discipline is inherent to the nature of the subject computer science. Discipline is demanded of the learner in using and maintaining the machine, in obeying the rules of logic and syntax of the programming language or application package and in respecting his classmates who are concentrating in close proximity, also desiring a solution to the problem being processed. The user is being disciplined by the subject and the environment, to adhere to rules that will achieve for himself and his fellow class pupils, a successful outcome or result. He is contributing to a space in which learning opportunities can be realized.

The computer centre can be an exciting place if the pupil feels he is welcome there, if it offers him the challenge to achieve and it exposes the opportunities offered by the

immense computer world outside his school environment.

## **2.5.5 COMPUTER SCIENCE PUPILS EXERCISE MEANINGFUL MODES OF BEING HUMAN IN SECURED TOGETHERNESS**

### **2.5.5.1 Exercising Meaningful Modes**

"Exercising meaningful modes" has been interpreted for purposes of this study (see 2.4.5) as the carrying out of activities in the school:

- \* to which the pupil can relate;
- \* which have an intent on his future;
- \* which encourage him to use his judgement to make choices.

A career in computers may not be the ultimate career choice for many school pupils, but there is hardly a factory, school, hospital, library, laboratory, shop or an office or industrial plant that does not utilize a computer. Whatever career a child may decide on, it is certain to suggest utilization of a computer at some stage to a greater or lesser degree. The relevance of computer skills in the child's future is no longer a debatable issue; it is a fact.

There are pupils who enjoy mathematics, others who favour accountancy and yet others who are captivated by history. Some children collect stamps, others have shell-collections, while most of today's youngsters have a music collection to compete with that of a radio music library. Computer exercises can find application in the entire kaleidoscope of adolescent activities. The computer may be considered as the "bottom line" of controlling, organizing and bringing efficiency into the processing of data which

affects the top echelons of national control, right down to the management of personal hobbies. It is an optional facility as the old order of handling data may still be clung to. However, once the potential of a computer has been experienced, it should convince the user of its enticing possibilities for use.

#### **2.5.5.2 Being Human**

"Being human" has the following characteristics which have been identified as relevant to this study (see 2.4.5.2):

- \* the experiencing of emotions typical of human existence;
- \* the ability to function as an individual within an overpopulated environment;  
and
- \* the right to the vital need for survival: an income which can provide food and shelter.

The problems of overpopulation are described as starvation, disease, unemployment, violence, illiteracy and lack of housing. An examination of these undesirable states of being, confirms that overpopulation reduces individuals to states that are rather inhuman than human. South Africans have been warned in the National Press that "... chaos looms: warning of teeming millions out of work by mid 90s". (Sunday Times, 1991.04.14:1) and "... crisis mounts as growing ocean of unemployed threatens to engulf South Africa". (Sunday Star, 1991.04.14 : Finance Section).

The scenario is indeed dismal, but the fact is that there were already four million unemployed people in South Africa in 1989 (National Manpower Commission 1990

Report). This was in spite of the government's many plans and setting aside a large amount of money for training. The proposed solution is an annual 8% economic growth rate that will accommodate the backlog and the new job seekers. Although the situation at present cannot offer employment to even the skilled workers, the economic situation demands that basic education is skill-intensive or employment intensive. This does not mean that school pupils should all be trained as labourers, but rather that their school-leaving certificates should guarantee training in communication skills and dexterity in at least one field that can be utilized by a potential employer. Aspects of the Education Renewal Strategy (ERS) document, issued in 1991, by the Department of National Education by the Science and Technology Education Commission will be discussed in Chapter Five (5.2), but it may be relevant here to quote the reply of the interim science and technology group of the African National Congress (ANC) (1991:4) to the ERS document:

"... one of the goals of education should be to develop trainable rather than trained school leavers".

The interpretation of "trainable" could convey two different meanings with diverse implications. If trainable means possessing a basic education regardless of its content and relevance to the employment field, then subsequent training of all school leavers would be a costly and prohibitive task for any country with a precarious economy. On the other hand, if trainable means that the school leaver possesses some basic skill and knowledge which will provide the foundation for future training by an employer, then the subsequent costs of in-service training would be feasible and realistic within the work place.

Computer science is one such discipline that can enable entrance to the job-market. A perusal of the Business Times (1991.04.14) advertisement of vacant posts revealed at least 40 computer-related vacancies advertised. In times of economic recession such as South Africa now experiences, a marketable employment skill will not guarantee employment, but it should certainly improve opportunities.

The individual citizen becomes consumed by the masses of people in an overpopulated society. A side effect of the computer revolution is the numerical identity that man has been awarded. He tends to think of himself as a single bead in an infinitely long string of uniformly coloured beads. Education for the masses, food for the masses, clothing for the mass market, mass production and mass action are the commodities which are available to man in a massed society. School and home education is where the child should come to realize that he is unique and entitled to unique action intended for him personally. It is within the classroom that the learner can be afforded occasions for self-expression that will convince him of his own personal dignity and unique abilities. Computer science offers pupils opportunities for self-assessment and he expresses this through emotions of

- \* joy when his unique program works successfully;
- \* satisfaction at solving a problem;
- \* disappointment at receiving "garbage" output;
- \* anger at a class mate's failure to complete a task as part of a team;
- \* confusion when failing to analyse a problem;
- \* frustration when a program will not compile;

- \* embarrassment when a seemingly unsurmountable task is identified as a simple logical error;
- \* competitiveness to obtain a result before a classmate;
- \* fear of the unknown and unfamiliar test questions;
- \* self-discipline when having to learn theory, rules and theorems verbatim;
- \* achievement when an answer is correct.

These are emotions which a learner should experience within the security of the school situation. There must be challenges, disappointments, successes and failures from which the learner can build a sound emotional domain. These emotions and learning how to handle them, entitle an adult in the making to personalize and enrich his mode of being human. Subject matter should allow self expression and individuality and not be an imposition of facts suitable for mass consumers.

### **2.5.5.3 Secured Togetherness**

Differentiated education which provides graded subject matter according to ability of the learners, serves to polarize learners but, if it is implemented with regard to the sensitivity of the individual learners, it enables a sense of security, acceptance and belonging to develop amongst classmates of similar cognitive abilities. It would be an ideal education situation if pupils were grouped according to their similar abilities and presented with material selected to suit their needs. Within such a class, a pupil will feel that there are expectations of him and he will be inclined to enter into discussions with the educator and his classmates, with the confidence that his contributions are meaningful and acceptable. In a class which accommodates all levels of cognitive prowess, the pupils of lesser

capabilities tend to become subdued in the shadows of the subject masters, and seldom enter into any dialogue as they feel that the teacher does not expect them to contribute anything meaningful, in comparison to what more competent classmates are able to do. It is essential that a child feels he can contribute to the knowledge of his classmates as well as his own in the security of being (human) together. The structure and selection of learning content has a primary rôle to play in encouraging this aspect of a child's education.

"Togetherness" is a simplistic term for "society". Within a school, the population is small and considerably more homogeneous than the urbanized societies of today. The rules for both the school and society are, however, the same, and pupils can come to appreciate the need for correct social behaviour and integration if classroom procedures encourage it. Co-existence and co-operation amongst pupils and teachers, sharing of knowledge, taking the lead, forming part of a team and adhering to rules are all acquired modes of social conduct. The computer education environment creates a co-operative spirit amongst learners and between teacher and learner. The situation may arise when a pupil has more exciting ideas to offer than the teacher has, and for this time, the teacher can transfer the leadership to the pupil. The "computer boffins" should be encouraged to assist and share their knowledge, and in so doing, create an atmosphere of co-operation in the class. The multi-faceted relations in a computer centre : teacher-pupil, teacher-class, pupil-pupil, pupil-computer and sometimes pupil-class, can serve as a training centre for acquiring correct modes of social persuasion.

## **2.5.6 COMPUTER SCIENCE FACILITATES MUTUAL INTEREST BETWEEN SCHOOL AND HOME**

Installing a computer in a home is done for two reasons:

- \* to enable the family members to utilize it for personal reasons
- \* to enable the working members of the family to complete work at home which they were not able to do during normal working hours.

The manner in which family members use a computer is generally limited to playing games or producing the occasional letter on the wordprocessor. It is infrequently used to monitor small home-businesses such as catering, speech and drama lessons, school-subject lessons and arts-and-crafts supplies. If any family member is involved in an education-oriented activity, as an educator or an educand, the possibility exists that wordprocessing facilities may be used frequently for writing of assignments or setting of examinations. There is also a possibility that a family member may require to repeatedly record sets of statistics such as scores or stock-market prices. Many avid gardeners record rainfall figures on a daily or weekly basis and if they avail themselves of an appropriate utility package or write a program according to personal specifications, useful information can be distilled from their efforts. The thoroughly modern mother may wish to computerize the running of the home by recording purchases, menus, recipes, payments or gardening activities. The efficient use of a computer in the home depends on the expertise available in using the commodity. Parents tend to suffer from computer anxiety and depend on the fact that "... you cannot teach an old dog new tricks". If children are taught at school that a computer has functions for reaching beyond its use

as a domestic video-arcade appliance, this knowledge can filter through to home use. A few uses of a computer in the home have been mentioned above; there are many more. A reversal of rôles can take place in the home, wherein the child becomes the tutor, helper and consultant with respect to computer activities. This will enable a "periodic breaking away" (Landman *et al.*, 1982, Scheme G) from the conforming parent-child relationship which is often filled with tension during the adolescent period of becoming adult.

If either parent has a computer related occupation, this, too, can provide a point of departure for interaction, sharing and conversation with a child who understands and is interested in computer applications. There are few occasions that permit a child to share any aspect of a parent's occupation, but the computer field does facilitate this. Mutual interests between adolescents and parents are rarely encountered, but a shared appreciation of the intrigue and excitement of a computer can achieve much to relieve the relationship tension and consolidate the primordial, parent-child love-relation.

#### **2.5.7           COMPUTER SCIENCE OFFERS OPPORTUNITIES TO EXERCISE ACQUIRED FREEDOM IN SECURITY**

Man's co-habitation with society is characterized by a series of laws, acts and ordinances which should be designed to protect rather than impede the freedom of the individual. Effective implementation of the relevant rules depends on man's understanding of the reason for the rules as well as the content of the rules. The school situation provides excellent training in adherence to rules, although many pupils pride themselves on being able to escape punishment if rules are transgressed. The reason why some defaulters

succeed with attempts at circumventing rules and regulations, is that school rules are usually social in nature and there are often not enough law-enforcers around to identify transgressors. Most subjects have rules inherent to their discipline, but detection of defaulters depends mainly on the educator when correcting a piece of work submitted for evaluation. Besides the benefits of using a computer as an evaluation tool to process information in a specific way, there is a subtle means that a computer employs to discipline its users: "garbage in - garbage out". There are rules of syntax, rules of logic and rules of operating from which no operating system nor compiler will tolerate even a slight deviation. In addition to the computer's pignonicity, pupils have to adhere to the teacher's demands for readability, modularity, documentation and refinement which assist in the promotion of neatness, accuracy of thought, presentation and attention to detail. Users are thus monitored from within the computer by the compiler and from without by the teacher.

The rules and regulations inherent in utilization of a computer do not limit the creativity of the individual. There is infinite space within the framework of order to create, discover, initiate, design and experiment with own ideas. This is an abstract enactment of life of an individual within society. There are modes of behaviour against which one is evaluated as a citizen, but the value of citizenship is assessed on the personal contribution and individual quality that he attributes to his rôle as a citizen. Computer science can offer the learner the opportunity to test his value as a citizen and the value of his knowledge by means of the educator setting assignments which require that the learner temporarily leaves the confines of the classroom and spends time in local businesses or industries which utilize computer systems. The study of computer science

equips the learner with skills which are in demand in commercial and industrial institutions. Part-time employment is thus a way of exercising freedom while still at school.

#### **2.5.8 A COMPUTER SCIENCE CLASS PERMITS A FORMALIZED EDUCATIVE OCCURRENCE**

A formalized educative occurrence characterized by educator, educand and a goal towards which the educand is striving, prevails within the computer centre, accompanied by the computer, an additional component of the educative occurrence. The authority is in the hands of the teacher, although, as stated in 2.5.7, this authority may, on occasions, be relinquished to a pupil who has acquired information and techniques through self investigation, which may be of benefit and interest to both the teacher and the class. The teacher, however, throughout the lesson, retains control and praises pupils for any contributions made towards subject enrichment. It is essential for the educator to maintain and update his subject knowledge, as such a shift in authority should take place only on rare occasions.

The rôle of the teacher during "hands on" practical sessions can be an exhausting one, as pupils encounter problem areas and appeal for help constantly. The teacher needs to be acutely perceptive of and familiar with typical errors made by pupils and it is during these periods of "de-bugging" individual programs that one-to-one teacher-pupil relationships are enhanced.

The study of computer science demands a discipline from its learners which is inherent

to the content. The subject has themes which require strict adherence to rules and techniques, while there are those sections which permit the pupil to exercise complete freedom of thought within the confines of syntactical rules. There are themes which enable research and investigation away from the dictates of the classroom, while other themes demand constant teacher-pupil interaction. Whatever the topic being addressed, the teaching-learning situation arising from the topic constitutes a formalized educative occurrence characterized by educator, educand, goal, authority, freedom, discipline and the computer.

#### **2.5.9 SUMMARY**

Revelation of the pedagogic school structure (see 2.4) confirms the rôle of the school in the cohesion and integration of the educand, the educator, the society and the home, with the learning content of the school's academic program. This theme has confirmed that computer science has an important contribution to make in actualizing the aims of the pedagogic school structure. Details of the learning content will be presented in 4.3.3 and will be validated according to the requirements of the pedagogic school structure. Thus far, the term "computer science" has been used to suffice for "the subject computer science" or "the learning content of the subject computer science". Learning content is described in a syllabus and it is now appropriate to discuss the syllabus as a reflection of the life world of the adolescent.

## **2.6 THE SYLLABUS AS A REFLECTION OF THE LIFE-WORLD OF THE ADOLESCENT**

### **2.6.1 Introduction**

The family teaches a child in an informal way, and this family influence continues until the adolescent or young adult leaves home to begin his own independent life. The school builds on this foundation in a more formal and organized way. All intervention by the adult must be presented to the child to help him to become what he ought to become, namely a responsible adult. The child must be confronted with reality so that he can accumulate a world of relevant experiences that increasingly enables him to make responsible choices in life.

Life as a whole must be considered when syllabuses, as components of the curriculum, are compiled. LANDMAN *et al.*, (1982:90) contend that the curriculum must reflect the arrangement of the total life-world. Thus, when designing syllabuses, the present needs and future needs of the adolescent, as perceived in relation to his age, moods, relationships and expectations, must be accounted for. Education specialists, according to LANDMAN *et al.*, delimit the main aspects of life into subject fields. The fields of communication, religion, history, mathematics, science, economics and technology are examples of aspects of the life-world of the adolescent that need to be addressed via subject study. A syllabus is designed by subject experts for each subject included in the curriculum. The syllabuses are more specific means of arranging the life-world, and must take into account the needs of the adolescent as dictated by his social, cognitive, affective, conative and aesthetic milieux.

## 2.6.2 THE SYLLABUS AS A MEANS OF SOCIAL ORIENTATION OF THE ADOLESCENT

The adolescent of the nineties, throughout the world, especially in South Africa, is witnessing radical political and economic changes, besides the predicted and expected changes that adolescents normally experience in their physical, cognitive and affective domains. Student riots in Peking, the general overthrow and rejection of communist regimes in Eastern Block countries, the stock-market crashes and oil price hikes emanating from the Middle East Gulf Crisis, the ever-changing "New South Africa" and *coup-d'etat's* in countries both near and far, are some of the external pressures that the adolescent has to fathom, reason and interpret in addition to the inherent crises typical of his growth period. The adolescent period recognizes a social awareness in its bearers which often manifests itself in extreme ideas on the social front. The media emphasis on the "evils of apartheid" have made South Africa's youth particularly socially-aware and it is this social awareness that needs to be confronted and accounted for when designing syllabuses for secondary schools.

COHEN (in: King & Brownell, 1966:14) reminds us:

"A certain awe for the word 'social' is one of the outstanding phenomena of current intellectual life. The triumphant elation and solace with which the social nature of man is announced and individualism denounced, seems to presuppose the belief that previous generations were not aware of the fact that men live together".

The school provides a place to "belong"; an arena for companionship, social

experimentation, dating, social activities and dialogues on trendy fashions and behaviour. The school socializes the child formally by means of its codes of conduct, systems of punishment and reward, and replaying of acceptable social customs and beliefs. The claim of social man on the curriculum will continue as long as some sort of social order, or class, or custom exists in society. The dangers of making social man the prime claim on the curriculum is illustrated by APPLE (1979:164) who emphasizes the need to ensure that any program introduced into a school is truly therapeutic and aimed at a holistic development of the learner. In so doing

"... it is unlikely to be perverted into merely a mechanism of social control".

APPLE further urges that any program be previously tested, prior to its implementation, to ensure that it is capable of accomplishing its intended goals. Without this

"... the program may become an intervention into peoples' lives and liberties for no acceptable purpose. The individual will have been sacrificed and society will have gained nothing" (Apple, 1979:165).

Furthermore, any latent outcomes or any undesirable effects of a school program must be foreseen beforehand and properly weighed. The programs should guarantee to pupils, educators and parents alike that they are compatible with a pluralistic and diverse society. The syllabuses should be designed so that the subject is available to, and feasible for, pupils of all class, race and cognitive abilities. The subject content should not be restricted to an elite group of pupils and neither must it ensure job-reservation to certain groups of society because of its elitist nature.

The design of syllabuses must accommodate the social and intellectual structure of the school to make it more responsive and responsible to the societal demands for knowledge, skills and attitudes, in order for its followers to deal intelligently with problems of everyday life. Care must be taken to ensure that the syllabus is not an excuse to change the individual child to propagate an existing social order.

### **2.6.3 THE SYLLABUS AS ACCOMMODATOR OF THE INTELLECTUAL DEVELOPMENT OF THE ADOLESCENT**

"Intellect" is defined in Webster's Encyclopedic dictionary (1944:383) as:

"That faculty of the human mind which receives or comprehends ideas, as distinguished from the power to feel or to will; the understanding capacity; the capacity for higher forms of knowledge".

The key-phrase in the above definition must surely be "comprehends ideas" in favour of "collects facts". DUMINY (n.d.:261) stresses the importance of cultivating insight rather than memorizing facts:

"This retention of facts is important, but, and this is fundamental, the essential part of the learning process must not be in memorization as such. It must be in learning with insight".

This fact is further substantiated by VAN VUUREN ed. (1976:91) contending that:

"... intellectual forming should be part of the wider challenge to design a personal world and should therefore involve more than the absorption of a certain quantity of knowledge ... it must improve the possibilities of the child".

Another phrase in Webster's definition of "Intellect" that is worthy of elaboration is "... the capacity for higher forms of knowledge". This phrase, together with "comprehend ideas" conveys the implication that true development of the intellect is optimum when thinking is on a higher, more abstract, non-concrete, non-perceptual level. The late adolescent period is, according to PIAGET (in: Ausubel *et al.*, 1978:236) the period of formal operational thought (see 3.5.4.4) and is the time when the mind is open and receptive to the correct stimuli that will nurture insight and formation of abstract concepts. True intellectual knowledge and insight enriches man in his social context; it opens up possibilities of fulfilling his cultural task and sets high moral demands on him. The intellectual aspect of man, according to VAN VUUREN *ed.* (1976:90), can never be isolated from other aspects of adulthood, and this intellectual aspect is an essential component of the child's self-realization.

According to GIELEN (in: Van Vuuren *ed.*, 1976:92), intellectual actualization is better realized in the school than in the home. The school program offers a more rigid and disciplined routine and the teachers are selectively more knowledgeable in their subject disciplines. The subject syllabuses are the heart-and-soul of the intellectual realm of the school. The syllabuses aim to promote the acquisition of knowledge, the cultivation of insight into, and coherence of the meaning of knowledge, and the ability to use the acquired knowledge to develop a personal code of ethics and values in life.

The fact that the school accents intellectual moulding more than other aspects of adulthood (Van Vuuren *ed.*, 1976:92), does not mean that this aspect is absolutized, but it is the primary task of the school. If a school's task is merely to prepare the pupil for

an examination, then the pupil will have experienced only a fraction of the prolific panorama of education on leaving that school. The task of the school for intellectual moulding centres around the subject syllabus, and for this reason stages in the compilation of syllabuses will receive specific attention in 3.3, under the heading "The Curriculum Cycle".

#### **2.6.4 THE SYLLABUS AS A VEHICLE OF THE PHYSICAL BEING OF THE ADOLESCENT**

GORDON (1975:7) states that:

"Life can be maintained only as long as the body organizes and integrates its world into an orderly arrangement".

This organization is a basic activity of the growing person; the individual is always active. He acts in such a way that "... he orders himself and his environment" (Gordon, 1975:7). The direction of an individual's behaviour is always, in normal development, towards increased complexity but away from randomness and disorder. This complex process of organization depends on growth and experience, and on those biological determinants that give the person both his common human (ontic) inheritance and his unique characteristics. GORDON also refers to numerous studies which indicate that children of the present generation reach certain points of maturation, both physical and psychological, earlier than previous generations. Reasons for this increased rate of development of today's generation are not clearly defined, but hypotheses offered are concerned with changing environmental conditions under which children are reared, including the changing technological situation.

"We are not able to separate mind and body, structure and function. They are inextricably interwoven into the system" (Gordon, 1975:9).

The nature of the experience of the child, when viewed in this light, assumes great significance as a potent force when planning school curricula.

The most visible signs of adolescence are the changes in height, weight and body proportions. Growth throughout adolescence is asynchronous, meaning that different organ systems and body parts do not keep pace with each others' growth patterns. Whatever awkwardness there is in adolescence, may be attributed to this, along with the appearance of facial and body hair and the problems with acne and other skin ailments. Concern in this study does not, however, lie with the external appearance of the adolescent, but rather the effects that this has on his needs as a growing person.

Educators and educationalists who work with, or plan curricula for adolescents must be aware of the growth status of the youngsters with whom they are dealing. They need to see where the educand's state of physical, mental and social development fits into the general scheme of classroom or school activities.

The vocational aspirations of young, pre-adolescent children are highly unrealistic; their image of the future being vague and autistic. They live essentially in the present (Gordon, 1975:282). One of the changes accompanying adolescence is the widening of perception to include future time. Both vocational and educational planning shift to a central place in the adolescent's perceptual world. Views of his ability are important in choosing for the future, and those who work with adolescents need to understand the

"self"-factors in educational and vocational choice.

Syllabus designers should therefore have a lucid conception of the adolescent's increasing need for:

- \* an organized environment;
- \* activities that can accommodate the complexities brought about by rapid, uneven, embarrassing growth patterns;
- \* physical activities that can incorporate the more astute perceptions of his developing reasoning mind;
- \* recognition of his increasing awareness of the world of employment; and
- \* educational planners to realize that today's adolescents are generally at a different level of maturity and in a different employment environment than previous generations at the same age.

The above five factors indicate that school activities should not force emphasis on physical activities for the often-awkward adolescent, but rather that these should remain optional. Instead, emphasis should be placed on activities which lend themselves to the physical co-ordination of body and mind, while at the same time fulfilling the adolescent's need for organized activities that relay some significance for the future and that can simultaneously challenge the shift towards intellectual awareness.

## **2.6.5 THE SYLLABUS AS A REFLECTION OF THE AFFECTIVE DEVELOPMENT OF THE ADOLESCENT**

The adolescent phase finds the not-yet-adult forming his own opinions and evaluating situations against a background of naïve experience. He is an idealist and, as stated previously, is overtly critical of what he sees about him, of both the animate and inanimate in nature. Pupils in the junior secondary phase (early adolescence) still hold their teachers in awe and seldom challenge their authority. Pupils in late adolescence often tend to challenge and question authority, which can result in a flood of negative emotions if educators are not effectively trained in the science of pedagogics and are, therefore, not able to deal with these conflict situations characteristic of adolescence. Such contentious events are not unfamiliar during the secondary school phase and the evoking of unpleasant emotions can gain momentum until eventually an "I-hate-school" vapour clouds the mind of the educand. FRANZSEN (in: Du Plooy & Kilian, 1985:109) states:

"... a person on his way to adulthood will be imperfect, confused and incomplete if anything goes wrong with his emotional development".

This places a demanding responsibility on the understanding, tolerance and patience of the educator, which cannot always be unconditionally prescribed. The subject-matter can, however, be prescribed.

In the senior secondary phase of schooling, some subject content should be designed to avoid having the teacher play the major rôle during every day's lesson. A learning

situation should be available whereby the adolescent can divert his attention from the teacher to another source, over which he can spill his emotions of creativity, genius, fervour, frustration, boredom or whatever is dominating his mood at the time. Practical subjects such as drawing, typing, cookery, art and design lend themselves to such emotional release, as do technical-workshop subjects such as welding, woodwork and architectural design. Computer science will be shown to be a subject which demands exercises in the practical, the creative, the logical, the abstract and the theoretical, wherein the educator can render service in varying degrees, ranging from lessons requiring 100% pupil-input to those requiring 100% teacher-output (Chapter Four (4.3.3).)

ERIKSON (in: Gordon, 1975:282) characterizes adolescence as a period fraught with the danger of rôle diffusion as the youth seeks identity. He says that adolescents are primarily concerned with trying to connect their acquired rôles and skills with the occupational prototypes of the day. This phenomenon, GORDON (1975:283) continues, is probably more predominant in industrial societies where there is a discontinuity of rôle between child and adult over the current extended period of dependency labelled "schooling". In the United States, for example, there is virtually no economic rôle for the adolescent other than consumer. This set of circumstances, says GORDON, contributed to the describing of the "marginal person"; a teenager occupying the ambiguous and ambivalent position of neither child nor adult, with symptoms of emotional instability and sensitivity.

In South Africa, the qualifications offered by the traditional matriculation certificate, ensure the creation of the marginal person. Costly post-matric study is essential to be considered as a viable proposition for the employment market. The adolescent leaves school with hopes and aspirations for his hard-earned freedom and yet his basic education at school-leaving age is inadequate to change his status from "consumer" to "contributor". For a large percentage of school-leavers, it is also inadequate to give guidance for further study. Their matriculation subject-choice often does not allow them admission to any avenue of study for which there is a manpower demand. This is particularly true of many of the Black matriculants who matriculate with three languages, history, biblical studies and biology as areas of specialized knowledge. ERIKSON'S statement (in: Gordon, 1975:282) weighs heavily on the curriculum planners of today:

"... adolescents are primarily concerned with the question of how to connect the rôles and skills acquired earlier with the occupational prototypes of the day".

With the circulation of several computer publications on the magazine market and the weekly appearance in a popular Sunday newspaper (The Sunday Star) of a ten-page computer news-update, it is convincing that a career in computers is an important occupational prototype of today.

#### **2.6.6 THE SYLLABUS AS AN EXPRESSION OF THE CONATIVE ADOLESCENT**

"Man has a task to perform in the world and, therefore, he is also a worker; for this reason he can and must be educated. The activity by which man transforms this strange world into a human habitat is what we call work ..." (Gunter, 1979:85).

Not everything that the human being does is considered to be work, and the physicist will argue with the philosopher as to what defines work, but work is, nevertheless, an important mode of human action. Human existence is, and remains from generation to generation, a never-ending task for which work is essential. Work is a universal human phenomenon and, according to LUIJPEN (*in*: Gunter, 1979:85) "... all work uplifts him".

Although man's task in the world comprises much more than his vocation, man does become a vocational being at a very early age. Man's vocation is one of the chief aspects of his adult life and one may safely say that the greater part of man's labour is taken up with meeting the demands of his vocation.

"The entire education of the child at home and at school serves as a preparation for his initiation into and incorporation in the life-world of adults, which is a working world ..." (Gunter, 1979:86).

Man possesses a multitude of innate possibilities and gifts which can be actualized, given the correct opportunity and motivation. If the child, particularly during his secondary school years, is exposed only to study material that enriches him spiritually but does little to prepare him for the working-world of the adult, then he will stand on the threshold of adulthood with little or no competence for the vocational assignment of life. It has been proposed that this preparation may begin after the school-going adolescent period has ended, but nowadays overpopulation, unemployment and the financial strains of tertiary education for all school-leavers, must be taken into account. Curricula must be designed and updated to meet the needs of today; what worked for previous generations will

generally have little success for generations of today and tomorrow. This concept is most aptly illustrated by BENJAMIN'S (1940) "Sabre-tooth Curriculum" anecdote (in: Kelly ed., 1984:1) in which the need for a change of curriculum, to suit the prevailing circumstances, was called for even in the times when man hunted and fished for his food in the jungle.

School syllabuses are the means whereby some adolescents find direction in their vocational lives, while other adolescents depend on what they have learned at school to secure a position in the working-world of the adult.

#### **2.6.7 SUMMARY**

When syllabus planners and designers set about documenting ideas about the content of a subject, the learners, the society and their place in the future should serve as guiding pointers to the choice of subject matter. Pedagogicians promote the concept of the Gestalts of the child, the adolescent and the adult, but this promotion is meaningless unless it reaches the understanding of the didacticians who design the syllabuses. A professionally trained teacher studies courses in general Education and Teaching Science during pre-service training. This acquired knowledge cannot be effectively actualized if the teacher is presented with a syllabus which has been designed without due consideration for the learner and the world in which he will be expected to survive. The syllabus should not be a documented list of subject topics repeated year after year with only the arrangement thereof being the obvious change. It should rather reflect the emotional, physical and intellectual needs of the learner as he is assisted by the syllabus to prepare a meaningful place for himself in the changing adult world.

## **2.6 CONCLUSION AND FURTHER PROGRAM**

Chapter Two has dealt with the adolescent learner as the main theme. As the adolescent approaches adulthood, the rôle of the school, the home, his peers and society accept new meaning in his life. He becomes career conscious and the school, with its academic programs prescribed by syllabuses, has an obligatory rôle to assume in assisting him to strive for the status of occupational man in society. The pedagogic structure of the school is described in Chapter Two as means to self-actualization of the adolescent, facilitating his aspirations for the independence and freedom associated with adulthood. The rôle of computer science as a subject that can facilitate in bringing to fruition the needs of the adolescent within the pedagogic structure of the school was revealed in general terms. Details of the subject content will be addressed in Chapter Four (4.3.3). The school structure depends largely on the academic syllabuses to achieve the desired outcome of adulthood for its pupils. The syllabus was discussed in Chapter Two according to how it can assist with the becoming adult of the adolescent learner.

With the adolescent learner thoroughly represented in Chapter Two, it now becomes necessary to embark on an in-depth dissertation in Chapter Three of the syllabus as the academic manifestation of the school curriculum. This chapter assumes a didactic character as the curriculum cycle is discussed, but the interdependency of pedagogic theory and didactic practice is evident during the exposition of the claims on the curriculum, the structure of knowledge and the criteria to be used when selecting learning content, and is and remains an essential component of curriculum design.

## **CHAPTER THREE**

### **3.1 INTRODUCTION**

In Chapter Two attention was given to various aspects which have a profound influence on the requirements which have to be considered in order for a school system to fulfil the pedagogical demands of a pedagogic environment which facilitates the path to adulthood of the adolescent. The facets of being adolescent have been exposed as approaching the goals of adulthood, sometimes remotely as dreams and, other times, as practical expressions of being realistically close to the status of an adult. The essences of the pedagogic school structure as alluding to the striving of the adolescent for adulthood, were exposed in Chapter Two and thereafter, computer science was discussed in relation to these essences. This study aims to reveal the parallel necessity of considering the alliance between Fundamental Pedagogic theories of the school-education situation, and the didactic practicalities of the teaching-learning situation. For this reason, Chapter Two introduced the school syllabus and the rôle it assumes in the life world of the adolescent.

This latter theme in Chapter Two serves as a bridge to the contents of Chapter Three, which are essentially didactic in nature, but the thread of pedagogical thought permeates all themes, especially the first, which deals with the claims for a pedagogically accountable curriculum. Thereafter the stages in the curriculum cycle are to be discussed. As this study deals with the selection of content for computer

science syllabuses it is relevant, in this chapter, to discuss the structure of knowledge and its implications for curriculum design. The final theme in Chapter Three will direct the reader's thinking essentially to the pedagogic mode by exposing the criteria for the selection of learning content to fulfil the requirements of the pedagogic school structure, as discussed in 2.4.

It is hoped that the importance of Fundamental Pedagogical reflection, when performing a task such as syllabus designing for schools, will become apparent through the essences brought to light in this chapter.

### **3.2 CLAIMS FOR A PEDAGOGICALLY ACCOUNTABLE CURRICULUM**

#### **3.2.1 INTRODUCTION**

Curriculum design poses a problem in advanced societies where considerable opportunities for schooling are available. The problem exists because a choice must be made from a great variety of different possibilities pertaining to social forces, community demands, industrial demands, individual learning demands and the nature and structure of knowledge. In modern civilization the cultural inheritance is no longer a circumscribed, standardized, stable body of content; it has become enormous in size and profoundly complex. It is considered unwise to permutate a matriculation course from a wide range of study directions, trusting that the learner will decide on a career once standard ten is completed. Career directions have to be chosen early in the secondary school phase so that the correct subjects can be embarked upon to

earn creditation for further study or employment opportunities. Each individual must choose from the seemingly unlimited store of materials to be learned. The field of mathematics is vast, as is the field of science and the rapidly expanding field of computers. The problem of curriculum design is to make the wisest decision about which topics should be studied to provide a secure and enlightened path to adulthood.

Curriculum designers must make the most judicious and appropriate selection of learning content.

"Human intelligence is too rare and precious a thing to squander on a haphazard program of instruction" (Phenix, 1962:57).

It is not only human intelligence that is a precious commodity to be utilized and revered. The human being and his human dignity, the fulfilment of his potentialities of every nature, also demand that curricula should be designed to satisfy all the conditions of pedagogical accountability. When curriculating for a specific school subject, there must be selection criteria which determine which topics are more desirable than others. The curriculum designers must choose those topics or themes evaluated to be most appropriate for achieving the goal of guiding the adolescent to adulthood. These selection criteria presuppose a scale of values. The central problem in all education is that of values. Questions must be asked about the proposed learning content and learning experiences: are they of social, cultural, communal and personal value to the learner? Presupposing all values in life form a philosophy of life, the selected learning content must ultimately harmonize with the learner's Philosophy of Life. These statements have very far-reaching effects, and, therefore,

it is necessary in this chapter to discuss the determinants of curriculum design in order to satisfy the demands referred to above. In the absence of a comprehensive theory for curriculum development, curricula will tend to be dominated by single considerations such as child centredness, subject content, societal demands or didactical requirements. Principles for curricula have been laid down by didacticians such as TANNER & TANNER (1975), PRATT (1980), TABA (1962), WHEELER (1967), TYLER (1949) and SCHWAB (1964). Principles for educating for the realization of a child's potential to become a fulfilled adult have been described by pedagogicians. These two approaches to education may be considered to be the theory (pedagogy) and the practical (didactics) of the education situation and the one cannot be realized without consideration for the other. Furthermore, a study of Curriculum Development by a work committee of the HSRC (Pretoria: 1981) revealed principles for determining content against the study of a comprehensive curriculum theory. Some claims on the curriculum will now be discussed.

### **3.2.2 THE CLAIM OF SOCIETY ON THE CURRICULUM**

Education occurs within a particular community which has certain needs and therefore makes demands on education to propagate its cultural, religious, social and economic prosperity. INLOW (1966:4) states:

"The most vital aspect of the structural stability of any society is the values by which it lives. These values evolve slowly, change slowly and constitute, at any given time, a bedrock foundation for an educational program".

WHEELER (1983:15) endorses this:

"To a large extent, then, the curriculum will be shaped by the culture of the society in which it operates. It will be affected by social needs, social values and social problems".

Society embraces its own needs, expectations and problems and in order to solve these problems it must address education at all levels: primary, secondary and tertiary. The function of the curriculum is to provide for all the identified needs of society. TANNER & TANNER (1980:672) stress, however, that educationalists must "... reflect ON social forces and not mindlessly reflect social forces".

According to KRUGER (1980:43) the demands that society makes on the curriculum are for:

- \* basic knowledge and skills; and
- \* social integration.

The HSRC Report (1981:47) clearly states that curriculum should be geared to the development of manpower for varied requirements of society. In order to perform this function, curriculum should be directed towards certain focal points demarcated by the level of education, and curricula should be developed to meet these needs. This study is relevant to the secondary school adolescent only, and for this reason the focal point of post-basic education, as described by the HSRC, has relevance.

Post-basic (after primary school) education incorporates three areas of tuition:

- \* secondary school education on a differentiated basis in school context;
- \* training courses according to needs of trade, commerce and industry; and
- \* a compendium of courses at the formal and non-formal levels which are

identified according to needs of the individual and are offered out of school.

It would be in the interests of the finances of both the employer and the employee to decrease the necessity of the latter two types of post basic education and incorporate them as far as possible into the secondary school education. That is, prepare the secondary school child to some extent for the requirements of the "working world".

According to SAYLOR & ALEXANDER (1966:102) the following community needs influence curriculum design:

- \* Fundamental convictions pertaining to values and morals of the community.
- \* Customs, traditions, expectations and values upheld by members of the community.
- \* Social, economical and political situations that are prevalent for the day and anticipated for the future.
- \* The home and family situations of the recipients of the curriculum.
- \* Admission requirements of colleges, technikons and universities.
- \* The psychology and sociology of cultural changes that are prevalent for the time, but also anticipated for the future.

If the above needs of the society are not addressed by curriculum designers when designing new learning content or learning experiences, or when reviewing, innovating and changing existing curricula, then, on leaving the learning institution, the participants of the curriculum will not be equipped to meet the demands of their society.

The demand of society on education comprises a demand for the type of education that is provided. The traditional view that everyone should traverse an "elite" type of education should be substituted by the fact that society has a need for a great variety of trained manpower. Obviously the demand for technologically trained manpower will be greatest in a technological society.

Curricular provision should meet the real demand for education and not an idealistic, artificial demand that may have been appropriate for previous generations. Curriculating should not provide for needs that do not exist. The HSRC Report of the Work Committee on Curriculum Development (1981:48) refers the reader to a HSRC study "Principles of Differentiation in Curriculum Development": (n.d.), paragraph 4.2.5., wherein such inappropriate curriculating is described:

"... all secondary school courses are apparently geared to university entrance, while the demand is actually to gear a substantially smaller part of secondary school instruction to university entrance, while the other courses should be courses in their own rights, geared for their own needs".

These "needs" refer to subjects which afford skills and knowledge to the great number of adolescents who wish to enter commercial and industrial fields on leaving school. The uncontrolled sitting for degrees at universities and studying of courses at schools for which there is no demand from the working environment, is an expensive undertaking for any country, but more so for a country with a limping economy. It has the additional defect that it raises false expectations in the pupils who will eventually suffer a sense of inadequacy upon completing a university course for which there will be little or no demand in the vocational field. The HSRC Report (1981:49)

suggests that:

"The educational needs of the entire society should be determined and not only the demands from schools".

Each learner is a participant in society and his preparation at school is to fulfil a meaningful rôle as an adult in society. He is, however, also an individual being, and this influence on curriculum design will now be discussed.

### **3.2.3 THE CLAIM OF THE LEARNER ON THE CURRICULUM**

According to the didactician WHEELER (1983:16) the aim of all education is to effect a positive change in the behaviour of the learner. The empirical educationalist and the fundamental pedagogician describe the aim of education as the attainment of adulthood. Yet another aim of education is given by BAUER (1992:6) as the actualization of the maximum potential of a child or learner. Whatever the formal definition of the aim of education may be, the curriculum designer should consider the learner in all manifestations of being. He needs to avail himself of psychological, sociological and pedagogical information which he has to justify pedagogically and accommodate in the curriculum. This implies a complete understanding of the nature or being of the learner, as well as how the learning processes can best be set in motion to achieve the most desired outcomes of education. Central curricularators (those not practising in the classroom, but situated in offices of education control) can, however, only plan for learner-groups in general because of the large numbers of the target groups. It is when planning for a specific group of learners (classroom level) that the purpose of the curriculum and the significance of the content becomes

meaningful for the individual learner. Curriculators design course content based essentially on the demands of society (reflecting certain work-life situations) and the expected intellectual performances for a certain age group. Subjects are then selected by a school according to the needs of the society servicing that school. Within the classroom, the mastery of the subject content is largely dependent on the maturity of the learners and the suitability of the content to their life-world. One problem that develops within the school-classroom situation is the discrepancy that exists between the needs and the interests of the learner. To the adult curriculum planner, the citizen-of-tomorrow is seen to have certain needs to be actualized in the classroom today, but the learner, in his naïve state, may not realize these needs. This type of incongruity results in a low-motivational state of the learner (Kruger, 1980:43) and one way of overcoming it would be constantly to relate the industrial, commercial, social and cultural needs of the society to the subject matter to be mastered.

"Die eise wat deur die gemeenskap en die individu gestel word moet didakties verantwoordbaar en didakties aanvaarbaar wees" (Kruger, 1980:44).

A curriculum may never be didactically acceptable unless it is pedagogically acceptable. The course content must harmonize with the milieu of the learner. His social, cognitive, affective, aesthetic, psycho-motor, conative and spiritual domains must be researched in terms of the course content to determine his expectations and needs. Essential to the creation of a motivating and fulfilling learning situation, is a prior analysis of the subject content according to the needs of the learner in his striving for adulthood. If this is neglected by curriculators when designing curricula,

a gross inconsistency will arise in the actual learning situation and little meaningful learning will take place.

The learner's readiness to master specific, non-determined content should be taken into account when syllabuses are designed within a curriculum. The expected affective (emotional), cognitive (intellectual) and psycho-motor (physical) levels of development must be taken into consideration. The curriculum will gradually change from a playful and predominantly affective-accentuated approach in the pre-primary years of schooling, into the more formal arrangement which is increasingly geared to cognitive knowledge and skills in the post primary phase of education.

Curriculum planners should be suitably schooled regarding the cognitive expectations of pupils of different ages. Within a certain age group, further differentiation of syllabuses is necessary to accommodate the various levels of cognitive abilities of learners. Curriculum planners, therefore, are expected to anticipate and recognize the different levels and types of mental exercises demanded of learners, and subsequently grade the subject contents into differentiated syllabuses. The changing ways in which learners can participate in learning content will be discussed in 3.5.2.

To a great extent the development of thought and concept formation is dependant on the development of language. A learner who is from an environment rich in language expression is usually better able to cope with learning content than a learner from an impoverished language background. Study in the technological fields and study at tertiary level is still largely dependant on imported textbooks for references. A subject like computer science is largely dependent on the English language for study

of computer technology, computer-languages and operation packages. It is essential, therefore, for learners of this subject to possess a reasonable command of the English language.

The intellectual abilities of the learners, their language proficiency and their needs, desires and expectations all contribute to a sphere of influence on curriculum design. The school curriculum is largely characterized by the syllabuses which prescribe the learning content of subjects offered by the school. Learning content as a claim on the curriculum will now be discussed.

#### **3.2.4 THE CLAIM OF LEARNING CONTENT ON THE CURRICULUM**

WHEELER (1983:20) states:

"In addition to a knowledge of the nature of the individual learner and the nature of the society in which he lives, there must also be a concern with the nature of the learning process and the subject matter on which it is exercised".

One of the central functions of the curriculum designer is to determine the nature and extent of the learning content. Criteria should be established by all interested parties to select content that reflects the norms, values and requirements of the society for which the content is intended. The HSRC report (1981:52) names several "forces" that exist in whose interest it is that certain content be accepted into the school curriculum and that certain content be discarded as inappropriate. These forces are concerned with:

- \* cultural preservation and extension within the society;

- \* maintenance and improvement of the quality of life;
- \* fostering of interhuman relations;
- \* promotion of national relations, i.e. citizenship; and
- \* consolidation and establishing of international relationships;

The addition of a sixth "force" is essential and probably the most relevant of all:

- \* fulfilment of the needs of the learner as he strives for adulthood.

These considerations form a spectrum within which the content should be selected and emphasis be awarded according to the needs of the society and the learner.

According to KRUGER (1980:45) it is of prime importance that the "didactibility" (didaktiseerbaarheid) of the content for learners of particular abilities be taken into account. Decisions must be made concerning the intellectual demands of the content and the intellectual development of the learner. The content must unlock the potential of the learner, but the learner has the obligation to also unlock the potential of the content. KRUGER (1980:47) thus writes of a "dubbele ontsluiting". Questions arise concerning the suitability of the content for the promotion of and sustaining of cultural and social needs, norms and values. It is the concern of the curriculum planners to provide answers to these questions against their knowledgeable background of human development, subject content, structure of knowledge and curriculaing procedures. The HSRC Report (1981:53) states five principles for determining curriculum content. As the report is very brief in its clarification of the principles, the author will attempt further interpretation of each one.

\* A Structural Function

The content should aid the learner to give structure to various encounters in life. The content should promote an organized process of thinking within its recipients. The key to problem-solving is "thinking in steps"; starting at the beginning of a problem and, by following a logical process of stepwise refinement, arriving at an end solution. Life, after all, consists, of problems which have to be solved. Education should aim to equip man with effective problem-solving techniques and this can be achieved by paying attention to the structure of knowledge when curriculaing. The structure of knowledge and its relevance to the curriculum will be discussed in greater detail later in this chapter in section 3.4.

\* A Content-giving Function

Learning content should contribute to the learner's increasing experience of adult life. As stated in 3.2.2 of this study, a major part of adult life is concerned with the working world. The selected content for syllabuses should relate classroom experiences with the anticipated experiences of the adolescent when he leaves school. Learning content should change progressively from the fantasies of fables and fairy-tales in the pre-primary school to the realities of the adult-world in the late-adolescent school era.

\* A Selective Function

The content (and learning experiences) should enable learners to master selected areas of reality adequately. Selected content should offer learners sufficient scope and depth of knowledge and skills to build on with further

study or experience. What is selected by curriculum planners must be such that, on mastery of the content, the successful learner has sufficient knowledge and skills to become a useful employee, should he wish to begin working on leaving school after completion of the senior secondary phase. The phrase "selected areas" indicates that the HSRC work committee favours specialization areas of study for secondary school pupils in preference to the traditional general matriculation course. This suggests that emphasis be placed on grouping of school subjects into "career types" e.g. technical sciences, biological sciences, natural sciences, humanities, commercial, creative arts. Schools will then have the obligation to offer extensive career guidance programs to guide pupils to select courses that will lay the foundation for future careers, in accordance with their abilities and expectations.

\* An Evaluation Function

The learner should increasingly be more able to act evaluatively and the content should be chosen to facilitate this function. To "act evaluatively" is a desired state of adulthood. As a child is born he begins to experience and react to sensations. Throughout his life, he internalizes his experiences and, in so doing, builds up a cognitive and affective "bank of knowledge" which facilitates evaluation of new experiences and internalizing of such experiences according to his own personal interpretations. The learning content should be selected so as to offer rich and pertinent experiences to the learner so that his path to adulthood is meaningful, anticipated and successful.

\* The Structure for Curriculating

The selection and orderly arrangement of content is dependent on the model for curriculating decided on for the country. A curriculating cycle will be dealt with in 3.3

As this study is concerned with the subject computer science, which makes substantial financial demands for specialized hardware, venues and staff, the claim of logistical provision on the curriculum will now be discussed.

**3.2.5 THE CLAIM OF LOGISTIC PROVISION ON THE CURRICULUM**

Curriculating includes the demarcation of learning experiences (see 3.3) which, together with the selection of appropriate learning content, assist the learner to achieve the aims set out by the curriculators. Curriculating must suit the availability of aids which may be required to actualize the subject content and the associated learning experiences. Logistic provision must describe aspects such as finances concerned with specialized venues, references for the content, specialized staff and the specialized equipment required for the course. Actualization of a syllabus depends on the financial support that may be made available by the state, local governments and services, commerce and industry, parent associations and school fundraising efforts.

The demands that progress and development, within a nation or a society, make on curricula at schools, result in constant efforts by central curriculating bodies to change and introduce innovations to syllabuses. If changes are to be made to existing

syllabuses, then caution must be exercised when the proposed changes are accepted; the logistics of all schools practising the existing syllabuses must be considered. The availability of the finances to effect the change must be realistic and feasible for all institutions concerned.

If curricularators are planning for the introduction of an entirely new syllabus, then the finances and problems embracing the presentation of such a subject, must be revealed to those bodies interested in or anticipating the introduction of the course.

Predicting financial requirements for the introduction of innovative ideas in the rapidly-progressing, technological societies can be an amorphous entity for any curricularating body. Fluctuations occurring in the gold price, the value of the Rand, the nature of sanctions and the inflation rate result in the nation's economy reflecting equally turbulent changes. Money made available during one fiscal year for an educational improvement may be drastically decreased or completely cancelled the next year, especially if implementation of the change depends on imported equipment. Technological equipment in itself, has its own innate changing character; what is considered "state-of-the-art" today may be declared obsolete and outdated tomorrow. Computers and other electronic apparatus are particularly susceptible to rapidly-changing composition and prices.

The success of the implementation of technologically based subjects is largely dependent on the monetary factors associated with it. At the time of writing this study an anomalous situation appears to exist: a demand for technologically competent school-leavers is accompanied by a national shortage of money to create work for

these school leavers. This situation may be minimized in the future, and curriculumators have an obligation to plan for an optimistic future. It is with this in mind that the claim for occupational man on the curriculum will now be promoted.

### **3.2.6 THE CLAIM OF OCCUPATIONAL MAN ON THE CURRICULUM**

When a child is asked "What is your father?", he often replies "a lawyer", "a doctor", "a teacher", "an electrician" etc. The deeper significance of such responses should not be lost. A persistent belief exists that the good life is defined by the quantitative and material forms of human goods and the security which money provides. Since the prestigious kinds of work are those that yield social approval, wealth, power and success, persons tend to be judged by their occupations. It is becoming the school's task to train pupils for something practical which, for most, means to give marketable skills. CONANT (*in*: King & Brownell, 1966:4) exemplifies the claim for occupational training in high school, college and university curricula:

"I submit that in a heavily urbanized and industrialized society the educational experiences of youth should fit their subsequent employment".

If man's most important goal is to be a worker, if his worth and dignity lie in his work, then any society which so defines the nature of man would find the quote appropriate. However, as clarified in earlier discussions on the adolescent as Being, there are many parts which make up the whole of man and it would be unwise to limit school education to the nature of work and occupation alone. The field of work is

vast, but a subject which permeates many, and is adaptable for almost all fields of employment, could surely be termed educationally occupational if it does not limit the learner to one type of occupation, but rather opens up opportunities to many fields of employment. Early occupational training tends to limit the accumulation of liberally educated individuals necessary for trade and professional leadership. When occupational training, according to KING & BROWNELL (1966:7), short-circuits liberal education, the education of the *person qua person* is reduced and his ultimate work is denied. The greater the intellectual background created by school learning, the wider the range of vocational options open to the individual. Curriculum planners are expected to research courses and course content to determine their contribution potential to the complete life world of the learner.

### **3.2.7 SUMMARY**

The extrinsic influences of the society, the individual, learning content, logistical requirements and the working environment on the design of a curriculum have now been exposed. Several references have already been made to the curriculum cycle and it is therefore appropriate to inform the reader of the stages in the curriculum cycle.

## **3.3 THE CURRICULUM CYCLE**

### **3.3.1 INTRODUCTION**

The following, somewhat disturbing, statement concerning curriculating procedures in the various departments of education in South Africa, appeared in the HSRC Work

Committee's investigation into education: Curriculum Development (1981:7):

"As yet, there is no mention of scientific curricula on a departmental or national basis in the RSA".

It would appear that the implementation of the present revised syllabuses was neither preceded nor supported by scientific curricula procedures. However, the report does offer the compensation that, in some departments, the way in which the syllabuses were compiled offered scope for a degree of testing and evaluation.

Over the period of the ten years, since the investigation into school computer education by the HSRC, it may be presumptuous to assume that a more scientifically-based set of procedures has been accepted by most Departments of Education in South Africa. This presumption arises from the fact that several universities offer studies in curricula procedures, and the knowledge gained by students schooled in this direction should have filtered through to curricula bodies in the various Education Departments. Failure to understand and employ empirically-based methods of curricula for syllabuses will surely result in a manifestation of events, in the school life of the child, detrimental to the attainment of independence and adulthood. If the learning content and learning experiences are selected without giving consideration to the various aspects dominating the life-world of the child or adolescent, then the long-term goal of education, viz. adulthood, may never be successfully attained. If either political, social or cognitive considerations alone command the choice of aims, learning content or learning experiences, then the outcomes of the education program will surely not reflect well-balanced, contented, future oriented young adolescents

ready to meet the daunting challenges of the adult world.

According to NICHOLLS & NICHOLLS (1980:86-98) the curriculumator has a mammoth task to determine the needs of the target group for whom he is curriculumating, and under what circumstances the members of the group will achieve the greatest benefits from the educational program being designed. NICHOLLS & NICHOLLS mention the following considerations:

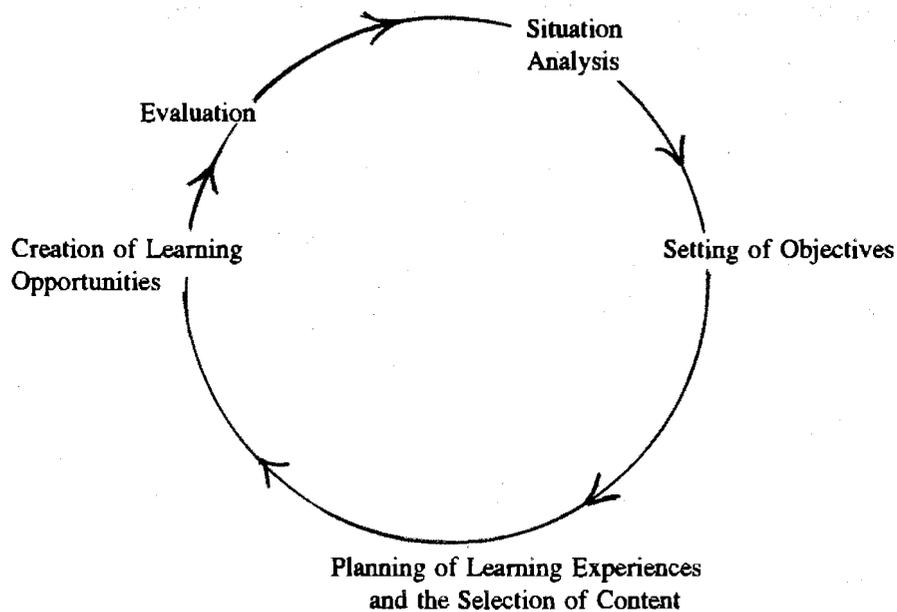
- \* Motivation strategies for the learning situations.
- \* Individuality of members of the target group.
- \* Structuring and ordering of learning content so that maximum coherence can be realized.
- \* Individual differences with regard to ability, learning style, cognitive development, emotional conditions, personality, changes in attitude, family and community frame of reference and peer-group pressures.

It is one thing to reflect on demands such as those mentioned above, which are not dissimilar to those mentioned in 3.2.2 to 3.2.6, but it requires a well structured format of curriculumating procedures to incorporate these demands in the actual design of syllabuses. For many decades curriculumating experts such as Tyler, Tanner, Payne, Pratt, Wheeler, Nicholls, Hirst and Heather have investigated, evaluated and reviewed the steps to be executed when designing educational material. The rationale for a meaningful, valid and logical curriculumating procedure has become obvious with the dramatic increase in knowledge and technology, and the subsequent problems encountered by curriculumators when confronted with the task of selecting appropriate learning content and learning experiences. The selected content must equip the learner

to distinguish for himself, that which is true and lasting, through self-experience and self-motivation, accompanied by, and influenced by, a more experienced adult.

The criteria for curriculum design are usually presented as a dynamic cycle wherein each component presumes the existence of the previous component. A never-ending process is suggested, with no definite initial or end point. The entire process is represented in a cycle which can be represented as follows: (compare with the models for curriculum design of WHEELER (1983:30), NICHOLLS & NICHOLLS (1980:21) and KRUGER (1980:34)).

FIGURE 4: THE CURRICULUM CYCLE



The components of this cycle deserve further illumination and discussion.

### **3.3.2 THE SITUATION ANALYSIS**

#### **3.3.2.1 A Point of Departure**

The most important factors to be analysed are those that influence the education situation, namely: the teacher, the child, the learning material, the community and the institution wherein the teaching-learning situation is established. An investigation must include the past, the present and an anticipation of possible changes in the future. The curriculumator must be in a position to differentiate between fact and opinion, between what is recommended and what is desired, between what is and what ought to be.

#### **3.3.2.2 The Society (Community)**

Education always takes place within a community with certain values, norms, views, convictions and needs in order to maintain its cultural identities. It is within this society that the learner finds himself. It is necessary for the curriculum designer to acquaint himself with, and understand the society for whom he is curriculumating so that cultural needs may find expression in the education situation.

Analysis incorporates anticipation. Possible requirements, changes and influences can be identified so that any defects in the education situation, caused by progress within a community, can be avoided. WHEELER (1983:15) stresses that it is essential to analyse a community and simultaneously anticipate any social, political or economical changes that may occur, so that the curriculum design becomes a relevant, living experience rather than a means of enforcing an old order that served previous generations.

### **3.3.2.3 The Educand**

WHEELER (1983:6) states that the aim of education is to effect a change in the learner's behaviour. This behavioural change should effect a degree of maturity in the learner (Marton & Säljö, 1976:4) bringing him closer to the goal of adulthood. The changes that occur in behaviour determine the learner's position and attitude to the society within which he finds himself. All his experiences are influenced by his parents, his home, his family, his peers, his educators; by the society about him. It is the task of the curricularator to take into account the learner as an individual within a community. WHEELER (1983:16) stresses the importance of knowledge of the possible physical, emotional, intellectual and social differences amongst learners for whom the curriculum is intended. The general claim that the learner has on the curriculum, is to secure a grasp on reality, but this can be actualized only through motivation and guidance, leading to manifestation of the individual's personal potential and capabilities.

### **3.3.2.4 The Educator**

While the curriculum is being designed, the educator's talents, aspirations, emotions and skills must be taken into consideration as a component of the pedagogic-didactic situation. The educator must also be familiar with curriculating procedures (Kruger, 1980:50) so that the ontic education situation of teaching (by the educator) and learning (by the educand) can be actualized with an understanding of the planning that preceded the classroom situation. The educator should be able to analyse his own situation regarding his position, that of the educands in his class and of the

circumstances influencing the choice of content.

Both NICHOLLS & NICHOLLS (1980:25) and KRUGER (1980:50) advocate the active rôle of the educator in the process of curriculum design. This active participation will secure a "hands on" input to the curriculum design, as well as affording the educator a greater understanding and a better interpretation of the syllabus. In this way, the educator can truly act as facilitator in bringing the educand from a state of "I don't know" to a state of "I know" via the syllabus content.

### **3.3.2.5 The Subject Content**

Didactics embraces the concepts of teaching and learning, but as a scientific investigation, pedagogics extends its field to that of the child in totality: the forming of the child so that he is able to answer to the challenges and fulfil the demands of adulthood. Subject content should be selected so that the many facets of the attainment of adulthood be promoted during the teaching and learning situations. The educator should create a teaching system that manifests a stable and meaningful relationship between the subject content and the goals of adulthood. WHEELER (1983:20) further suggests that an obvious differentiation should exist between the content designed to develop specific skills and the content intended to inculcate general attributes that are required to foster the attainment of personal independence. The curriculum designer must take cognizance of this relationship in the stage of analysing the situation so that the selection of learning content and learning experiences is meaningfully executed.

### **3.2.2.6 Other Factors**

Besides those factors mentioned above, there are other influences which must be considered during the situation analysis. These include the nature of the institution (academic, technical or commercial schools), funds available, physical facilities, the changing nature of knowledge and costs of training teachers for the field of study. Another important factor is the costs involved with curriculum change and innovation. Life changes and so, concomitantly, does education and its components, the educators, educands and subject matter.

The question that now arises is: what does the curriculum designer do about the problems identified in the situation analysis? This brings into focus the next step in the curriculum cycle, namely the setting of objectives which are formulated to describe the nature of the desired changes in the existing situation.

### **3.3.3 SETTING OF OBJECTIVES**

There are several terms, such as "aims", "ends", "goals", and "purposes" which, according to STRYDOM & HELM (1981:26), can be incorporated as "objectives". To simplify the situation, "aims" are considered to be long-term, general goals and "objectives" are the short-term, specific goals. KRUGER (1980:62) claims that curriculum aims imply the successful actualization of several curriculum objectives. These curriculum objectives are described in the learning outcomes that are inherent to the selected learning content and learning experiences of the syllabus. The outcomes can be evaluated against the proposed objectives and the results of the

evaluation can be fed back into the situation analysis for reconsideration of the prevailing situation. Every well-formulated curriculum objective should have two components (Kruger, 1980:54), namely the "inhoudskomponent" (content component) and the "handelingskomponent" (action component). This implies that an objective embraces the cognitive domain of the child, and a psycho-motor domain associated with that cognitive aspect of the objective. There should thus be learning-content to be mastered by the child, as well as "an action" to be performed by the learner so that his mastery of the content can be evaluated by the educator. Inherent in the actualization of these content and action components of the objectives, are affective objectives which can possibly be evaluated only after the cumulative effect of many such content-action attainments, and are thus termed long-term goals or aims.

Curriculum aims cannot be described as "specific" as they are coloured by the total human culture wherein the learner finds himself. General goals are usually conceptualized according to the life- and world-view of the community and generally represent the ruling party's intention with a curriculum. More specific aims can be formulated by the curriculumator to adjust the intentions of the curriculum to the nature of the academic institution. Aims are formulated first, and thereafter more specific objectives are stipulated relating exactly to what the pupil should be able to do (action) following successful mastery of the content. An example is:

- \*        Aim:        This course aims to contribute towards developing in the child an appreciation of the rôle of the industrial (or commercial) world.

- \* Objective: At the end of this course pupils should be able to design and execute programs in PASCAL using control structures.

The question now arises as to how the educator and the educand in the education situation are influenced by the curriculum's formulation of the aims and objectives. The educator must consider the aims and objectives as set by the curriculum, and set his own objectives for the school situation, the community situation and the classroom situation that will test the pupils' knowledge (cognitive) development, skills (psycho-motor) development and his attitudes and disposition pertaining to the subject. This curriculum by the educator is possible only if effective aims and objectives are lucidly proposed by the curriculum.

Formulation of aims and objectives is possibly the most important stage in the curriculum cycle. The aims and objectives must be guided by the problems and prevailing situations identified in the situation analysis. In turn, the aims and objectives must guide the curriculum to select the appropriate learning content and learning experiences that will ensure the actualization of the aims and objectives. This stage in the curriculum cycle will now be explained.

#### **3.3.4 THE PLANNING OF LEARNING EXPERIENCES AND THE SELECTION OF CONTENT**

The curriculum designer must bear in mind throughout all stages in the curriculum cycle, that adulthood, and its associated state of independence, is the ultimate aim of education. Pure rote learning and the memorization of facts (i.e. becoming a well-

informed person) will hardly equip an educand for the many challenges that will confront him in the adult world. The selection and planning of learning experiences should consider the social, emotional and intellectual situatedness of the child, for without such reflections, the learning experiences may aggravate already-existing problems instead of alleviating them.

The acquisition of skills is possible only through the learner's direct experiences, whereas another individual's wisdom, such as experienced in group work and discussions, may contribute indirectly to the moulding of the child. The classroom situation which facilitates an exchange of ideas and expertise amongst pupils, is already teaching the child the importance of team-work and social integration in the work place. Learning experiences should be selected to develop creativity, motivation, critical thinking, abstract thinking, logical thinking and an awareness of the type of behaviour expected of the learner in the world beyond the school environment. Learning experiences should equip a child to use knowledge to cope with life, rather than remember facts so that life becomes an exercise in recall.

As far as the selection of content is concerned, it is essential to establish a balance between the quantity of knowledge and the quality of knowledge. For knowledge to be classified as being of quality, it must inherently foster in the learner, insight, creativity and motivation for further study. Knowledge selected merely for its wide coverage of facts, may lead to indoctrination, as the choice of appropriate facts from the multitudinous volumes of established facts, may become a subjective exercise at the discretion of the curriculumator. Knowledge of facts is a temporary acquisition, as

knowledge changes day by day.

Quality knowledge allows for an in-depth study of a discipline, where the learner is permitted to criticize, interpret, simulate, design and redesign situations according to the opportunities afforded him by the learning experiences. It is vital that the learner's abilities, interests and needs be taken into consideration when content is selected.

How is the selected content, and how are the learning experiences, made available to the learner? This brings us to the next stage in the curriculum cycle, namely the creation of learning opportunities.

### **3.3.5 THE CREATION OF LEARNING OPPORTUNITIES**

It is the task of the curriculum designer to structure the learning experiences and learning content so that the educator can create learning opportunities in the classroom that will ensure realization of the learning objectives. The curriculum designer need not be definitively prescriptive, as it is ultimately the educator who must assess and react to his own teaching-learning situation, characterized by his own personal interpretations and guided by the nature of the pupils before him. The curriculum design can, however, prescribe aspects such as division of content into modules, chronological presentation of topics, psycho-motor skills to be mastered in the classroom, the degree of difficulty of tasks at the various levels of content presentation and intellectual skills (memory, comprehension, application, analysis, synthesis, evaluation) to be actualized by the learner.

Methods of presentation of content and the simultaneous integration of learning experiences should be suggested by the curriculum designer. Techniques such as self-investigation, discussion, lecturing, self-design, critical analysis, model building, group-project or individual-project and demonstration can be recommended. The educator may then use these general suggestions to guide his choice of the specific method to be employed to achieve the lesson objectives. If specific skills, such as the use of computers, are inherent to the subject, then the extent of the learning opportunities to master such skills, must be prescribed by the curriculum designer.

Learning opportunities are those that facilitate the transition of the curriculum designer's selected content from a theoretical stage to a practical situation wherein the student internalizes the knowledge and makes it his own. The actual results of the created learning opportunities and the intended results, as proposed by the objectives, have to be compared and assessed. This comparison is made possible by the evaluation stage of the curriculum cycle.

### **3.3.6 EVALUATION**

Curriculum objectives indicate what must be achieved by a learner after the successful completion of the relevant academic program. Desired states of behaviour are clearly stated by the curriculum designer. Evaluation is simply stated as the attempt to correlate the proposed learning objectives with the actual learning outcomes. The results of the evaluation are then used to analyse the prevailing changed situation. Evaluation is an on-going process that is never finalized because it leads to a new situation-analysis, which then demands a review of the curriculum objectives, and the cycle continues.

All learning outcomes must be evaluated. That is, the educand's total change of behaviour must be evaluated. Mention is made (Wheeler, 1983:126) of content evaluation (evaluation of changes in the cognitive domain) and acquisition evaluation (evaluation of changes in the psycho-motor and affective domains). Considering these two aspects under which the learner can be assessed, it would appear inappropriate to evaluate the success of a curriculum program by considering only the results obtained by the learner in a written, theoretical examination. The aim of any education endeavour is to effect a behaviour change in the learner, so that he makes a progressive move towards the state of adulthood. At this stage, in South Africa certainly, the "success" of the school curriculum programs are assessed primarily, if not solely, on the results of written matriculation examinations. Only the cognitive domain is being evaluated, while the other determinants of adulthood are ignored. Perhaps this is reason enough for the high failure rate at universities amongst first year students (Hofmeyr & McLennan, 1990:3).

The evaluation stage in the curriculum cycle should indicate the success (or otherwise) of, not only the progression towards adulthood of the educand but also, the teaching methods and the relationship between the educator and the educand. A critical self-evaluation of the educator can be realized with questions such as:

- \* Have the methods of content presentation motivated the child towards further study?
- \* Did the teaching techniques elicit the most sophisticated thought processes possible in the child?

- \* Have the endeavours transposed the child from a state of dependent I-know-not to a state of independent I-know?
- \* Is the child better equipped, mentally, physically and emotionally, to confront the challenges of the world about him?
- \* Has the education relationship been established as one to which the educand feels he may always return informally in the future?

Evaluation, thus, embraces the subject content, the progress towards adulthood of the educand and the effectiveness of the educator in uniting himself, the educand and the subject content into an education relationship. Evaluation of curriculum matters is an extensive, many faceted topic and the reader is referred to VAN HEERDEN (1987: Chapter 2) for a concise literature study on this subject.

### **3.3.7 SUMMARY**

It has been confirmed that with the design of a curriculum the prevailing situation of the society, the school, the educator, the educand and the existing learning content must be analysed, from which the curriculum aims and objectives will evolve. On the foundations of these aims and objectives, the learning experiences are planned and learning opportunities are created to integrate the selected learning content with the multi-faceted education of the child. The actual behavioural changes experienced by the educand (the learning outcomes) are evaluated, the results of which are compared with the proposed aims and objectives. An analysis of the existing circumstances begins again.

With the stages in the curriculum cycle now familiar to the reader, the author perceives the nature and structure of knowledge an important part of this study, as syllabuses prescribe the knowledge to be mastered in the education situation. The relevance of the structure of knowledge in designing of curricula will now be investigated and evaluated.

### **3.4 THE RELEVANCE OF THE STRUCTURE OF KNOWLEDGE TO CURRICULUM DESIGN AND CURRICULUM CONTENT**

#### **3.4.1 INTRODUCTION AND OBJECTIVES**

A simple phrase that stresses the importance of knowledge is "Knowledge is Power". Knowledge is power over kings, countries, countrymen and over one's own life. Discussions about curricula are important because the curricula act as vehicles of distribution of the produced and packaged knowledge. Each claim that is made for a particular curriculum is, in practice, a claim that knowledge should be distributed in a certain way. These claims have been discussed in 3.2 of this chapter. Knowledge can be seen as something that is produced, distributed and consumed. The consumers are rarely in contact with the producers and similarly, the integration of this knowledge into the curricula is not subject to public debate.

The objectives of this study of knowledge as an important consideration for the selection of learning content are:

- \* To be able to relate the nature and structure of knowledge to its position and relevance in a curriculum plan.

- \* To illustrate how the various views of the nature and structure of knowledge provide an important base for curriculum planning. These views (Hass et.al., 1974:161) will help the planner to decide ...
  - what to include in the curriculum;
  - how to plan for the different kinds of knowledge to be taught;
  - how to provide for the individual differences of learners.
- \* To be able to draw conclusions with respect to, and to suggest, adaptations to a curriculum plan that are based on the various approaches to knowledge and its structure.

A notable effort to reform the curriculum through the restructuring of each of the major knowledge categories through the structure-of-the disciplines approach was undertaken in the United States during the 1950s and 1960s (Tanner & Tanner, 1975:399). This movement was not successful at first, but as time proceeded the structuring of disciplines took its rightful place alongside the learner and society when curriculum planning was embarked on. Today it is considered essential to meaningful outcomes of the education event.

### **3.4.2 QUALIFYING CONCEPTS**

#### **3.4.2.1 Structure**

Structure is defined in WEBSTER'S Dictionary (1944:717), as "... the organization of the parts making up the whole ... as in instruct ...". BRUNER (1966:7) claims that understanding the structure of a subject permits many things to be related to it

meaningfully. "To learn structure, in short, is to learn how things are related".

#### **3.4.2.2 Knowledge**

When small groups of people develop as social systems with an increasingly complex culture, they assign meaning to their experiences in order to interpret the world around them. These experiences-with-meaning help them to survive in their interactions with each other. Thus a collection of meanings arise which makes up the group's stock of knowledge. Within such a group, knowledge can be differentiated according to age, sex, interests and expectations (Musgrave, 1973:1). As societies become more complex, so knowledge is divided into more discrete areas, shared only by distinct groups of society requiring a particular type of knowledge. In this respect, HIRST (*in*: Open University, 1972:17) divides knowledge into distinct "forms of knowledge": mathematics, physical sciences, human sciences, history, religion, literature and the fine arts and philosophy. Different fields of knowledge, he adds, can draw content from any of the forms of knowledge, e.g. the field of medicine may require knowledge from the physical and human sciences and mathematics. MUSGRAVE (1973:7 e.v.) distinguishes between Academic and Behavioural knowledge, while SCHWAB (1964:15) describes ARISTOTLE'S three major groups of disciplines, namely Theoretical, Practical and Productive. Fundamental Pedagogicians include in their body of knowledge, the study of norms associated with the actualization of the child as he is assisted with preparation for adulthood.

### 3.4.2.3 Curriculum Planning and Knowledge Structure

Curriculum planning has been analysed in some detail in 3.3, but it is now necessary to define curriculum planning specifically from the perspective of the influence that knowledge imparts to it. A tentative definition is proposed by TANNER & TANNER (1975:45):

"The planned and guided learning experiences and learning outcomes, formulated through the systematic reconstruction of knowledge and experience, under the auspices of the school, for the learner's continuous and wilful growth in personal-societal competence".

This definition regards knowledge and the methods of acquiring such knowledge, as dynamic. The curriculum must account not only for established knowledge but emergent knowledge as well. Hence, the curriculum must account for the rapidly changing life-world of the learner.

The rationale proposed by TYLER (*in*: Tanner & Tanner, 1975:57) for analyzing and developing the curriculum begins with a quest for answers to five questions:

- \* Why, where and for whom is learning being anticipated?
- \* What educational purposes are sought?
- \* What educational experiences can be provided to attain these purposes?
- \* How can these educational experiences be effectively organized?
- \* How can it be determined that these purposes are being attained?

In essence, these five questions underlie the five phases of the curriculum process as described in 3.3.

Phase 1 : Situation analysis.

Phase 2 : Aims, goals and objectives.

Phase 3 : Planning of learning experiences and selection of content.

Phase 4 : Organization and integration of experiences and content.

Phase 5 : Evaluation.

Phase 3 and Phase 4 would be of particular importance when considering the structure of knowledge as the determining factor in the planning of a curriculum. WHEELER (1983:40) states:

"Emphasis on the type of content studied results in the enumeration of a number of organized disciplines ... there is a need for clarification of the conceptual frameworks which support the disciplines, the realms of meaning or the sectors of knowledge".

Hence it is not the accumulated, packaged, traditional knowledge that is the vehicle to realize the aims and objectives of the curriculum with respect to the pupil and the community, but rather the structuring of the knowledge and the relevance of the knowledge that will determine its intrisicality for the learner. BRUNER (1966:31) endorses this by stating that:

"... the curriculum of a subject should be determined by the most fundamental understanding that can be achieved of the underlying principles that give structure to that subject".

Knowledge of the structure of a discipline does not provide all the answers to planning a curriculum. The planner must consider the following factors, as outlined by TYLER (in: Ford & Pugno eds., 1964:4).

- \* What knowledge is needed today to meet the demands to be placed on the learner in the rapidly changing world?

- \* The nature of the community feeding the educational institutions. Pupils differ in what they have previously learned and in their attitudes to learning.
- \* The knowledge to be distributed must be teachable and learnable.
- \* How far does the knowledge promote belief in the importance of intelligence, initiative and independence, i.e. does the material contribute to human-social values? Does it foster the goals of adulthood?

BRUNER (1966:31) stresses that meaningful knowledge is knowledge that is "... usable in one's thinking beyond the situation in which learning has occurred".

TANNER & TANNER (1975:279) support Bruner's view by claiming that only one of the objectives of teaching via structure is the hope of a good academic performance by the learner in that field. Other objectives include the enhancement of a learner's social, ethical, spiritual and aesthetic milieu of life, consolidating the Fundamental Pedagogician's perspective of adulthood as being the aim of Education.

### **3.4.3 THE SELECTION OF KNOWLEDGE**

Five of the factors influencing the selection of knowledge for school syllabuses will now be proposed and discussed.

#### **3.4.3.1 The Development of the Mind**

PRING (1976:38) is in agreement with HIRST (1974:27) that education is about the development of the mind, and further, that "mind" is logically determined by "knowledge". They both agree that the acquisition of knowledge is to "... have mind more abundantly". They differ in opinion, however, about the importance of the

cognitive; HIRST stresses that knowledge is purely a mental activity, whereas PRING includes practical knowledge. HIRST (1974:28) claims that:

"No matter what the ability of the child may be, the heart of all his development as a rational being is, I am saying, intellectual ...".

Intellectualism does not imply a body of undisputed facts, but rather the intellectual ability, that results from experience, to distinguish right from wrong, good from bad, safe from dangerous and beneficial from disadvantageous. Intellectualism implies the development of the mind so that normative decisions can be made for the benefit of the self and society. PRING (1976:23) distinguishes between propositional knowledge and "knowledge-how". HIRST and PRING conduct their studies from a reductionist's (philosophical) point of departure. Education, being concerned with the development of the mind, concerns the individual and his personal experiences, while the structures employed in the organization of knowledge are "those of others' making". PRING (1976:23) asks:

"Why should improvement of mind be in mastering another's way of seeing things?".

Improvement of one's own mind should preferably imply mastering one's own way of seeing things. Before a learner has reached adulthood, he depends on the educator's guidance to help him distinguish that which is worthy of perfecting from that which is preferably rejected.

ARISTOTLE'S classification of the disciplines into three groups is worthy of note: **Theoretical disciplines** are those whose aim is "to know". The knowledge making

up these is as stable as knowledge can be. The **Practical disciplines** encompass knowledge which is changeable but based on actions taken for their own sakes and not as a means to some other ends. Such knowledge would include aesthetics, ethics, morals and politics. The Fundamental Pedagogic criteria for adulthood would be practical knowledge that an educator would utilize to guide an educand to adulthood. The final group includes the **Productive disciplines**; those devoted to making and would include such learning as creative art, design, engineering, didactics, medicine, drama, accounting and law.

TANNER & TANNER (1975:469) classify the total curriculum according to three broad functions: (1) General Education which includes knowledge that all educated members of a free society share together; (2) Special-interest and enrichment education and (3) Specialized education - including vocational and professional studies. The similarity between TANNER'S classifications and ARISTOTLE'S groups are very apparent and deserve further attention.

#### **3.4.3.2 General and Specialized Knowledge**

As societies develop in complexity and size, knowledge becomes more specialized and organized into discrete areas available only to those people wishing to invest their intellect in those specific areas. TANNER & TANNER (1975:456) state that specialization is necessary for the functioning of an advanced technological society, and that from the 1970s there has been a rising concern to address knowledge and the curriculum to solve the explosive problems of the times. TANNER & TANNER (1975:456) define general education as:

"... that part of a student's whole education which looks first of all to his life as a responsible human being and citizen of a free society".

KING & BROWNELL (1966:3) describe the general curriculum as having little particularity and concreteness. It would lead to what DUMINY (n.d.:259) refers to as "... glorification of the intellect", with no particular knowledge to do anything specifically well.

The explosions of the latter quarter of the twentieth century (technology, knowledge and population) have caused subject specialization to begin progressively earlier in a pupil's life. BELL (1975:457) in opposition to specialized education, calls for schools to be places of intellectual exploration where the learner can:

"... momentarily resist the harness that society now seeks to impose at an earlier and earlier stage on its youth".

KING & BROWNELL (1966:3) on the other hand, are of the opinion that man is what his occupation is, and it is, therefore, the school's task to train pupils for something practical. CONANT is quoted by KING & BROWNELL (1966:5) as saying:

"I submit that in a heavily urbanized and industrialized free society the educational experiences of youth should fit their subsequent employment".

This opinion is consolidated by PHUPHELI (in: The Sowetan, 1992.05.12) who stated that the attention now being paid to skills training could not have come any later in South Africa. Throughout the world, focus is being given to the type of education

that fits people into jobs. PHUPHELI illustrates this viewpoint by drawing attention to Germany and Japan, countries with the strongest currencies, who have, for many decades, invested in skills training. The Pacific Rim countries followed suit and are now emerging as major players on international stock and financial markets. There is a need for specialization in our advancing society, but a society controlled wholly by specialists is not a wisely ordered society. The problem is to save general education in a system where specialization is necessary. Curriculating wisdom would involve the selection of subjects, such as computer science, that have application in many fields of work and study, and that have a multidisciplinary nature, drawing from several disciplines of knowledge for constitution of their content.

#### **3.4.3.3 New Knowledge**

With the knowledge explosion of the latter half of this century, many domains of knowledge appear to have disintegrated. HIRST (1974:26) defends the "old frontiers" of knowledge by claiming that they have merely become more differentiated; the picture being more complicated. HIRST does not believe that new disciplines or forms of knowledge have developed, but rather that specialization within specialization has occurred. He refers to "new knowledge" as "second-order constructions" as opposed to "primary knowledge".

SCHWAB (1964:28) is of the opinion that scientific knowledge, particularly, is neither profound nor final. Older conceptions, although correct, are replaced by a new

formulation which puts old facts and new ones together in more revealing ways. A striking example of this are the theories developed to explain the structure of the Atom.

#### **3.4.3.4 Theoretical Knowledge and Practical Knowledge**

SCHWAB (1964:17) reflects on the unfortunate situation prevailing in schools whereby all knowledge is treated as theoretical. He illustrates the situation with the example of students of musical appreciation being schooled to merely give the opus number and composer's name after listening to a musical score. Educators even manage to theorize knowledge from ARISTOTLE'S productive disciplines. An example of this is the presentation of the General Science Didactics course at DET Teacher Training Colleges in South Africa. Every student in the primary teachers' training course must follow this didactics course, regardless of whether or not science or biology is a major subject in their curricula. Didactics implies "how to teach" and the majority of students have to learn how to teach general science even though they have no content knowledge and therefore do not know what to teach. This didactics course is, therefore, presented in a purely theoretical manner and motivational strategies employed by the lecturers are usually exhausted after the first six lessons!

WHEELER (1983:37), in discussing selection of content, emphatically states that knowledge, in its organized form, has no place until man does something with it; experiences it in such a way that behaviour is learned.

KING & BROWNELL (1966:7) stress the need for a prior "liberal education" i.e. a general education, before embarking on occupational training. Occupational training

which involves a high percentage of practical knowledge, may be suitable for the present, but could be obsolete in the future.

CONANT is quoted by KING & BROWNELL (1966:6) as saying that these practical skills can be taught in secondary schools with an acceptable degree of competence for the job-market. HIRST (1974:27), as mentioned previously, emphasizes only the cognitive approach to knowledge acquisition, thus considering only theoretical knowledge. He states:

"The forms of character development and skills that are frequently sought, are what they are because of the cognitive elements they necessarily involve".

Hence, any skill presupposes theoretical knowledge.

PRING (1976:39) describes practical knowledge as the "know-how" and stresses its importance in the curriculum. To sketch, climb mountains, play a piece of music, dance a jig, are also cognitive activities which cannot be reduced into propositions (theoretical knowledge). PRING is of the same opinion as SCHWAB that knowledge in the curriculum is too theoretical.

PRING'S contribution was published in 1976 and SCHWAB'S in 1964. Some twenty to thirty years later many more specialized, practical fields of study have been introduced into the curricula at schools. Commercial and technical fields, ballet, music, art and computer science are some of the directions which pupils may have the opportunity of choosing within the school curriculum. The level of development of these vocational fields of study varies dramatically amongst the different Education Departments in the country and it would be accurate to state that the majority of



### 3.4.4 THE DISCIPLINES

#### 3.4.4.1 Defining a Discipline

Some think of knowledge as organized bodies of facts and concepts and that all knowledge that man has amassed is subsequently sorted into organized, useful structures known as disciplines. PHENIX (1962:156) considers a discipline to be a discipline only if an area of study displays analytic, synthetic and dynamic qualities. If a body of knowledge fails in this respect, then he refers to it as a "field of study". SCHWAB (1964:28) also feels that the curriculum should consist only of knowledge that comes from the disciplines.

HASS et al., (1974:161) define a discipline as

"... a man-made set of generalizations that explain the relationships among a body of facts and concepts".

Scholars in each discipline have, according to HASS et al., developed methods of inquiry for discovering new knowledge. PHENIX (1962:150) feels that the whole academic event of teaching and learning should be a retracing of these processes of inquiry which gave rise to the discipline. HASS et al., add that a discipline, because it is man-made, is subject to revision if a different organization should prove more functional.

SCHWAB (1964:29) stresses the "man-made" nature of the disciplines which, particularly in the social sciences, leads to subjectivity. He refers to this as the "pluralism" of bodies of knowledge. There is more than one body of knowledge in

anthropology, sociology and politics for example, depending on, amongst other things, the ground motive of the researcher. SCHWAB continues to point out the danger of a dogmatic approach to one of several theories in a field of study. This dogmatic approach to the disciplines can lead to indoctrination, which can successfully be avoided if the knowledge is studied in the light of the substantive structures that underlie it. These substantive structures will be clarified in section 3.4.5.1.

PRING (1976:25) contends that to master a discipline is not to memorize facts from it, but rather to learn how to solve a problem, create something or produce what is wanted. To this end he agrees with HASS et al., and PHENIX that there are specific, but not necessarily unique, rules of procedure within each discipline. To successfully master a discipline according to PRING, is to work alongside a successful practitioner; to be directed and corrected by him. (The author questions the rôle of computer aided instruction in PRING'S postulate.) Mastery of a discipline would be part of the overall education program of the school. The Fundamental Pedagogic stipulation of the rôle of the educator and the educand in an education situation would be in agreement with PRING'S postulate.

Disciplined knowledge exists in a teachable form, according to PHENIX (in: Tanner & Tanner, 1975:412) and what is more, well structured knowledge is acceptable to a learner regardless of a learner's nature, needs or interests. PHENIX (in: Tanner & Tanner, 1975:413) however, some five years later retracted this statement to replace it with a study on "relevance" of curriculum content to the learner.

#### 3.4.4.2 Interdisciplinarity

SCHWAB (1964:14) proposed that different disciplines have widely different conceptual schemes, and hence there are major differences between one discipline and another in the way that they verify their knowledge. Many scientists do not agree with SCHWAB'S idea that the disciplines are discrete bodies of knowledge with no unity. SCHWAB retracted this idea in 1970. WHEELER (1983:20) states:

"The source material for the curriculum is the body of disciplines that constitutes contemporary knowledge ... it is not enough to identify the subject matter of education. The relations between the disciplines must also be considered, in order to determine what may or may not be co-joined and what decisions should be made about the sequence of instructions".

The "new" SCHWAB (1971:182) reviewed the dependency of Physics on Mathematics, Biology on Chemistry, Sociology on Biology and formulated the problems of organization of the disciplines. Amongst these problems are those of identifying significantly different disciplines and those of locating their relations to one another.

COMTE (in: Schwab, 1971:186) presents a hierarical organization of subject matter which emphasizes the interrelatedness of the disciplines. Whether this scheme is read in the dogmatic order or in the objective order (Mathematics, Physics, Chemistry, Biology, Sociology) is not important here. What is relevant is that a knowledge of each discipline requires a knowledge or mastery of the discipline preceding it. Such a permanent dependency of one discipline on another for understanding of the discipline's body of knowledge could be termed "multidisciplinarity" while the

temporary borrowing of knowledge amongst disciplines to investigate a hypothesis, could appropriately be termed "interdisciplinarity". Both are acceptable, honourable and feasible situations. No body of knowledge can exist in isolation. Computer science has a definite multidisciplinary character as its content includes mathematics, history, electronics, communications, chemistry and physics.

While reflecting on this topic of interdisciplinarity, the author considered it necessary to discuss the science of Fundamental Pedagogics according to the statement of KILIAN (1973:49):

"Pedagogics which is also an autonomous science, ... aims at establishing universally valid results. It intends to be valid for all people and for all ages ... . In this way pedagogics lays the foundation of various systems of teaching and education endorsing different views of life ... it also provides the opportunity for people holding different philosophies of life to establish their education systems on the truths revealed".

Describing pedagogics as autonomous arises from utilization of the phenomenological method to investigate the phenomenon of education and revealing the essences of the education situation. These essences are fundamental to the education situation and do not depend on other disciplines such as sociology and psychology for their validity and acceptability. However, when a study such as this one, concerning the technological-mathematical-practical science of Computer Science, is undertaken, it concerns the adolescent, the computer and the teacher in an education situation (Fundamental Pedagogics and Technology), the selection of course content (Didactics, Computer Science and Fundamental Pedagogics), the employment environment and its demands on the education of the adolescent (Socio-economics and Fundamental Pedagogics) and

the pedagogic school structure (Fundamental Pedagogics). Such a study illustrates the essences revealed in Fundamental Pedagogics and their relevance to a subject discipline (computer science) in the school-didactic situation.

### **3.4.5. METHODS OF STRUCTURING KNOWLEDGE**

BRUNER (1981:450), on discussing structure, states:

"A good theory is the vehicle not only for understanding a phenomenon, but also for remembering it tomorrow".

During the 1950s and 1960s educators enthusiastically picked up on the idea of the structure of the disciplines as a means for maximizing transfer of knowledge (Tanner & Tanner, 1975:279). BRUNER (1966:6) agreed that understanding structures and fundamental principles "... appears to be the main road to adequate transfer of training". According to TANNER & TANNER (1975:278) the proposers of the discipline-doctrine failed to achieve their aim as most subjects, including mathematics and physics, had no organizing principle or structure. A structure must have a base succeeded by planned, consequential stages, leading finally to the existing ultimate of structure. This, too, is what a structured discipline must represent so that a scholar in that discipline will form, in his cognitive, realistic, meaningful bodies of knowledge. Throughout his studies he will be encouraged to go a step further. Structure, then, will encourage further study (cf. Tanner & Tanner, 1975:280).

The following theories on the structure of knowledge are worthy of note.

### 3.4.5.1            JOSEPH J. SCHWAB (1971:183 e.v.).

SCHWAB names three problems concerning the structure of the disciplines.

#### 3.4.5.1.1            The Organization of the Disciplines

This problem involves the identification of the various materials which constitute each discipline (membership), identifying similarities between disciplines and finally, identifying differences between disciplines. The organization of the disciplines will provide answers to questions relating to isolation of disciplines, interdisciplinarity and multidisciplinary.

#### 3.4.5.1.2            The Substantive Structure of each Discipline

The second problem is that of identifying conceptual structures for each discipline. These conceptual structures are the underlying structures which initiate and guide inquiry into a subject, e.g. the study of the atom will utilize the conceptual structure of a wave to explain the uncertainty of the position of an electron in the atom. Fundamental pedagogics is an example of a discipline identifying conceptual structures. LANDMAN et al., (1982:vii) list the six structures of the Educative Occurrence:

- \*        Relationship Structure.
- \*        Sequence Structure.
- \*        Activity Structure.
- \*        Aim Structure.
- \*        Philosophy of Life Structure.

\* School (Didactic) Structure.

This study has utilized the last-mentioned School Structure as the underlying structure to guide the investigation into the relevance of computer science as a discipline that can assist with the self realization of the adolescent. These conceptual structures must be understood in terms of their powers and limitations. Different researchers into one science may use different conceptual structures and hence the bodies of knowledge so produced will be different. Further research into the disciplines will require examination of the conceptual structures first, and a possible subsequent revision of the conceptual structures.

3.4.5.1.3 The Syntactical Structures of the Disciplines

The syntactical structures of the disciplines deal with the methods of inquiry into a science and the methods and criteria used for evaluating or substantiating the data used in the investigation. Webster's Dictionary (1944:603) uses the words "arrangement", "members" and "relations" to define Syntax. SCHWAB provides the following description of the steps in a Syntax:

- \* Describe the whole.
- \* Describe the parts making up the whole.
- \* Describe the effects that each of the parts of the whole have on each other, using data to confirm observations.
- \* Describe the function of each of the parts of the whole and their contribution to the function of the whole.

This study will attempt to describe syllabus content for computer science to be

presented in secondary schools, based on a fundamental pedagogic study of the factors underlying the selection of content. In this way the content is selected to ensure a syntactical structure of a discipline suitable for secondary school adolescents. According to SCHWAB'S description of the steps in a syntax, this study has proceeded as follows:

1. Describe the Whole:

Computer science syllabuses for secondary school adolescents: a fundamental pedagogic perspective.

2. Describe the parts of the whole:

- \* The adolescent.
- \* The school.
- \* Factors influencing the selection of content.
- \* The subject content.

3. Describe the effects that each part of the whole has on the other parts, using data to confirm observations.

The selection of content for syllabuses is determined by:

- \* The adolescent's needs in relation to himself, his peers, his home and society.
- \* The expectations that the learner and society have of the pedagogic structure of the school.
- \* The pedagogically determined activities within the school that direct the actualization of the adolescent.

The essentials of the pedagogic school structure must be realized through

presentation of the scientifically selected subject content. These theories are to be tested (verified or rejected) against the results obtained from processing questionnaires.

4. Describe the function of parts of the whole and the contribution to the functioning of the whole.

- \* The Subject content is proposed.
- \* The selection of content is validated according to the needs of the adolescent and its rôle in fulfilling the expectations that are placed on the school structure.

The author suggests that the content selected and the arrangement thereof will result in a syntactical structure of syllabuses for computer science in secondary schools.

The relevance to the curriculum of SCHWAB'S organizational substantive and syntactical structuring of knowledge can be summarized in the following three points:

- \* The organization of the disciplines will assist with the combination of disciplines that compliment each other and depend on each other, to be utilized in further courses of study or careers reliant on the knowledge and skills acquired from the discipline.
- \* The Substantive Structure must be part of the subject content, as the understanding of the fundamentals underlying a disciplined study are necessary for total comprehension.
- \* The Syntactical Structure will unite the content of a discipline, the user (learner) of a discipline and the benefits of a discipline to the methods

of a discipline, i.e. Theory, Practice, User and Significance of Content will become one.

### **3.4.5.2 PHILIP H. PHENIX (1962:151 e.v.)**

"Knowledge that is hard to teach is ... inferior. Knowledge which readily enlightens the learner's understanding is superior".

PHENIX'S idea of the structuring of knowledge has one aim in mind and that is to make knowledge teachable. He structures knowledge in three steps:

#### **3.4.5.2.1 Simplification of Knowledge**

"Our humanness rests upon a wise ascertain, not upon indiscriminate hospitality to every message impinging on us from the world about us" (Phenix, 1962:152).

PHENIX'S method of simplification is that of Analysis - the abstraction of experiences - the converting of experiences into symbols. To abstract is to discern properties, qualities and forms of things; to retain the relevant and discard the irrelevant; to interpret and explain.

A well analysed and simplified discipline will become progressively more revealing and less difficult to internalize.

#### **3.4.5.2.2 Synthesizing of Knowledge**

Analysis must precede Synthesis. Analysis is the structuring of organized, realistic parts or schemes, which PHENIX refers to as cognitive concepts. Synthesis then weaves these concepts into comprehensive patterns or wholes. A discipline is then a

"... community of concepts". Ideas cannot be understood in isolation, but within the unity of a discipline they remain vivid.

#### 3.4.5.2.3 Dynamism of Knowledge

"A discipline is a LIVING body of knowledge containing within itself a principle of growth" PHENIX (1962:155). (The author has added the emphasis.)

A well disciplined field of study will initiate in scholars, desires for further revision and discovery. PHENIX notes that many educators and researchers do not follow the syntax of a discipline but rather create their own ways of organizing knowledge. This could lead to problems of actualization of the knowledge or a misinterpretation of the knowledge.

#### 3.4.5.3 JEROME S. BRUNER (1966:30 e.v.)

BRUNER'S (1966:31) emphasis on structuring of knowledge is the teaching of fundamental principles. Underlying principles give structure to a subject (cf. Schwab's conceptual structures). Reasons presented for teaching fundamental principles are:

- \* Subject is made more comprehensible.
- \* Memorization, recall and use of these principles are easier than with sophisticated ideas.
- \* Fundamental principles represent the most basic, general case. Subsequently more elaborate facts can be built on them.
- \* By relating to fundamental principles one bridges the gap between elementary

and advanced knowledge.

#### **3.4.5.4 RICHARD PRING (1976:66 e.v.)**

PRING lists four features of a structured activity, which can be compared to those of SCHWAB and PHENIX:

- \* Central Organizing Concepts - (Substantive).
- \* Principles of Procedure - (Syntax).
- \* Criteria of Success - (Data and Evaluation).
- \* Problems and Interest - (Dynamism).

The four theories of SCHWAB, PHENIX, BRUNER and PRING presented here would make sense to any teacher experienced in presentation of a school subject. The theorists do not, however, mention the collective importance of influences such as the learner and society, together with the structuring of the disciplines, on curriculum planning. Little mention is made of the importance of practical skills or the practical component associated with knowledge. The educationalists and curriculum planners today have had 20 to 30 years, since this movement attempted to glorify the disciplined structuring of knowledge, to realize the mutual importance of the many factors that determine the success of a curriculum. A structuring of the disciplines is essential for meaningful learning to occur, but must not be seen in isolation. The eventual aim of guiding the child towards being able to meet the demands of responsible, meaningful adulthood must always be kept in mind when structuring the disciplines. The fundamental question to be answered is: What relevance has the construct for the learner's actualization of adulthood?

### 3.4.6 GENERALIZATIONS

The following observations are a result of the preceding study on the Structure of Knowledge.

- \* A structured discipline cannot be generally applicable *per se* to every curriculum. The structured discipline must be modified to suit the cultural and economic needs of the community. Irrelevant knowledge must be discarded without detriment to the logical structure of the remaining content. Consideration must be given to the future needs of the community, (cf. Phenix's stage of Analyzing), and the present needs of the child.
- \* Disciplines cannot exist as isolated domains and interaction between different subject experts and curriculum planners is essential when planning the curriculum. Pupils can be assisted in choosing relevant course combinations if the disciplines have previously been well organized (cf. Schwab's Organization of the disciplines).
- \* Both SCHWAB and BRUNER (conceptual structures and fundamentals, respectively) emphasize the teachings of the basics. A structure without a solid base has little or no futurity.
- \* Acquired knowledge must be put to use. Hence, knowledge which is purely theoretical is only a passenger of the mind, and not of any use. Practical knowledge is the successful application of theoretical knowledge.
- \* Structuring of knowledge must take place when planning and, again, when implementing a curriculum. The teacher can begin to structure knowledge

when he is aware of the population size and intellectual level of the pupils before him.

- \* SCHWAB'S mode of synthesizing of knowledge is essential to avoid the inclusion of disjointed, unrelated topics in a course. These disorientated topics have no links in the cognitive structure of a learner and are thus rapidly forgotten.
- \* Knowledge must be structured in accordance with its application for and relevance to the reality of the world outside the school. Knowledge must not be packaged for the confines of the classroom. It must leave the school with the learner and accompany and assist him in life.

#### **3.4.7 SUMMARY**

Knowledge should be structured by expert scholars in the disciplines. These structures may then be modified by curriculum planners and implementers to suit the prevailing circumstances of the target group, e.g. age, level of ability, physical environment, physical needs, emotional needs, social needs and conative expectations of the adolescent learner. In this manner a motivated, harmonious actualization of the knowledge will ensure a positive step towards adulthood for the adolescent. With this essentially didactical description of the structure of knowledge now complete, it is necessary to relate the criteria for the selection of learning content to the essences of the pedagogic school structure.

### **3.5 CRITERIA FOR THE SELECTION OF LEARNING CONTENT TO FULFIL THE REQUIREMENTS OF THE PEDAGOGIC SCHOOL STRUCTURE**

#### **3.5.1 INTRODUCTION**

The rôle that the learning content, prescribed by the syllabus and presented at the school, plays in the development of the child in totality, has been highlighted in 2.4.

Amongst the considerations mentioned are:

- \* the need for the individual child to feel secure within the learning space created for him;
- \* the need for the child to recognize the purpose of the knowledge to be mastered, for life now and in the future;
- \* the need for the child to relate what he is learning to the world about him;
- \* the need for the child to recognize the unity amongst himself, his school and his family;
- \* the need for the child to experience the freedom of creative expression within a disciplined environment;
- \* the need for provision of opportunities to develop social, emotional and intellectual skills that could be necessary for the child's integration with life's experiences;
- \* the need for actualization of learning content to establish the confidence for periodic breaking away and enhanced experiences of freedom.

There is, simultaneously, the demand of the nature of the knowledge itself: is it absolute? Does it provide for independent study? Does it develop intellectual skills other than rote learning?

Criteria will now be described regarding the learning content to be selected to satisfy the demands of the pedagogic school structure and the nature of the knowledge itself.

### **3.5.2 THE INTELLECTUAL ACTIVITIES INHERENT TO THE CONTENT**

The terms "intellectual", "intelligence", "intellectual ability" and "intellectual activity" express many different ideas. For this discussion intelligence will be acknowledged as the result of the development of all functions of the human brain (Clark in: CEFT, 1985b:12). The ancient Romans described what is today regarded as intelligence:

"... a private spirit or deity residing in all individuals, and acting as a helpmate and protector from the cradle to the grave". (Anon in: CEFT, 1985b:12).

TERMAN (in: CEFT, 1985b:12) argues that intelligence stems from an ability in a person to exercise sensitive judgement in solving problems, an ability to adapt to new situations and to learn by performing tasks from experience. Authorities on intelligence agree that intelligence is a general ability, possessed by all human beings to a greater or lesser extent (CEFT, 1985b:12). This general ability is a composite of several competencies including retention, reasoning ability, perception and abstract thinking. CATTELL (1963 in: CEFT, 1985b:12) describes intelligence as a combination of human traits which enable him to change and adapt himself to

situations as they arise and actually increase his own capacity, becoming more than what he is at birth. The development of the intelligence in man implies not becoming more than his inborn characteristics, but becoming more in his ability to use those inborn characteristics.

Intelligence as a combination of human traits stresses the urgency to educate the child at school to achieve a harmonious synchronization of all his life-factors, not only the examination-factor.

Much interest centres on how pupils cope with the problem of mastering the massive body of knowledge they are set to learn. A large number of learning theories have been postulated, such as those of Gagné, Gal'perrin, Bruner and Parlett, but "... empirical evidence for most is still lacking" (Wilson, 1981:18). It would be an unrealistic endeavour to attempt to define the most appropriate learning styles required for a specific body of knowledge to be mastered, but the type of intellectual activity that is required for, or inspired by, actualization of specific content, is, indeed, a feasible undertaking. In selecting and organizing learning material, BLOOM'S taxonomy (in: Behr, 1982:59) should be considered and this will now be presented with a certain conciseness introduced, considered necessary for this study.

#### **3.5.2.1 Bloom's Taxonomy of Intellectual Activities**

BLOOM and his associates developed an idea of cognitive hierarchies, arranged in order of six gradations of complexity. The following table is reproduced from BEHR (1982:61):

<u>TABLE 1</u>	
CATEGORY	STUDENT'S ACTIVITY: LEARNING OR TESTING
Knowledge	state, recall, recognise, select, measure
Comprehension	identify, illustrate, formulate, explain, contrast
Application	predict, select, assess, show, compute, construct
Analysis	select, compare, differentiate, separate, contrast
Synthesis	summarise, generalize, conclude, relate
Evaluation	judge, support, criticize, attack

TANNENBAUM (in: CEFT:1985b, 11) suggests that emphasis in presentation of subject matter should shift amongst these different complexities in relation to the varying cognitive abilities and ages of the different pupils. He classifies the three activities of knowledge, comprehension and application as "BASICS" and the remaining three activities as "HIGHER LEVEL THINKING PROCESSES". For purposes of this study, BLOOM'S taxonomy of intellectual activities will be grouped into three categories:

#### 3.5.2.1.1 Knowledge

Certain types of knowledge promote essentially a reproductive or rote learning method of study, in which learning is equated with committing to memory. Rote learning will be practised by all scholars at some time, and it may even be characteristic of fields of study at school such as biology, history and biblical studies. Studies by MARTON and his colleagues (in: Wilson, 1981:18) have suggested that many learners adopt a

reproductive or "surface" approach to study of materials, even in situations where in-depth, reading-for-meaning is required.

Facts are not the only commodities that may be committed to memory. Actions to produce results may also be classified as knowledge for memory. A pupil may memorize a sequence of actions to follow in order to effect a result from a mechanical machine, a computer, laboratory apparatus or even certain problem types in mathematics and science. A test of knowledge will require that a learner reproduce or recall a set of information or actions with which he has been previously acquainted. The result does not depend on personal interpretation; there is only one answer, and it is that which the learner is required to commit to memory. AUSUBEL et al., (1978:24) refer to "reception learning" in which the entire content of what is to be learned is presented to the learner in final form. No independent discovery on the learner's part is necessary. AUSUBEL et al. further distinguish between meaningful reception learning (the task or material is comprehended by the learner as it is internalized) and rote reception learning (the learner attaches no meaning to the task or material as he internalizes it).

Memory training forms a prominent rôle in the development of the cognitive domain, which is that "storehouse" of knowledge and experience from which man draws his tools and basic strategies to deal with life's encounters. As a child progresses through school and approaches the senior-school phase as an adolescent, he becomes disenchanted and bored with the thought of ingesting volumes of facts and knowledge verified by other people. The adolescent, very likely, would rather experience the

excitement of learning by discovery, research and experimentation. He (the adolescent) is at a stage where he wishes to discover the freedom that his knowledge can facilitate. AUSUBEL et al., (1978:25) state that "... most classroom instruction is organized along the lines of reception learning". This statement would probably subdue any other reason for the high failure rate of first-year students at universities. In addition to retention learning, there must be a calculated shift to discovery learning, problem solving, research, analysis and creativity through the remaining two intellectual activities.

#### 3.5.2.1.2 Comprehension and Application

Learning material may be internalized in such a way that it is never recalled nor utilized for any further problem-solving or explanation purpose by the learner. The fact or definition is an independent entity to be recalled from memory as a verbatim statement whenever an examination or test requests it. This would be a most undesirable state of affairs in any learning situation and would be termed meaningless rote learning. Retention learning, as previously discussed, is a necessary foundation to any learning encounter, but it is manifested as meaningful retention learning only if the learner discovers principles and experiments independently, in order to be able to understand and use the knowledge meaningfully. The learner must test and illustrate his comprehension of the knowledge by applying it to solve problems. Examples of such retention-comprehension-application situations are:

- Learning theorems in mathematics and then applying them to solve related problems.

- Learning laws of motion or chemical principles in science and then using them to explain situations in the world surrounding us.
- Learning Mendeleev's Laws of Genetics and using them to predict the appearances of future generations of a plant or animal species.

Problem-solving should be used in the classroom to extend, clarify, integrate and evaluate the understanding of knowledge presented to the educand by the educator. It is a means of putting to the test, the knowledge itself and the degree of success the learner has achieved in internalizing that knowledge. AUSUBEL et al., (1978:25) refer to "guided discovery learning"; the pupil is guided by rules of application and methods of approach, as determined by the structure of the knowledge underlying the problem to be solved, to discover solutions to problems and relationships that exist amongst factors that previously appeared discrete.

#### 3.5.2.1.3 Insight

AUSUBEL et al., (1978:25) distinguish between "guided discovery learning" and "autonomous discovery learning". The former relies on an accepted method or set of rules to be adhered to in order to arrive at a solution to a problem; there is "a way of doing things" which the learner accepts has been tried and tested and possibly patented. The latter type of learning demands far more intellectual coaxing from the learner; he is required to extend his mental abilities when solving problems. The learner's creative abilities, experience, self-confidence, analytical abilities and intellectual bravado are evaluated as he is required to research, investigate, design, select, create, hypothesize, formulate or conclude. The learner is required to avail

himself of all knowledge, problem-solving experiences and life-situations that have contributed to his personal storehouse of experience or cognitive domain, in order to solve insight-type problems. He is also required to discover principles independently in order to be able to understand and use them meaningfully. He is guided by a framework of rules and regulations but the direction of intellectual production is prompted by his own creative and cognitive capabilities.

This type of intellectual activity contributes towards the formation of the self-concept of the child; it demands a certain courage of the learner to put his ideas into action, but once results are secured, the self-confidence concerning his own capabilities is escalated. As a child approaches the adolescent stage, the bravado to test his own hypotheses and to be heard in the adult-world, is an activity parallel with other adolescent factors of growth. The adolescent has flamboyant thoughts, untempered by caution, and it is possibly at this stage in his intellectual development that he himself, assisted by the education encounter, can realize, direct and nurture his creative talents.

#### **3.5.2.2 Synopsis**

The intellectual activities above are a classification of the levels of thought processes which should receive greater or lesser attention, according to the age and intellectual capabilities of the educand, when selecting learning material. Consideration of the types of intellectual activities when selecting learning content should assist the curriculumator with the

\* description of teaching and learning activities to ensure the execution of

- purposeful activities;
- \* choice and organization of learning material that has relevance for the learner's future;
  - \* choice of learning material that will adequately challenge the intellectual capabilities of all learners, thus providing a secure space for the actualization of learning opportunities;
  - \* choice of learning material that will expose the learner to modes of being human within the secure space of the education encounter;
  - \* choice of learning material that can relate the school to home and family situations;
  - \* choice of learning material that has relevance for the local or regional community activities and industries;
  - \* choice of learning material that will afford the adolescent learner the experience to feel secure to exercise his freedom of thought and action.

Accountability of anticipated intellectual activities is thus an important aspect which directs the selection of learning content. Another is "Course Differentiation" which is directed, to a considerable degree, by the type of intellectual activities demanded by the learning content. This will be discussed hereafter.

### **3.5.3 DIFFERENTIATION OF LEARNING CONTENT**

The pedagogic school structure prescribes that the child be provided with a secure space in which purposeful activities can be executed. It has been established in 2.4.4 that the child will feel secure if he is able to cope with the subject matter, while still

being challenged to confront the unknown. The learner must recognize that what he is learning has meaning; it must be a means to an end (adulthood) and not an end in itself (examinations). The adolescent is particularly career orientated and all school activities, that have a bearing on a career direction, are favourably accepted.

Course differentiation may be effected in three ways:

- \* by selecting and grouping content according to the use that it is anticipated the learners will make of the knowledge and skills provided by the course;
- \* by selecting and grouping of content according to the intellectual activities demanded, with emphasis shifting in the direction of insight-type activities for the more difficult course, and priority being awarded to practical applications and retention learning for the least difficult course; and
- \* by grouping content into modules of related knowledge, each module being complete and examinable in its own right. The number of modules selected by learners and the nature of the modules as determined by their content, will specify the character of the course, the level of difficulty and due skills acquired on completion of the course.

A course may be differentiated with any of the three descriptions above in mind, if the subject suggests a strong career attachment. For purposes of this study, differentiation will take the form of three courses, described as follows:

### **3.5.3.1 Grade-A Course**

Subject matter considered suitable for this course would be such that all three types of intellectual activities be inherent in its study. A large component of the course should demand from the learner, creative, investigative and analytical exercises, which could develop the type of intellectual nimbleness that is required of university students. The field of study should be as broad as possible, incorporating into the syllabuses as many topics, themes, exposures and viewpoints as would be necessary to motivate further study in the subject. Pupils who choose to follow this "Grade-A" course would preferably be those who intend to follow a career in the field of computers, or a related scientific field, which requires further study at a university or technikon.

### **3.5.3.2 Grade-B Course**

The grade-B course would include material requiring that learners' intellectual performances include retention learning, comprehension and application activities and discovery-learning. The difference between grade-A and grade-B courses would be, primarily, the degree of difficulty of tasks set for pupils. The volume of learning content should (or could) be reduced for a grade-B course, both still embracing as broad a field of study as possible to provide the learner with sufficient expertise to understand and appreciate the value and potential of computers in the world of business, commerce, industry, education and medicine. Greater emphasis on application-packages can be introduced in this course than what would be recommended for the A-grade course. Pupils who choose, or are selected, to follow

this course, are not necessarily potential tertiary students, but they should realize the need for computer skills and knowledge for their chosen embarkments after leaving school, be this tertiary study or career-building.

### **3.5.3.3            Grade-C Course**

Pupils who elect to follow this course of study at school would emerge from the education experience as a "package expert" rather than a "programming expert". The primary accent of this course would be on learning to operate packages that are used prolifically in the employment sector. Application packages, such as wordprocessors, spreadsheets, databases, debtors and creditors ledgers and desktop publishers, often have an implicit need for programming abilities, and therefore, pupils following this grade-C course should also be introduced to simple programming. Retention-learning and comprehension-application activities should be included in the syllabus content, the degree of difficulty and the volume thereof being considerably less demanding than that of a grade-A course. Pupils electing to follow this course would be those who desire to enter the employment field immediately on leaving school. This course should provide them with valuable skills and expertise to compete for employment, as well as an enhanced self-concept because of the individual successes achieved on actualizing the subject content designed specifically for their needs.

The considerations discussed, thus far, that affect the selection of learning content, have included intellectual activities and course differentiation, which necessitated a reference to the post-school activities of the adolescent school-leaver. Yet another consideration is that of the age of the learner.

### **3.5.4 THE AGE OF THE LEARNER**

As the child experiences changes in physical and intellectual capabilities, so does his growing sense of awareness for feelings of competence and ableness (or incompetence and unableness) become a more conscious part of his everyday life. As one of the foremost child-development researchers of this century, PIAGET has produced volumes of research and theory related to cognitive and intellectual growth in children. While administering intelligence tests to children he observed that the same wrong answers were given frequently by children of the same age. He also noted that children of different ages were giving a different set of common wrong answers (in: Hamachek, 1979:83). This led PIAGET to believe that perhaps it is not just that older children know more than younger children, but that the thought processes amongst different age groups are qualitatively different.

What follows is a description of how PIAGET related the intellectual functioning and cognitive development of the child to age-related eras called stages of development. Only those phases incorporating the adolescent era will be described in detail (Piaget in: Hamachek, 1979:150-163).

#### **3.5.4.1 Sensori-motor Period (Piaget's Stage 1)**

This stage extends from birth to approximately eighteen months of age. The child's interactions with his environment are governed by overt actions such as grasping, touching, reaching, sucking, seeing or hearing. A baby does not "think" but rather explores and discovers, and relates to objects by the actions he can perform on them.

It is especially important for the infant to handle as many objects as possible during this stage, as it is during this period that his achievements and learnings form the foundation for future cognitive development and growth.

Most of the child's learning during this phase is done within the secure space of the home, in the presence of his mother or another adult appointed to care for him. "Safe experiences" (those that do not hurt) are usually condoned and permitted by the adult-in-charge, but the "unsafe experiences" (those bringing displeasure) seem to occur momentarily when the child escapes the adult's attention. Even during this early phase of life, the security of the pedagogic relation establishes itself in the world of the child. The warmth, love, security and patience that should abound in the child's world during this period, will establish the set for all future pedagogic encounters.

#### **3.5.4.2 Preoperational Period (Piaget's Stage 2)**

During the Sensorimotor stage, the child neither verbalizes nor visually represents his experiences, as do adults when they link experiences with word symbols. The preoperational period (two to seven years approximately) is distinguished by the child's first attempts at symbolization. An overriding characteristic of the child's thought processes during this period, is what PIAGET calls "egocentrism". The child appears to be self-centred because his cognitive development is incomplete; he is not able to step outside his own point of view to see how others perceive a situation. The child behaves as if his way of experiencing, observing and behaving is the only one that exists. PIAGET'S research has shown that cognitive development

is really a process of losing this egocentricism. This means that seeing things from different perspectives and understanding the different possible views of the same situation, is indicative of a mature being.

The parent or teacher intervention during this preoperational stage will assist the child with the basics of social integration. The child must be exposed to as many situations as possible, involving not only his peers, but children from other age groups as well. Norms must be set for accepted behaviour and the child should understand the reason behind these "social limitations" as well as the content thereof.

Particularly from age four to age seven do children start to form relations between objects, based on intuition rather than reasoning. The child is involved in concrete learning experiences and therefore the more teaching aids that are used by parents and teachers during this period, the more relationships the child may form.

#### **3.5.4.3            The Concrete Operations Period (Piaget's Stage 3)**

This stage spans the ages from seven to twelve years. It is during this time that the child's external behaviour and perceptual schemes seem to get organized into logical, conceptual, internal systems. The child no longer has to perform a physical operation to understand it. He would be able to reason the relationship between the volumes of liquid that different shaped containers could hold (Principle of Conservation). This age group is also able to mentally reconstruct situations or observe them differently in order to understand them (Principle of Transformation).

#### **3.5.4.4 Abstract Thinking Period (Piaget's Stage 4)**

According to PIAGET, a child of twelve years begins the period of propositional or formal operations. This means that the child shifts away from the specific, concrete thinking of the pre-adolescent, to the more reasoning skills associated with adolescent problem-solving. From twelve to fifteen years of age, the young adolescent refines his thinking to the "possible" rather than the "here-and-now actual". It is during adolescence that the capacity for imagining and hypothesizing situations exists. This is followed by reasoning the consequences of such a situation. PIAGET confirms that the rate of this development is influenced heavily by each adolescent's specific social environment and history of experiences (cognitive domain). Evidence indicates that it is between the ages of twelve and fifteen that a youth develops and refines his capacity to think in terms of symbols. Concrete entities are able to be symbolically represented, enabling the learner to think at a level detached from concrete reality. The development of the ability to think in terms of abstractions or symbols is an essential condition for being able to hypothesize or theorize a solution to a problem as a logical, formal sequence of events.

#### **3.5.4.5 Synopsis**

An adolescent may, depending on the occasion or circumstances, think intuitively, concretely or formally. When questioned "What is sin?", an intuitive answer would be "It is something bad", while a concrete example would be "It is an action against the word of God; disobeying the Ten Commandments". The adolescent formal thinker may reply "Sin is relative to the circumstances prevailing. If a starving child

steals food, can that be a sin?" PIAGET'S tests over a period of forty years, on various groups of children, showed that the combined number of intuitive and concrete answers to questions given by eleven to thirteen year olds, was greater than or equal to the number of formal answers. However, the fourteen to eighteen year groups provided eleven times as many formal answers as they did intuitive and concrete responses.

What seems to happen, according to CASE and COLLINSON (in: Hamachek, 1979:161), is that from the ages seven to fifteen, there is a steady increase in the tendency to think formally rather than a sudden appearance of this higher level form of thinking. After fifteen, the level of thinking is primarily formal, but it develops in sophistication as the adolescent approaches adulthood. Formal thinking is a function, not only of innate intelligence, but of experience, social environment, ethnicity and previous learning.

From PIAGET'S experiments and ensuing theory, it is encouraging to know that it is an ontic characteristic of man to "think for himself", and not rely heavily on knowledge from the concrete or knowledge from the mouths of others. Learning content should be selected to free the formal thinking of the adolescent, rather than trap it within the concrete world of masses of facts which have to be committed to memory. Care must be taken when selecting content to cater for the intellectual level of thinking that the adolescent may be at, according to his age. PIAGET'S theory is an indication for the educator as to what type of answer to expect from a specific age group when evaluating answers to questions. Intellectual and cognitive development

is a blend of maturation and learning and varies from child to child.

A major implication for teachers is that children mature at different rates. Sometimes one adolescent may learn slower than another, not because the former is more stupid than the latter, but rather that he lacks the experiential background or because he has not yet reached the same level of formal thinking. Sensitivity to this situation can alleviate the stress that a pupil may feel when comparing his ability to that of his peers. The educator can recommend a plan of action that can encourage a child to exercise formal thinking. Many children feel more comfortable with the accepted facts of another and the dependable obvious of the concrete, but they must be encouraged to think for themselves and to put their ideas to test. Many teachers, too, feel more secure with a textbook of facts and, hence, encourage rote-learning, which minimizes any flexibility of thought amongst learners. Education needs to be revolutionized to follow the natural path of the child's intellectual development; from intuitive thought, through concrete thinking to the highly desired state of formal, abstract interaction. Vast volumes of knowledge in the form of facts is to be discouraged in favour of learning to reason, hypothesize, criticize, analyse and solve problems. If the appropriate learning material is introduced to the child at the right time on his way to adulthood, much of the agonizing, characteristic of schooldays can be transformed into feelings of achievement, success, belonging, security and acceptance, as the child attains the goals of adulthood through mastery of the learning content.

### **3.5.5 LEARNING CONTENT AND THE LIFE-WORLD OF THE ADOLESCENT**

The adolescent as being has been discussed in some depth in 2.2. From this, certain priorities in the world of the adolescent can be identified, successful actualization of which can motivate him to venture with certain confidence into the world of the adult. The syllabus, as a reflection of the lifeworld of the adolescent, was discussed in 2.5. From this discussion of the syllabus, it became apparent that curriculumators should have a fundamental knowledge of the needs of the adolescent, as well as the needs of society, in order to fulfil the expectations of both in their interrelatedness.

For the purposes of validating or justifying why certain topics are suggested for inclusion in a computer science syllabus, the following will be amongst the considerations:

- \* Does the content prepare the learner for an occupation?
- \* Does the content facilitate a social integration with his peers?
- \* Does the content facilitate an integration with members of the learner's family?
- \* Can the content relate to activities in society of a commercial, industrial or social nature?
- \* Does mastery of the content prescribe a disciplined and ordered approach by the learner, thus developing traits needed for social existence?

### **3.5.6 THE SHIFTING EMPHASIS ON TEACHING AND LEARNING AS PRESCRIBED BY THE LEARNING CONTENT**

In many classroom situations, the teacher is, unfortunately the principal performer, while the learners attempt to memorize as much of the content of the performance as possible. It is the writer's firm conviction that education for the scientific world and technological future should develop in learners the skills associated with thinking, solving problems and investigating, rather than retaining a superabundance of facts which have a habit of changing in an innovative world. When teaching activities dominate a lesson, learning tends to be associated with retention of facts, whereas creative behaviour is encouraged when learners are doing and teachers are advising.

When justifying the inclusion of specific themes and topics in a computer science syllabus, the extent of the rôle of the teacher, the computer and the learner will be addressed.

### **3.5.7 SUMMARY**

The aim of education is adulthood. The adolescent is striving for adulthood; he is on the threshold and there are preparations to be made and requirements to be met before he can cross that threshold. It is the obligation of the school to set the stage for the adolescent's attainment of adulthood. The learning content often takes on new meaning for the adolescent as he enters the senior secondary phase of schooling. He sees it, no longer as a means for promotion to the next standard, but rather as a means for embarking on the goals he has set for his future. The future of the adolescent as

a young adult is prompted by thoughts of a career, social relationships and acceptance, accelerated independence, both emotional and financial, and spiritual and cultural harmony in his life. If the learning content is selected, designed and presented, with the needs and aspirations of the adolescent as a primary influence in all curriculating activities, then the education event cannot be described only as "child centred" or "school centred" or "society centred", but rather "holistically centred".

### **3.6 CONCLUSION AND FURTHER PROGRAM**

Chapter Three has dealt primarily with the school curriculum, highlighting and emphasizing throughout, the rôle of the subject syllabus in the general curriculum. The phases in the planning of the macro school curriculum befit the planning of contents of the syllabus and whatever claims are made for a curriculum are applicable to claims made for a syllabus as set out in 1.4.8. Subject syllabuses are generally drawn up by subject experts, some of whom have served a period of time as teachers in the field of that subject. Often these syllabus designers have little or no knowledge of curriculating principles nor a knowledge of the fundamental essences of the educand in the education situation. This chapter has attempted to reveal the interrelatedness of the school, the subject content and the adolescent in the task of syllabus designing. Syllabus designing is not merely a task of selecting the most appropriate themes from a body of knowledge, but it is primarily a task of humanizing a syllabus so that it may become a means of self-actualization of the learner on his way to adulthood.

Chapter four is constituted by three themes. One theme reveals the actual content

selected for a computer science syllabus. Another theme exposes the existing situation in South Africa pertaining to the subject computer science in secondary schools. The situation was assessed from replies to questionnaires sent to several Departments of Education. The final theme is an announcement of the conclusions drawn from the replies of pupils to questionnaires and personal interviews concerning computer science education. The responses of the pupils will be related to the being of the adolescent as discussed in 2.2. The selection of content will be validated according to the criteria set in 3.5 and according to the essences of the pedagogic school structure as described in 2.4.

## **CHAPTER FOUR**

### **4.1 INTRODUCTION**

Chapter Two revealed the nature of the adolescent and the desired state of adulthood. Discussions included the nature of the school as a pedagogic system designed to facilitate the path of the adolescent to adulthood. The syllabus as a utility of the school, assisting with the task of preparing the adolescent for life-tasks, was also discussed in Chapter Two. The attempt at a fairly comprehensive description of the adolescent in relation to himself, adulthood, the school and the syllabus, necessitated a study of the curriculum, knowledge and learning content in Chapter Three. The curriculum was discussed in terms of the claims that aspects of society, school and man have on it. The cycle for planning and designing a curriculum was also presented in some detail. As this thesis aims to identify learning content suitable for a differentiated computer science syllabus, it was essential to discuss, in depth, the structure of knowledge and criteria for selecting learning content so that the requirements of the pedagogic school structure can be fulfilled as the adolescent masters the learning content within the school environment.

Chapter Four represents an investigation into the practical application of the theoretical knowledge presented in the previous two chapters. This transition from theoretical knowledge to practical application is essential if any knowledge is to be considered worthwhile (see 3.4.3.4). The actual content selected for computer science study will

be described and validated according to the theories presented in Chapters Two and Three. An entry into a totally pragmatic situation is established in this chapter, wherein computer science pupils' opinions and experiences are recorded and evaluated. It is anticipated that the outcome of this evaluation will further substantiate the claims made for computer science in the previous two chapters: that the subject has undeniable possibilities to assist the school with the actualization of its pedagogic aim of bringing the adolescent closer to the status of being adult. It now becomes necessary to determine the prevailing status of computer science in secondary schools in the country.

## **4.2 AN ASSESSMENT OF THE RECENT SITUATION PERTAINING TO COMPUTER STUDIES IN SOUTH AFRICA**

### **4.2.1 INTRODUCTION**

A questionnaire (Appendix A) was designed to ascertain the existing situation pertaining to the presentation of computer science and computer education in the four provinces of South Africa. Six Departments of Education were sent the questionnaire and five responses were received. The following Education Departments replied:

- \* Orange Free State;
- \* Cape;
- \* Transvaal;
- \* Education and Culture; and
- \* Education and Training.

It is not intended to draw a comparison amongst these different departments, but rather to present to the reader a focus of the *status quo* of computer science in schools and the emphasis attributed to it within the Departments. For this reason, the situation will be described without mention of the specific Departments' names. Each question has been evaluated using a simple counting procedure and the results are presented as numerical facts. Where appropriate, questions are succeeded by an interpretation of the numerical data. Some questions require personal opinions and comments. An attempt to distil the answers to these questions as a reflection of the adolescent has been made.

#### **4.2.2 EVALUATION OF THE RESPONSES : SECTION A**

##### **4.2.2.1 Questions 1, 2 and 3**

Three Departments offer computer science as a matriculation subject. Four Departments offer computer education and computer literacy courses (see 1.4.10). Two Departments have no official, centrally-situated structure controlling the development of computer science as a school subject. One Department has a centrally situated structure controlling computer literacy courses, while the remaining Department emphasises computer-aided instruction and learning, rather than computer science, and for this purpose there is a centrally situated body. Those Departments offering computer science as a matriculation subject have been functional for periods from nine to eighteen years.

#### **4.2.2.2 Questions 4 and 5**

Three Departments describe the functioning of the subject of computer science as established, successful and still growing. All three would like to see further differentiation in the course content and have the subject introduced as part of a six-subject curriculum. The option to take it as a seventh subject must be maintained, however. One Department states that the development of the subject is proceeding slowly and is targeted for high-achievers only, as a seventh subject. The subject is non-existent in the remaining Department.

#### **4.2.3 EVALUATION OF THE RESPONSES : SECTION B**

Only the Departments offering computer science as a matriculation subject completed section B.

##### **4.2.3.1 Questions 1, 2 and 3**

All three Departments claim less than 5% of the pupil population is involved with the subject. Most of these pupils are involved with the subject at a centrally situated venue, serving several schools in the area, after school hours. There is a concerted effort being made by two of the Departments to facilitate offering of the subject as part of the academic curriculum. There are schools at the moment which have computer science time-tabled as a choice subject from standard eight. The researcher has experienced that, because of cuts in state spending for education, computer science will no longer be offered as a seventh subject option in the region where she teaches after 1992. Schools that have qualified computer science teachers are encouraged to

include the subject on their time-tables. Pupils not having this option available may attend classes run by the local technical college, at a cost of approximately R300,00 per annum. These classes are held after normal school hours. It would appear that the costs of running computer science as a seventh subject have proved excessive in the light of the recent shrinking State budgets available for education. This situation has two consequences: either the parents pay more for an enhanced education for their children or schools will have to consider introducing the subject as part of the school curriculum. As parents will certainly be paying more for the basic education of their children with the compulsory introduction in February 1992 of "model-C" for all State-subsidized schools, it would seem reasonable to state that parents may insist on computer science being introduced under the umbrella of the basic school fee. An increased demand for computer science as a full-time, school subject may be what school principals will encounter as the nineties proceed.

#### **4.2.3.2 Questions 4, 5, 6, 7, 8**

Two Departments rely on a combination of the applicants' course average, mathematics average, language average and the results of an aptitude test, to admit pupils to the computer science course. One Department relies solely on the outcome of an aptitude test. The successful applicants pursue the course for three years from standard 8 to standard 10. Only one Department offers three hours per week tuition, while pupils from the other Departments receive two hours per week. The course is offered on higher and standard grade throughout. All Departments offer regular in-service training courses for those teachers involved with the subject.

The author's experience permits the comment that the differentiation between higher grade and standard grade courses is merely a matter of excluding one programming language from the standard grade syllabus and thereafter scaling down the evaluation standards. This practice tends to produce a weaker computer science pupil, instead of taking into account the human dignity of the less able pupil by providing him with a course that prepares him adequately for a potential career. Sound pedagogical planning should emphasize those aspects of computer science that pupils are expected to be able to master, taking into account what is anticipated to be of interest and of value to each group of learners according to their intellectual potential.

#### **4.2.3.3      Question 9**

This question required that an indication be made of what the present course contents are for standard 8, standard 9 and standard 10 in each Department. The variation in content was quite substantial. The Department that offers computer science classes for three hours per week for each standard, certainly covers more topics than the other two do. What is encouraging is the fact that only one Department does not include the use of application packages. Two Departments have hands-on experience with wordprocessors, data bases and spreadsheets as part of their syllabus. It must be mentioned, however, that these two Departments offer two programming languages, whereas the other Department offers tuition in three languages. Further encouragement is received with the realization that system designing is part of the syllabus in one Department. This Department forwarded the teacher's guide for computer science and this gave further information on how teachers should guide the

pupils in their progress with the project. Pupils are transposed into the world of the systems analyst with the challenge to design systems such as:

- \* airline/hotel booking systems;
- \* cricket scorer: including all analyses;
- \* the generation and printing of biorhythms;
- \* school administration systems.

This Department had paid considerable attention to the grading of projects according to pupils' abilities.

Boolean algebra is omitted entirely by one Department. This topic can be graded to suit the abilities of lower to higher grade pupils. At the higher grade it presents a sophisticated challenge to pupils' mathematical abilities. It is an important component of a computer science syllabus as it provides the foundation for understanding the electronic wonders of computers.

#### **4.2.3.4 Questions 10 and 11**

Two Departments feel that the growth and development of computer science is definitely limited, while the third indicates a slight limitation. A shortage of qualified teachers is blamed in two Departments while the third department lists the financial aspects as the only influential factor. Finances relating to hardware, software, teacher training and teachers' salaries are listed as contributory factors. Unfortunately, computer science does incorporate an expense factor: hardware, software, textbooks, maintenance of hardware, updating of software and teacher knowledge are costly

items. These costs cannot be borne solely by the State; parents and the business and industrial sectors of the community should acknowledge the importance of the subject of computer science, and thereafter accept partial responsibility for its implementation and maintenance.

#### **4.2.4 EVALUATION OF RESPONSES : SECTION 3**

##### **4.2.4.1 Questions 1 and 2**

One Department supplied Commodore-64 workstations to schools in 1984. These computers, effective as they are for learning purposes, are now considered outdated. Attempts are underway to change the format to IBM-compatible computers. Computer centres have recently been installed at central venues throughout the country at the expense of the State budget. This indicates a positive move, on behalf of the State, towards progress and development of computer studies. Many schools have financed their own computer installations, using donations from parents and funds obtained from fund-raising events. The private sector has also donated funds towards establishing computer centres at some schools. It would appear that there is a combined effort within communities to facilitate the use of computers in schools. This fact is most encouraging.

#### **4.2.5 SUMMARY**

The situation regarding computer science in state schools could be described as established and positive for a small percentage of pupils in certain sections of the community. The syllabuses need further differentiation and concerned parties need

to be convinced that the subject has all the potential to foster, amongst its participants, the aim of education: adulthood with the promise of a meaningful existence within the society.

Having established that computer science is a subject available to a small percentage of school children in South Africa, it is now relevant to discuss themes for a computer science syllabus which will motivate the introduction of the subject as being suitable for pupils of all intellectual abilities at a secondary school.

### **4.3     THE SELECTION OF CONTENT**

#### **4.3.1         INTRODUCTION AND AIMS OF THE SYLLABUS**

The presentation of themes for consideration for a school computer science syllabus is a task which could be fraught with uncertainty, as the science of computers changes as the masters of science and technology reveal new and updated ideas and inventions. Fortunately, most scientific subjects have a core-nature (substantive structure) that underlies the theory for and application of their use, and computer science is no exception. It is about this core nature that discussion of each theme will revolve. Each theme will be evaluated under several headings and these will be explained henceforth in 4.3.2. The ultimate decision pertaining to the selection of a theme will rest on the qualities inherent to the theme that fulfil the requirements of the pedagogic school structure as discussed in 2.4 and 3.5.

A syllabus is a document of content for learning and is always presented with a

selection of aims that presupposes the learning content. Some of the aims as set out for this study have their origin in BISHOP (1987:1) while others have been formulated by the author. The aims are categorized into two domains: the affective and the cognitive-psychomotor domains. The affective domain of the aims is concerned mainly with attitudes concerning computers and technology, while the cognitive-psychomotor domain of the aims is concerned with the acquisition of knowledge and skills.

#### **4.3.1.1 Affective Aims**

The aims of a computer science course at school would be to develop in the pupils:

- \* an appreciation of the place of the computer in industry, business and the individual lives of modern man;
- \* an appreciation of the impact that computer technology has had on the quality of modern-day life;
- \* an understanding of the rôle of the computer in man's quest for discovering the hitherto unknown secrets of the universe and nature;
- \* the realization that the computer is, and will continue to be, an integral part of the business, industry, education, communication and medicine, but that its efficiency ultimately relies on man;
- \* the ability to place computing in its proper perspective, both in terms of the wider implications of the use of computers, and from the point of view of the likely future of computing;
- \* an appreciation of the scientific and mathematical principles incumbent on

computer design and functioning;

- \* a relationship with the world of business and technology through computer applications and skills; and
- \* a relationship with peers and family through mutual utilization of the computer.

#### **4.3.1.2 Cognitive-Psychomotor Aims**

The pursuit of a computer science course should develop in the pupils:

- \* the ability to perceive structures in collections of data and to manipulate these data structures to provide useful information;
- \* logical thought processes that direct reasoning into refined procedures of thinking in steps in order to solve problems;
- \* adequate mathematical abilities that will enable an understanding of mathematical principles that underlie the science of a computer;
- \* an ability to write programs in high-level programming languages;
- \* a knowledge of the principles of, and the skills required to perform, information processing using currently available software;
- \* the concept of a system and the ability to use this concept in practical situations;
- \* the realization of the importance of clear, logical, step-wise thought procedures that must be utilized to gain maximum efficiency from a computer; and
- \* the ability to structure language concisely and clearly in order to communicate technical information.

With these aims of the syllabus now outlined, it is relevant to discuss the format for evaluating the themes for a computer science syllabus that will promote the realization

of these aims, as well as validating computer science as a pedagogically accountable subject that facilitates the adolescent's path to adulthood within the pedagogic school structure.

#### **4.3.2 THE FORMAT FOR EVALUATING THE SELECTED CONTENT**

The themes to be discussed henceforth do not exhaust all possibilities for a computer science curriculum. They have been chosen for one or more of the following reasons:

- \* the theme appears in either A-level syllabuses or GSCE syllabuses of the United Kingdom;
- \* the theme is at present a component of the syllabus of at least one of the Education Departments of the Republic of South Africa;
- \* the theme provides the groundwork for components of computer syllabuses of universities or technikons in South Africa; and
- \* the theme is commonly offered at present at computer-training colleges or academies to further career opportunities.

Each theme or topic will be discussed under specific headings with the aim of providing the reader with the following information:

##### **4.3.2.1 Topic Description**

A brief description of the contents of the topic will be presented to orientate the reader with the nature of the knowledge (theoretical, practical, mathematical, problem-solving, self-investigation) of the theme.

#### **4.3.2.2 Group**

This will suggest the school standard or age group for which the theme is regarded suitable.

#### **4.3.2.3 The Progressive Structure of the Topic**

The progressive structure of the topic will be presented as being of:

- \* Linear Structure: The entire topic is dealt with in one standard.
- \* Concentric Structure: The entire scope of the content is introduced in the initial stages of the course and thereafter only the degree of difficulty of dealing with the content differs from standard to standard or from group to group.
- \* Cyclic Structure: The topic's level of difficulty and scope (content) increases as the class standard increases.

#### **4.3.2.4 Grade**

The grade for which the topic is suitable: grade A, B or C (see 3.5.3) will be suggested.

#### **4.3.2.5 Pedagogic Implications of the Topic**

An attempt will be made to establish if the themes suggested for inclusion in a school computer science curriculum, can be confronted by educator and educand, to complete an education situation that fulfils the requirements of the pedagogic school structure, to facilitate the educand's attainment of adulthood in the decade of the technological nineties. In order to achieve this, the characteristics of the pedagogic school structure,

as discussed in 2.4 and 3.5, will be recalled as each topic is considered for inclusion as suitable syllabus content for a secondary school adolescent. In order to select content, or to validate the selection of content, the author has reflected on questions, relating to the requirements of the pedagogic school structure, which would indicate if the proposed theme would, ultimately, assist the adolescent on his way to adulthood and facilitate a harmonious integration with family, peers and society. The questions are concerned with:

#### 4.3.2.5.1 Execution of Purposeful Activities

- \* What type of learning activity does the topic facilitate: memorization, comprehension/application, insight? (What cognitive exercises are inherent to the topic?)
- \* Is there a practical component? (Does the topic foster psychomotor development?)
- \* What is the rôle of the teacher?
- \* Does the topic promote pupil initiative, creativity and decision making? (Is the ability to think independently [affective development] fostered by the topic?)

#### 4.3.2.5.2 Organized and Systematic Exercise on the Future

- \* Does the theme promote, in the learner, the development of logical thought processes that will assist the adult-in-making to confront and solve problems in Life?
- \* Would the theme be of assistance in a future career or tertiary study course?

#### 4.3.2.5.3 Creating a Space in which Learning Opportunities can be Realized

- \* What hardware (computers and peripherals) and software (packages), if any, are necessary?
- \* Does the topic facilitate pupils of varying academic abilities working side by side at different paces?
- \* Does the topic foster the creation of a learner's own personal space?

#### 4.3.2.5.4 Exercising Meaningful Modes of Being Human in Secured Togetherness

- \* Is the content able to expose avenues of social contact between the learner and his peer group?
- \* Does the content hold any prospects for personal use or of financial rewards for the learner?
- \* Is there an inherent ability within the course content to enhance the learner's feelings of usefulness within his immediate or distant social community?
- \* Does the subject content have the ability to evoke a range of emotions within the learner?
- \* Is there opportunity for classmates to exchange ideas and benefit from team-work experiences while mastering the content?

#### 4.3.2.5.5 Mutual Interest Between School and Home

- \* Does the content have the potential to be used within the home environment?

- \* Does the content have business or industrial applications which could be shared between learner and employed parents?

#### 4.3.2.5.6 Opportunities for Exercising Acquired Freedom

- \* Does the content equip the learner with sufficient knowledge to enable him to venture sporadically into the world of the employment sector to test his knowledge?
- \* Is there an inherent potential for the learner to test his own solutions to problems posed by the teacher?
- \* Can the opportunity arise for the educand to present his own ideas as a challenge to those of the educator?

Only if a question highlights the influence that the particular theme will have on the learner's route to adulthood via the structure of the school, will that question be referred to.

#### 4.3.2.6 Summary

The ultimate area of discussion of the theme will include a summary of those characteristics of the pedagogic school structure enhanced by the contents and structure of the theme.

### **4.3.3 THE THEMES SELECTED**

#### **4.3.3.1 Problem-solving Techniques**

##### **4.3.3.1.1 Description**

Pupils would be introduced to the subject by analysing and designing a data processing system (rail or air transport, library, school, business, banking) which would benefit from computerization using algorithms and flow charts to plan the path to solving a problem. The use of data-items, records, files and systems to communicate information amongst people and institutions would be included in the presentation. This section is intended to be purely theoretical; an introduction to the problem solving and investigative nature of computer studies.

##### **4.3.3.1.2 Groups**

Standard seven primarily, but could be repeated in standard 8.

##### **4.3.3.1.3 Structure**

Linear, although the theory studied in this section develops into practical work with programming applications.

##### **4.3.3.1.4 Grades**

A, B and C.

#### 4.3.3.1.5 Pedagogic Implications

Exercises in problem-solving techniques would involve a minimum of rote learning, accompanied by comprehension and application and possibly investigative research. The rôle of the teacher would be that of informer, discussion leader and evaluator. Independent, logical and creative thinking on the part of the pupils is required. Pupils would be required to investigate an institution outside of their school environment, thus obtaining a glimpse of the commercial and business worlds. No computer hardware is needed. No differentiation according to pupil abilities is required. Projects may be set for pupils to work together in groups. A pupil may study a parent's place of employment if it utilizes a computerized data processing system.

#### 4.3.3.1.6 Summary

This topic meets the requirements of the pedagogic school structure in respect of the following:

- \* purposeful activities are executed;
- \* there is an organized exercise on the future;
- \* the learner can create his own space in which learning can occur;
- \* learners may work together in a secure space; and
- \* there could be a mutual interest between school work and home.

### **4.3.3.2 The History and Social Implications of the Computer Industry**

#### **4.3.3.2.1 Description**

The historical development of the computer, from the first counting machine to the fifth generation computer is to be studied. The theme should facilitate an understanding of the social and economic effects of the use of computerized systems on individuals, organizations and society.

#### **4.3.3.2.2 Groups**

Standard seven only.

#### **4.3.3.2.3 Structure**

Linear - completed in standard seven.

#### **4.3.3.2.4 Grades**

A, B and C.

#### **4.3.3.2.5 Pedagogic Implications**

The cognitive exercise could be predominantly rote learning with understanding, unless this topic is dealt with by means of investigative research by the pupils. Careers in the computer field, as well as in associated industries, are highlighted and can be investigated individually or as a team.

#### 4.3.3.2.6 Summary

This theme fulfils the requirements of the pedagogic school structure in respect of the following:

- \* purposeful activities are executed;
- \* there are possibilities for experiences of being human in secured togetherness;  
and
- \* there is an organized exercise on the future.

#### 4.3.3.3 Computer Architecture

##### 4.3.3.3.1 Description

Candidates should demonstrate a knowledge and understanding of the functions of the main hardware and software components of a computer system and their relationships with the representation of stored data and programs. This theme would include the study of operating systems, translation programs (assemblers, compilers and interpreters) and modes of computer operation. Communication links for LANs (low-area networks) and WANs (wide-area networks) and their incumbent technologies may be included.

##### 4.3.3.3.2 Groups

All groups included in the secondary-school curriculum.

#### 4.3.3.3.3 Structure

Cyclic.

#### 4.3.3.3.4 Grades

This topic is suitable for all grades, A, B and C, with consideration being given to the fact that the study of the technological data underlying LANs and WANs may not be necessary for grade C.

#### 4.3.3.3.5 Pedagogic Implications

The level of difficulty and the extent of the contents of this topic would prescribe the types of learning activities necessary for mastery of the contents. Rote-learning, facilitating successful implementation of comprehension-application learning, would certainly be characteristic of pupil activities, while insight learning could form part of investigation research projects. The knowledge and understanding secured by learners who are appropriately informed and successfully guided towards mastery of this topic, should facilitate the making of informed choices of hardware, software and communication technologies relevant to different applications in home, local, national and international networks. Pupils should gain insight into associated satellite industries of the computer world. There is broad scope within the topic for differentiation according to the cognitive abilities of pupils and the varying vocational emphasis. There is potential for learners to visit local institutions and research the uses and networking of hardware and system software.

#### 4.3.3.3.6 Summary

This theme fulfils the requirements of the pedagogic school structure in respect of the following:

- \* purposeful activities are executed;
- \* there is an organized and systematic exercise on the future;
- \* a space is created (perhaps outside the classroom) in which learning opportunities can be realized;
- \* there could be mutual interest in the topic between learner and parents; and
- \* there are opportunities for the learner to exercise his acquired freedom .

#### 4.3.3.4 Internal Representation and Manipulation of Data

##### 4.3.3.4.1 Description

This theme includes the study of bits, bytes, words and various number systems including, definitely, the binary number system. Basic operations of  $+$ ,  $-$ ,  $\times$  and  $\div$  within each number system, as well as conversions from one number system to another, would be included in the theme. Internal representation of numerical data in binary form in a location of given size, together with a comprehension of the methods utilized to perform arithmetic operations on this data are suggested for inclusion. A study of registers, buses, processors and access speeds are relevant for this section.

#### 4.3.3.4.2           Groups

All levels of secondary-school study.

#### 4.3.3.4.3.           Structure

Cyclic.

#### 4.3.3.4.4           Grades

The entire contents would be relevant for groups A and B, but the degree of difficulty of problem-solving would differ. Group C would benefit from only a basic understanding of data representation in binary form.

#### 4.3.3.4.5           Pedagogic Implications

Learning activities include rote, comprehension-application and insight activities, with the emphasis being on comprehension-application. The teacher's rôle is dominant during explanations of the correct methods utilized by various computer configurations for data representation, but thereafter the pupils' disciplined approach to application of the rules and memory recall, will consolidate successful solutions to problems. There is much "computer jargon" associated with the computer field, and a study of this content theme will enable learners to interpret much of that jargon. There is the facility within the content to differentiate according to cognitive abilities of pupils. Learners would master a body of knowledge, not commonly possessed by the most enthusiastic computer-user and, for this reason, they may be able to assume an informative position within their families and social environments.

#### 4.3.3.4.6 Summary

This theme fulfils the requirements of the pedagogic school structure because:

- \* purposeful activities are executed;
- \* there is an organized and systematic exercise on the future;
- \* learning opportunities can be created according to the pupils' interests and abilities;
- \* there is the opportunity to exercise meaningful modes of being human in secured togetherness; and
- \* there could be a mutual interest between school and home.

#### 4.3.3.5 Machine Code and Assembly Language

##### 4.3.3.5.1 Description

A study of mnemonics, representing one or more machine code instruction, and a study of assemblers that convert mnemonics into machine code, is included in this theme. The theme would also include investigation into status registers, stacks, assembly instructions, bit-orientation, loaders, arithmetic and logical instructions. A study of this theme would permit the learner into areas of data processing seldom ventured by computer users.

##### 4.3.3.5.2 Groups

Standard nine or ten only.

#### 4.3.3.5.3 Structure

Linear

#### 4.3.3.5.4 Grades

This section of work would be appropriate for the A-grade. It certainly would not have any relevance for the C-grade syllabus, but it could be included as an enrichment or optional topic for the B-grade.

#### 4.3.3.5.5 Pedagogic Implications

The learning activities would appear to be mainly comprehension and application. Teaching activities would be intense during the initial stages of the course, but thereafter individual pupil-application would predominate. The contents of the course would be of use to the learner in a career involving computer system-analyst work. The theme offers the educator the opportunity to differentiate according to pupils' varying abilities within a class group. Machine-code "dumps" (lengthy binary literature conveying error messages) could be obtained from local businesses or industries working on macro computer installations, and in this way the classroom work can be linked to the employment and production sectors. Decoding and encoding language has an innate excitement for a school-going human being, and the opportunity to master the associated mystery of machine-code "dumps" would be substantially motivating to the learner. He can, indeed, feel informed and secure about information that most people would fear to venture near.

#### 4.3.3.5.6 Summary

This theme fulfils the requirements of the pedagogic school structure because:

- \* purposeful activities are executed;
- \* there is an organized and systematic exercise on the future;
- \* a space, incorporating the local businesses and industries, can be created where learning opportunities can be realized;
- \* meaningful modes of being human in secured togetherness can be executed; and
- \* there are opportunities for the adolescent to exercise his acquired freedom.

#### 4.3.3.6 Electronic Logic

##### 4.3.3.6.1 Description

Modern digital computers are constructed of many integrated circuits (ICs). This topic would involve an investigation into the structure of microchips on the ICs and how electronic logic and binary logic combine to carry out the multitude of complicated functions of a computer. Included in the study would be logical gates, decoders and encoders, adders, flip-flop circuits, shift registers and binary counters. Boolean algebra, truth tables, combinatorial circuits, Karnaugh maps and networks would provide the theme with a mathematical-digital nature.

##### 4.3.3.6.2 Groups

Standards 8, 9, 10.

#### 4.3.3.6.3 Structure

Cyclic.

#### 4.3.3.6.4 Grades

The topic Electronic Logic is extensive and has possibilities for grades A, B and C. Grade C, however, may limit the study of the structure of the microchip and ICs to a theoretical study. The mathematically orientated sections would assume a basic orientation if included in the grade-C course.

#### 4.3.3.6.5 Pedagogic Implications

Pupil-learning would include rote learning, comprehension-application and insight activities. The topic provides a broad platform for a variety of activities from both educator and educand. There is also potential for content differentiation according to pupil abilities and course emphasis. The topic offers the opportunity for pupil initiative, decision making and the development of logical thought processes. Rules need to be learned and applied consistently in order to succeed at solving problems. A study of the micro-chip as the epitome of modern technology, could develop a sense of wonder in the learner for the achievements of modern science. There is a certain sense of fun and competitiveness attached to the problem-solving activities.

#### 4.3.3.6.6. Summary

The study of Electronic Logic fulfils the requirements of the pedagogic school structure in respect of the following:

- \* purposeful activities are executed;
- \* a space can be created for the realization of learning opportunities for all pupils;  
and
- \* there are opportunities for exercising meaningful modes of being human in secured togetherness.

#### **4.3.3.7          Programming**

##### **4.3.3.7.1          Description**

Candidates will be expected to write programs in one (or more than one) high-level language using techniques for a user-friendly computer interface (ref. 4.3.3.11).

Included in the course of study should be control structures, documentation, subroutines, character-handling, searching, sorting, file-handling, formatting of input and output, arrays, calculating, validating, inserting, extracting and deleting of data, information, records or files.

##### **4.3.3.7.2          Groups**

Standards 7 to 10.

##### **4.3.3.7.3          Structure**

Cyclic.

##### **4.3.3.7.4          Grades**

Grades A, B and C will benefit from a course in programming although the content

and the degree of difficulty should vary considerably amongst the courses.

#### 4.3.3.7.5 Pedagogic Implications

There are teachers and pupils who find programming the most challenging and exciting of the entire computer science syllabus.

The type of learning includes comprehension, application and insight accompanied by an ongoing, "hands-on" practical component using the computer. The rôle of the teacher is predominantly that of "advice giver - if or when needed". The program compilers have "help files" and error messages which further minimize the rôle of the teacher. Although the final output of a pupil's program may be "perfect", this does not mean that all intermediate steps are also perfect; the teacher must evaluate the programming techniques used by the pupil. Programming demands logical, organized and structured thought patterns, but it simultaneously allows for extensive, pupil initiative and creativity. There is an insatiable demand for programmers in all computerized employment environments. The range of expertise varies from writing sophisticated programs to computerize a department, to writing simple segments to access data from a database in a specific way.

Every pupil in the class needs to have sole access to a computer and free access to appropriate software. Pupils may work at their individual pace and degrees of difficulty may be introduced to suit the range of pupil-abilities within one class. Pupils may exchange ideas and assist each other as programs develop. Error messages provide challenges to "debug" as fast as possible and mixed emotions of

amusement, frustration and success are simultaneously released with the output. Competent programmers can market their expertise to small businesses, sporting clubs and hobby clubs. Programs can also be written for family members for academic purposes, purchases and household bookkeeping. It is not unheard of for pupils to offer more sophisticated, more efficient or more ingenious solutions to problems than what the teacher may suggest.

#### 4.3.3.7.6 Summary

Programming fulfils all the requirements of the pedagogic school structure, by facilitating:

- \* the execution of purposeful activities;
- \* organized and systematic exercises on the future;
- \* the creation of a space in which learning opportunities can be realized;
- \* the exercising of meaningful modes of being human in secured togetherness;
- \* mutual interest between school and home; and
- \* opportunities for exercising acquired freedom.

#### 4.3.3.8 The Range and Scope of Computer Applications

##### 4.3.3.8.1 Description

This theme requires two approaches:

- \* A theoretical study of the wide range and scope of computer applications that enhance the quality of life and man's understanding thereof.
- \* A practical study of more than one application that may enhance the learner's

opportunities to improve his own quality of life.

The theoretical study would include an understanding of:

- \* Commercial data processing packages such as stock control, debtors-creditors ledger, airline bookings, education administration and payrolls.
- \* Technical, mathematical and scientific applications such as medical diagnostic aids, computer aided designing, aircraft simulators and engineering calculations.
- \* Communication and information systems such as Teledata, Beltel, databases, networks, wordprocessing, electronic mail, spreadsheets and desktop publishing.
- \* Process control using analogue computers in the form of robots in industrial and domestic procedures.
- \* Education Applications for tuition and evaluation purposes.
- \* Leisure Applications such as computicket, home computers and computer games.

The practical component of this theme would involve the learner in:

- \* an organized and systematic approach to data capture and data manipulation using a database package and a spreadsheet;
- \* the presentation of communication documents using a wordprocessor and desktop publisher;
- \* the execution of business bookkeeping routines using appropriate commercial packages; and
- \* the creation of graphic output using an appropriate package.

#### 4.3.3.8.2 Groups

All syllabuses for secondary school computer science courses may include the use of application packages to a greater or lesser degree. It is, therefore, suitable for all standards.

#### 4.3.3.8.3 Structure

Cyclic.

#### 4.3.3.8.4 Grades

The greater part of the Grade C syllabus would include the theory and practice of mastering application packages. Grade A pupils would be required to have a "working knowledge" of this theme, while grade B pupils would have a more pronounced emphasis on the practical component than grade A pupils.

#### 4.3.3.8.5 Pedagogic Implications

The use of computer application packages transfers the learner from the computer science field of study to the field of the computer operating. There is no rote learning as such, but rather familiarization with a system through repetitive application. Creative thinking and initiative is exposed in the utilization of facilities to organize files, maximize package opportunities and produce readable, informative output. The learning is not confined only to the utilization of the package but also to the field for which the package is being used. The use of the wordprocessor, for example, enhances communication skills, language skills, typing skills and spelling. Critical

report writing and keeping pace with current affairs is encouraged with the use of a desktop publishing package. Business and commercial knowledge is acquired while using bookkeeping packages.

The rôle of the teacher is similar to that of a swimming coach; he explains the correct technique and corrects faults, but the application is solely confined to the learner. Perfection and style depends on motivation, application and repetition.

Proficiency in the use of application packages offers the learner an opportunity for employment on leaving school. The practical applications chosen are those which are offered, at very high costs, at the computer academies that train adults for employment in the computer field.

One computer per learner in the class is required, together with printing facilities and appropriate software. This would involve a considerable expense for each school. The contents of the course is suitable for pupils of all grades, who may work at their own pace on projects of varying difficulty. Classmates may learn from each other and team work is facilitated by the desktop publishing package. Competition prevails amongst pupils to create something different from the rest of the class.

The application packages mentioned may be used by learners to organize and record hobby collections, write letters, present assignments, organize clubs and societies and "keep the books" of any fund raising occasion. Learner's may also offer their services to any private enterprise in order to earn pocket money.

Typing skills are necessary for this course. The author has experienced that pupils

become extremely adept at two-finger typing. It is recommended, however, that either the typing teacher be summonsed to offer an initial course to learners or that the readily-available computer programs be utilized to develop or introduce typing skills.

#### 4.3.3.8.6 Summary

The teaching and learning situation associated with the use of application packages fulfils all the requirements of the Pedagogic School Structure in that:.

- \* purposeful activities are executed;
- \* there are organized and systematic exercises on the future;
- \* a space can be created in which learning opportunities can be realized;
- \* meaningful modes of being human in secured togetherness can be exercised;
- \* there is a mutual interest between school and home; and
- \* there are opportunities for exercising acquired freedom.

#### 4.3.3.9 Projects

##### 4.3.3.9.1 Description

The aim of project-work is to contribute towards developing in the pupil an ability to:

- \* analyse and design the computer solution to a practical problem;
- \* implement and test the solution;
- \* provide a user-friendly interface between the user and the computation; and
- \* provide a documented presentation of the problem, the path to the solution and the solution.

The project should consist of the solution to a problem either identified by the pupil or suggested by the teacher. The solution may be arrived at by utilization of software either designed by the pupil or which had been obtained from an acknowledged source, such as an application package. It may also be a combination of both. Where the learner chooses to produce his own software, this may consist of one well-documented program or a suite of programs. Where the learner uses pre-written software, its exact nature must be clearly identified.

The project should be pursued over an extended period, during which each stage should be assessed by the teacher before the next stage commences. Documentation should provide the evaluator with information on the analysis and design of the problem and the solution. A user's guide should be adequately documented to enable a computer-illiterate user to run the system successfully. Pupils should be encouraged to enter their projects in the "EXPO for Young Scientists" held every year throughout South Africa.

Pupils should be guided towards problems that are sufficiently intellectually demanding to allow them to demonstrate the level of problem solving of which they are capable, their creativity, reasoning and judgement. The problems should draw the pupils into fields beyond those usually encountered in school subjects, which could be relevant to the pupil in the world beyond the school environment.

#### 4.3.3.9.2            Groups

The project is suggested for standard 9, but it may be considered for standard 10.

Grade C may complete a project in standard 9 and another in standard 10.

#### 4.3.3.9.3 Structure

Linear for grades A and B, but possibly concentric for Grade C.

#### 4.3.3.9.4 Grades

All grades must be exposed to at least one project, but more than one is suggested for Grade C. The level of difficulty and demands of the project(s) will differ amongst grades.

#### 4.3.3.9.5 Pedagogic Implementations

There is no rote learning during project activities. Comprehension, application and insight would describe the major cognitive exercises guiding the execution of a project. Teachers should guide pupils towards sufficiently motivating projects and thereafter assume the rôle of consultant and evaluator. Project work provides the educator and educand with the opportunity to break away from the traditional school education situation and move towards the tertiary situation, where educator guides educand in a research-investigation situation.

Projects should be recommended that imply creativity, problem solving, serviceability and possibly even profitability. Such projects can create feelings in the learner of achieving an intellectual, creative and utilitarian niveaux.

It may be necessary for the teacher to vary the nature and detail of the advice given

to pupils before the commencement of and during the progress of the project. This is one way of achieving differentiation during coursework. Whilst learners of modest ability may well be able to handle the separate stages in appropriate problems, the development of a complete computerized system enables high achievers to demonstrate their overall mastery of the problem. Pupils can be encouraged to do coursework on a "real" situation, by visiting local businesses and industries and offering to identify potential situations that could benefit from "computerization". Parents' employment venues could also serve as a venue for coursework. This theme offers exciting possibilities for home-school-society liaisons.

#### 4.3.3.9.6 Summary

This theme satisfies all the requirements of the Pedagogic School Structure in that:

- \* purposeful activities are executed;
- \* there are organized and systematic exercises on the future;
- \* a space can be created in which learning opportunities can be realized;
- \* meaningful modes of being human in secured togetherness can be exercised;
- \* there is a mutual interest between school and home; and
- \* there are opportunities for exercising acquired freedom.

#### 4.3.3.10 Operating Systems

##### 4.3.3.10.1 Description

The study of operating systems would commence at the first "hands-on" practical

session in standard seven and thereafter develop in content as the subject demands it. The operating system may be compared to the timetable of a school; without its organization, function and control is impossible. The nature, objectives, functions, desirable features and structure of a typical operating system should be studied. Case studies of two systems, such as MSDOS and UNIX, could be undertaken by all grades, but pupils should become proficient in the use of only one system. Pupils would be expected to effectively utilize all the facilities of an operating system throughout their practical work.

#### 4.3.3.10.2        Groups

Standards 7, 8, 9, 10.

#### 4.3.3.10.3        Structure

Cyclic.

#### 4.3.3.10.4        Grades

This theme is essential for all grades.

#### 4.3.3.10.5        Pedagogic Implications

A certain amount of rote learning is required when studying the nature and functioning of a typical operating system, however this retention becomes a living experience when the learner starts to use the operating system to organize and mobilize files on the computer. The enigma that often surrounds a computer arises from an inability

to utilize and manipulate the operating system. Associated with mastery of the operating system is mastery of the computer, as the user learns to decode the job-control language. This theme does not offer any differentiation according to ability, as all computer users should gain full control of the operating system. The teacher's rôle would be to explain the many function codes of the system, as the necessity arises, and thereafter the learners should be able to utilize the functions effectively. No computer operates without an operating system and for this reason this theme is the common denominator of all computer users. Pupils will, therefore, be "linking" to computer users in all spheres of employment, society and leisure.

#### 4.3.3.10.6 Summary

This theme fulfils the requirements of the Pedagogic School Structure in that:

- \* purposeful activities are executed;
- \* there is an organized and systematic exercise on the future;
- \* there is a mutual interest between school and home; and
- \* the theme provides opportunities for exercising acquired freedom.

#### 4.3.3.11 Interfacing

##### 4.3.3.11.1 Description

An interface is a device, usually hardware, that enables two pieces of equipment, that would otherwise be incompatible, to communicate with each other. Interfaces can range from very inexpensive pieces of hardware connecting a simple printer to a microcomputer, to fully fledged computer systems organizing communication between

two non-compatible devices in a network.

The theme would include:

- \* serial and parallel transmission and access of data;
- \* synchronous and asynchronous transmission of data;
- \* multiplexors;
- \* the concepts of handshaking, buffers, spoolers and interrupts;
- \* tri-state buffers; and
- \* digital and analogue signals.

#### 4.3.3.11.2          Grades

This theme is recommended for standard 9 and standard 10.

#### 4.3.3.11.3          Structure

Linear.

#### 4.3.3.11.4          Grades

A, B and C.

#### 4.3.3.11.5          Pedagogic Implications

This theme would intrigue those pupils who would like to know how "the inside" of the computer works. Rote learning is essential as several defining descriptions have to be learned. However, the theme holds possibilities for comprehension, application and insight activities depending on the depth of study offered to each grade. The

content draws on technology and science and also contains input from electronics. There is opportunity for differentiation of syllabus content amongst the three grades with C-grade, for example, understanding the difference between analogue and digital computers while A-graders could be expected to carry out calculations involving digital to analogue (D to A) and A to D converters. Exciting studies can be conducted involving the use of analogue computers in traffic control, weather forecasting and industrial processes. The learner will understand the working relationship between micro-technology and the macro world; a realm of knowledge possessed only by the technological elite! Pupils may visit appropriate installations to witness their knowledge being applied.

The rôle of the teacher is demanding, but with an in-depth study of the theme, the pupils' creativity and problem-solving abilities can be distilled. To ensure rote learning with understanding, projects can be set requiring that pupils investigate and report on an interfaced system in the local community.

#### 4.3.3.11.6 Summary

This theme satisfies the requirements of the Pedagogic School Structure in that:

- \* purposeful activities are executed;
- \* there is an organized and systematic exercise on the future;
- \* a space can be created in which learning opportunities can be realized;
- \* there is opportunity for mutual interaction between school and home; and
- \* there are opportunities for exercising acquired freedom.

#### **4.3.4 SUMMARY**

The subject content presented here does not exhaust topics from the field of computer science, suitable for learning experiences of secondary school adolescents, but it does illustrate the value of computer science as a subject rich in affective, cognitive and psychomotor experiences that can enhance feelings of worth in the learner as he sees, reflected in the content, relationships with the world, his peers and his family. The exposition of this content has accentuated mastery of the field of computer education as a task designated for an education situation and therefore, cannot be delegated to the computer academies of business districts. Computer science can be graded and differentiated to challenge and alert the most sophisticated intellects while simultaneously motivating the perfection of the physical skills of computer operating. It is a field of study that permeates the personal life of the adolescent, his home, the school, the community in which he lives and the wider network of national and international communications. To substantiate this statement, the pupils' questionnaires will now be evaluated.

#### **4.4 EVALUATION OF PUPILS' QUESTIONNAIRES**

##### **4.4.1 THE QUESTIONNAIRE AND THE SAMPLE**

One questionnaire was compiled and issued to the pupils of three different computer science classes over a period of two years. Two standard 10 groups and one standard 9 group constituted the sample. Each group completed the questionnaire at a different stage of their studies: the beginning of standard 9, the beginning of standard 10 and

the end of standard 10. All pupils who completed the questionnaire were studying computer science as a seventh subject and attended one two-hour class every week, after school hours at a central venue on the East Rand as appointed by the Transvaal Education Department. All groups were under the tuition of the author. The pupils were given the option of remaining anonymous. A total of thirty-one questionnaires out of a possible forty, were returned by the pupils.

The sample of students reflects academic performances that are considerably above average; eight pupils obtaining in excess of four distinctions in their matriculation examinations. There are, however, pupils who are average achievers who pursued the subject in recognition of the need to be computer literate. Admission to the course in standard 8 does generally address the participating group as an "academic elite".

The author wrote programs to evaluate the questionnaires. The task of inputting the programs, debugging them and printing the output, was handed to a pupil who had recently completed standard 10. This pupil altered the programs as he felt necessary to effect an efficient output. The programs, written in PASCAL, are included in the addendum as Appendix C.

A copy of the questionnaire is included in the addendum as Appendix B. Each question and the implications of the pupils' responses, will now be discussed.

## **4.4.2 ANALYSIS OF THE QUESTIONS AND THE RESPONSES**

### **4.4.2.1 Question 1**

This question determined the standard that was completed when the last year-end examination was written. Eighteen pupils had completed standard 8, six had completed standard 9 while the remaining seven had already sat for their final matriculation examination.

### **4.4.2.2 Question 2**

#### **4.4.2.2.1 Nature of the Question**

The question was formulated to determine the reason(s) why computer science was being taken as a seventh subject. Nine possibilities were given and pupils could select any number of the nine responses, but they had to indicate the order of importance of each reason.

#### **4.4.2.2.2 The Results and the Interpretation thereof**

The output of the program that evaluated this question is as follows:

The control scores for QUESTION 2 are:

<u>OPTION</u>	<u>SCORE</u>
Need for Computer Literacy	176
7-Subject Status	135
Enjoy Computer Work	120
Need Literacy for Career	110
Facilitate University Entrance	93
Follow Computer Career	90
Privilege	61
Parents Desire it	42
Enjoy/Social Classes	30

The pupils have identified the need to be computer literate as the main reason for pursuing the three-year course. The fact that a "seven-subject matric has extra status" rates high on the reason listing, is a reflection of the group who completed the questionnaire; these pupils are high achievers who are striving for excellence in results that may facilitate admission to particular university courses or the securing of study bursaries.

There is an apparent recognition of the need to be computer literate "for Life" and not merely for pursuing a career, as the pupils did not rate "The need for computer knowledge for my chosen course/career" as high on their reason-listing as "I recognize the need to be computer literate". This supports the claim that computers touch people from all avenues of life, in so many things that they do, in and out of the work situation. It is, therefore, a matter of urgency that educationalists realize that computer studies is a subject that should be available to all pupils at secondary school level, as computers are going to be part of our lives for many "centuries" to

come. This message was televised on Sunday 05.01.1992 on TV1 at 10:00 during a program produced by an American company, "Corporation for Community College Development". The video, relayed to South African audiences, visually illustrated the impact of computers on our daily existence, and the need for people to "encounter" computers with confidence, no matter how progressed they may be into the geriatric phase of life.

#### **4.4.2.3 Question 3**

##### **4.4.2.3.1 The Nature of the Question**

This question determined the types of careers that the pupils hope to embark on. The number of pupils intending to pursue a career in computers was arrived at, as well as the number of pupils who had been influenced in their choice of career by the study of computer science. Pupils also identified the career that they hoped to qualify for one day.

##### **4.4.2.3.2 The Results and the Interpretation thereof**

The output of the program written to evaluate question three is as follows:

The results of QUESTION 3 reflect that:

1. There are sixteen pupils who intend pursuing a career in computers.
2. Twelve pupils have been influenced in their career choice by the study of Computer Science.
3. Some of the careers desired are:

ELECTRONIC ENGINEERING  
MATHEMATICIAN  
MARKETING MANAGER  
COMPUTER PROGRAMMER  
CHARTERED ACCOUNTANT  
PHARMACIST  
MECHANICAL ENGINEERING  
COMMERCE  
ACCOUNTANT  
PHYSICIST  
ACTUARIAL SCIENCE  
COMPUTER ANALYST  
MEDICINE  
LAW  
CIVIL ENGINEERING  
NUCLEAR CHEMIST  
GEOPHYSICIST

The sixteen pupils who intend pursuing a career in computer science is unusually high and is probably peculiar to only this particular group. The author has found that, on questioning pupils at the end of their matriculation course in computer science, there are perhaps one or two pupils, often none at all, who intend making the computer field their career. Bearing this in mind and observing the types of careers that pupils identified as desirable, it is apparent that all of the careers mentioned are computer-integrated but only two careers (computer programmer and computer analyst) are

computer-intensive. This supports the contention that the present emphasis afforded to computer science in schools is inappropriate; more school leavers need to be trained for a computer-integrated environment (an environment that utilizes computers for increased efficiency) than for a computer-pure environment (an environment that is established to develop the usability of the computer). The course content at the present time concentrates on the systems analyst and the computer programmer. These are essential people in the computer field, but the proportional need for them is low compared to the need for computer literate people who would use computers to facilitate efficiency in their work situation and daily life tasks. The careers identified by the pupils appear to be particularly ambitious but this is, once again, characteristic of those who completed the questionnaire.

#### **4.4.2.4 Question 4**

##### **4.4.2.4.1 The Nature of the Question**

This question was structured to determine to what extent pupils enjoyed computer science in relation to other subjects in their curriculum. Their achievements in computer science are also compared to those of other subjects.

##### **4.4.2.4.2 The Results and the Interpretation thereof**

The output of the program written to evaluate question four is as follows:

The results of QUESTION 4 reflect that:

The average symbol for Computer Science is B.

The average symbol for Mathematics is B.

There is a 7% difference in the average marks obtained in Mathematics and Computer Science.

The average for Mathematics is higher than that for Computer Science.

There are thirteen pupils who enjoy Computer Science more than their achievement in the subject.

There are thirteen pupils who achieve higher in Computer Science than what they tend to enjoy the subject.

On average Computer Science is the 4th most enjoyed subject at school.

The average difference between those who achieve higher marks in relation to enjoying Computer Science is 2 point(s).

The average difference between those who enjoy Computer Science more than their achievement in the subject is 0 point(s).

There are twenty pupils who enjoy Mathematics more than Computer Science.

There are six pupils who enjoy Computer Science more than Mathematics.

The difference between those who enjoy Mathematics more than Computer Science is 3 point(s).

The difference between those who enjoy Computer Science more than Mathematics is 1 point(s).

Before these results are evaluated, it must be brought to the reader's attention that the

pupils who completed the questionnaires attend computer science classes only once a week, for approximately thirty weeks of the year, for two hours each week. Daily consolidation of work done previously is thus absent, or rare, and under these unsuitable teaching and learning circumstances, pupils tend to work in a wave-like manner; the crest of the wave arriving on the day of the computer science lesson and the trough passing through the rest of the week. This unfortunate set of circumstances may, in the author's opinion, result in a waning and waxing of enthusiasm for the subject, accompanied by a similar performance in, application to, and achievement in computer science.

There is a correlation between pupil-achievements in mathematics and computer science. This correlation can be expected for the group that completed the questionnaires as above-average marks in mathematics was a criterion for admission to the course. Pupils do achieve higher marks in mathematics than computer science, and it would appear that pupils enjoy mathematics more than computer science. Computer science rates as the fourth most popular subject amongst these pupils. Projecting such a popularity poll amongst a more random sample of pupils of varying academic abilities, the author would expect computer studies, with its variable practical component, to feature more favourably on the popularity scale. There is a correlation between the pupils' achievements in computer science in relation to other subjects in their curricula, and the rating of enjoyment of the subject. This could be expected of a school pupil's assessment; the subject that is most enjoyed is that in which achievement is the highest. A correlative sliding scale would be expected to apply for the remaining subjects in the curriculum.

#### **4.4.2.5 Question Five**

##### **4.4.2.5.1 The Nature of the Question**

This question was designed to compare the difficulty of computer science with mathematics and other subjects, amongst which were science, first language, biology, history or geography and a technical subject. The program that evaluated the question grouped all the subjects, other than computer science and mathematics, into one group called "other".

##### **4.4.2.5.2 The Results and Interpretation thereof**

The output of the program evaluating this question is as follows:

The results of QUESTION 5 reflect that:

The subject considered most difficult is  
**MATHEMATICS.**

The subject considered least difficult is  
**OTHER.**

(This is comparing **COMPUTER SCIENCE** to  
Mathematics and one other subject.)

These results are self-explanatory; mathematics is considered more difficult than computer science, while computer science is generally considered to be more difficult than the other subjects. Pupils could be expected to find mathematics more difficult

than computer science because of the predominantly abstract nature of mathematics. The fact that computer science in its present form, studied by the more academically able pupils, is considered to be a "not-so-difficult-not-so-easy" subject, would prompt the author to suggest that it could be suitably modified to stimulate and satisfy the academic needs of pupils of all academic persuasions.

#### **4.4.2.6          Question 6**

##### **4.4.2.6.1          The Nature of the Question**

Question six was set to determine the pupils' opinions regarding the availability of computer science as part of a six-subject, full-time academic curriculum. Pupils were also requested to name the subject that computer science could replace, if such a replacement were desired.

##### **4.4.2.6.2          The Results and the Interpretation thereof**

The output of the program written to evaluate question six is as follows:

The results of QUESTION 6 reflect that:

The percentage of pupils who would like to see COMPUTER SCIENCE as part of a six-subject matric is : 71.875 percent.

Among the subjects which would be omitted are:

ACCOUNTANCY  
GEOGRAPHY  
SCIENCE  
AFRIKAANS  
ENGLISH  
BIOLOGY  
BUSINESS ECONOMICS  
TECHNICAL

The program, unfortunately, did not determine if those pupils who did not consider computer science suitable as part of a full-time school program, would like to see the subject remain as a seventh subject option or if it should be deleted altogether from the school subject-options. On examining the questionnaires again, it was found that six of the pupils (out of the nine who did not want computer science as part of a six subject curriculum) preferred it to remain as a seventh subject to enrich the status of the matriculation results. The remaining three pupils would not like to have any school subjects, in their existing curricula, replaced by computer science. It would seem appropriate to propose that 90% of the pupil-sample under consideration would elect to have computer science as part of their full-time matriculation package. There is evidence of an appreciation and regard for the subject amongst its learners.

The subjects nominated for exclusion to facilitate the inclusion of computer science,

show a diverse selection from all of the language, commercial, humanity, science and technical fields. It is of interest to note that mathematics was not amongst the subjects nominated for exclusion. Perhaps this is the generation that has unanimously come to agree with KEYSER (1940:77):

"Mathematics, even in its present most abstract estate, is not detached from life. It is just the ideal handling of the problems of life".

#### 4.4.2.7 Question 7

##### 4.4.2.7.1 The Nature of the Question

Question seven assessed the pupils' opinions regarding the suitability of the course, that they were studying, for the various grades at school.

##### 4.4.2.7.2 The Results and the Interpretation thereof

The output of the program that processed the pupils' responses is as follows:

The results of QUESTION 7 reflect that:	
The number of pupils who think that the course is suitable for:	
<u>CHOICE</u>	<u>NUMBER</u>
ALL High School pupils is	6
HIGHER GRADE pupils only is	20
HIGHER AND STANDARD grade pupils is	14
MATHEMATICS PROFICIENT pupils only is	16

The pupil-poll suggests that the present course is not suitable for all high school

pupils. Practically all of the pupils concerned were following the higher grade syllabus which is the reason why approximately 50% of the pupils consider the course suitable for mathematically proficient pupils only; this course has a challenging Boolean Algebra component. The fact that 65% of the participating sample of pupils consider the course that they pursued suitable for higher-grade pupils only, indicates that the course is challenging, and this may be extrapolated to suggest that such a course could never be condensed into a commercially-based course run over several weeks at the familiar "academies" for computer training.

#### **4.4.2.8            Question 8**

##### **4.4.2.8.1            The Nature of the Question**

In question eight pupils were invited to mention parts of the syllabus which they regard as unnecessary or unsuitable for the course.

##### **4.4.2.8.2            The Results and the Interpretation thereof**

The output of the program written to process question eight is as follows:

The results of QUESTION 8 reflect that:

The topics suggested for EXCLUSION from the course are:

HISTORY OF COMPUTERS  
NUMBER REPRESENTATION  
ARRAYS  
THEORY  
MICROCOMPUTER ARCHITECTURE  
SOCIO-ECONOMIC PROBLEMS

With the exception of "arrays" and "number representation" the topics nominated for exclusion from the syllabus are all "rote-learning" themes or what is called "theory". The pupils obviously do not like theoretical themes and prefer topics which offer freedom of thought and creativity. One of the pupils who suggested that "History of computers" be excluded added the comment that "It is interesting, but has nothing to do with careers". Learners in the senior secondary phase are career orientated and their futuristic plans are being endorsed constantly with warnings, via the media, of unemployment and the necessity for skills and experience. "Number representation", although working with numbers, is also a type of drill-routine practice in which pupils must perform a rigid series of steps, requiring only accuracy and no intellectual decision making. Arrays are part of programming and, as has been mentioned before, some pupils find the manipulation thereof difficult. Adolescents have the desire to test their ideas and create solutions to problems. Any rote-learning topic that restricts the freedom to think and propose and test, would not have a high popularity vote amongst a senior secondary group of adolescents, especially of high intellectual ability.

#### 4.4.2.9 Question Nine

##### 4.4.2.9.1 The Nature of the Question

Question nine invited the pupils to name topics which they thought should be included in the syllabus for computer science.

##### 4.4.2.9.2 The Results and the Interpretation thereof

The output of the program written to process the results of question nine is as follows:

The results of QUESTION 9 reflect that:  
The suggested topics for INCLUSION to the course are:

- DOS
- DBASE
- LOTUS 1-2-3
- WORD PROCESSING
- DIFFERENT LANGUAGES
- COMPUTER ELECTRONICS
- RESEARCH PROJECTS
- PASCAL FILE HANDLING
- PROGRAMMING 'C'

The pupils realize the need for receiving tuition and training in the application packages that are used prolifically in commercial and business ventures. This group of pupils would enjoy the programming section of the syllabus as it is challenging and stimulating; hence the request for more programming languages and applications. The author has suggested the inclusion of research projects and computer electronics in the

suggested syllabuses discussed in 4.3. These suggestions, made by the pupils are realistic, sensible and pragmatic, and indicate that the pupils have their "fingers on the pulse" of the computer environment.

#### **4.4.2.10            Question 10**

##### **4.4.2.10.1           Nature of the Question**

Question ten was structured in a tabular form to assess the pupils' viewpoint concerning the learning skills pertinent to computer science, mathematics and science. The skills were named and it was required that they indicate if the particular skill was pertinent to any of the three subjects. A total of 13 skills was listed.

##### **4.4.2.10.2           The Results and the Interpretation thereof**

The program designed to evaluate question ten produced the following output:

The results of QUESTION 10 reflect that:

The Percentage of pupils who identified each skill as being pertinent to the relevant subject is:

**Computer Science**

SKILL	PERCENTAGE
Memorization	90.63
Thinking in Steps	87.50
Designing Solutions	100.00
Number Manipulation	71.88
Rules for Problem Solving	56.25
Home Language Use	56.25
Creativity	81.25
Real-world	68.75
Hand-Eye	65.63
Hand-Mind	71.88
Neatness	71.88
Accuracy	87.50
Organisation of Ideas	100.00

The Percentage of pupils who identified each skill as being pertinent to the relevant subject is:

**Mathematics**

SKILL	PERCENTAGE
Memorization	56.25
Thinking in Steps	96.88
Designing Solutions	65.63
Number Manipulation	100.00
Rules for Problem Solving	87.50
Home Language Use	15.63
Creativity	15.63
Real-world	25.00
Hand-Eye	3.13
Hand-Mind	62.50
Neatness	78.13
Accuracy	100.00
Organisation of Ideas	71.88

The percentage of pupils who identified each skill as being pertinent to the relevant subject is:

**Science**

SKILL	PERCENTAGE
Memorization	90.63
Thinking in Steps	87.50
Designing Solutions	53.13
Number Manipulation	62.50
Rules for Problem Solving	93.75
Home Language Use	59.38
Creativity	15.63
Real-world	78.13
Hand-Eye	15.63
Head-Mind	62.50
Neatness	46.88
Accuracy	93.75
Organisation of Ideas	65.63

The Average Number of skills nominated by a Single Pupil for Computer Science is : 10.09

The Average Number of skills nominated by a Single Pupil for Mathematics is : 7.78

The Average Number of skills nominated by a Single Pupil for Science is : 8.25

The Percentage Nomination of skills per Subject is:

Computer Science	38.64
Mathematics	29.78
Science	31.58

Mathematics and science were included in the exercise to enable the reader to compare computer science skills assessment with the skills assessment of these two subjects.

Mathematics enjoys a prime consideration in the rating systems of universities', technikons' and colleges' for establishing admission to these institutions. If an applicant's mathematics symbol is impressive, then he is considered to have the necessary potential to embark on the tertiary course. Hence, whatever mathematics demands from or develops in a learner, it is considered to be worthwhile. The thirteen skills described in question ten were designated in an attempt to describe most of the skills associated with science, mathematics and computer science learning. The author has had a minimum of seventeen years experience of teaching each of these subjects to highschool pupils or tertiary students and has become very familiar with the modes of thinking and learning associated with the three subjects.

Learning should be about organizing and classifying of ideas and solving problems. Intelligence quota (I.Q.) tests are primarily based on these two abilities. The author is most gratified to see that the pupils who have been exposed to computer science classes, unanimously rate computer science as the subject in which the skills of "designing solutions to problems" and "organizing of thought patterns" are demanded and developed. This, after all, is what learning and development of the intellect is concerned with. The percentage of pupils who rated "creativity" as a skill pertinent to the study of computer science, is also pleasingly high. A subject which encourages intellectual creativity must surely find its place amongst the more coveted subjects of a school curriculum.

Computer science has surpassed both mathematics and science in the identification of skills by pupils and concerning the average number of skills identified per pupil. This

certainly indicates to curricularators that it is a subject worth developing for the school curriculum.

#### **4.4.2.11 Question Eleven**

##### **4.4.2.11.1 Nature of the Question**

Question eleven was an "open invitation" to pupils to comment on the present course; criticisms and suggestions were asked for.

##### **4.4.2.11.2 Results and Interpretation thereof**

No program was written to evaluate this question. The comments primarily concerned the desire for "more practical work". These comments referred to the desired use of more application packages such as wordprocessing, databases and spreadsheets. This is a very important aspect of computer literacy and the pupils are justified in presenting their request.

One group of pupils did not, at the time of completing the questionnaire, have access to "hands-on" computer experience. This group complained bitterly about this situation. It was rectified shortly after that. Those pupils who did have regular "hands-on" lessons, consolidated its importance and even suggested "less theory and more practical". For those pupils who followed an academic (traditional) type matriculation course, a subject such as computer science, which offers a combined practical and academic nature, is an interesting and stimulating relief from the conventional pen-to-paper learning style. The reader is reminded that the pupils

studying computer science as a seventh subject, constitute an "academic elite" group and it is therefore interesting to note that these pupils are in favour of the practical aspect being enhanced. An appropriate balance of the cognitive and psycho-motor learning experiences is desired and necessary for all pupils, regardless of intellectual ability.

#### **4.4.2.12 Questions Twelve to Sixteen**

##### **4.4.2.12.1 The Nature of the Questions**

These questions were set to determine to what extent the computer served as a communication link or common ground between pupils and their parents or friends. Not all the questions were evaluated using the computer. Only 23 pupils completed this section of the questionnaire as these questions were added to the original questionnaire only after the first standard ten group had completed it.

##### **4.4.2.12.2 The Results and the Interpretation thereof**

The output of the program written to evaluate the pupils' responses to this set of questions is as follows:

The results of QUESTIONS 12 - 16 reflect that:

21 pupils have computers in their homes.  
This represents 91,30 percent.

12 pupils share computer activities with members  
of their family.  
This represents 52,17 percent.

16 pupils exchange computer knowledge with their  
friends.  
This represents 69,57 percent.

The number of pupils who have computers in their homes is pleasingly high, but this certainly cannot be taken as an indication of the average for a typical South African home. Many of these pupils are afforded the privilege of a computer at home purely to assist them with the study of computer science. The number of pupils who share knowledge with family members and friends is encouragingly high, but it is the comments made by the pupils concerning these liaisons that are worth mentioning:

- \* I have created home finance programs for my mother.
- \* I wrote a program to help my brother with learning tables.
- \* My mother, father and I help one another with DOS.
- \* I helped my parent write a program for financial purposes and I wrote a program for a cousin for a school project.
- \* I'm helping my father; explaining to him why I like computer work.
- \* I type letters and things for my family.
- \* My brother, who is doing computer science at Wits, discusses programs with me.

- \* We all use the computer at home, but my mother uses it only for telephone numbers and addresses.
- \* I wrote a program for my mother and my sister to create a file for Christmas cards. They use the computer once a year, but my dad and I use it all the time.
- \* I organize my father's financial accounts. I helped him build and maintain a database.
- \* I helped my aunt rid her computer of a virus.
- \* I have helped my sisters with projects using "Newsmaster".
- \* My mom uses the computer for school work (tests) and my father for figures and graphs for work. We all discuss with each other for interest sake.
- \* My father and I exchange all ideas all the time.
- \* I type the minutes and keep the books of my mother's toastmistress club. She pays me (not enough).
- \* My family are all dumb (jokes) but they are learning. I am teaching them.

These were some of the comments shared by the pupils relating to their family-computer integration. The comments expressed about exchanging computer knowledge with friends concerned mainly three aspects:

- \* Games.
- \* Projects at school.
- \* Computer science programs.

The comments above, concerning family-computer cooperation, create a positive, encouraging feeling about the computer and its rôle as a means of communication between the adolescent and his family. The adolescent can assume the rôle of the

leader and the expert; a situation critical to his self-esteem. Indeed, the computer can no longer be regarded only as a technological, financial, organizational asset; it permeates the world of the family relationship as well.

#### **4.4.3 PUPILS' RESPONSES AND THE PEDAGOGIC SCHOOL STRUCTURE**

The pupils' responses to the questionnaire need now to be related to the pedagogic school structure. The capacity that the subject of computer science (or computer studies) as a facilitator of the goals of the pedagogic school structure, has already been discussed in 2.4. The pupils' responses have consolidated the following tentative claims made in chapter two concerning computer science and the pedagogic school structure:

##### **4.4.3.1 The Execution of Purposeful Activities**

The pupils have indicated that they want more practical work (programming, application packages) and less theory. They appreciate and enjoy the periods of self-application; times when they can design solutions, organize ideas and plan strategies. They have elected computer science to be the subject that demands the greatest number of learning skills when compared with mathematics and science. Of all three subjects, computer science most convincingly puts them in touch with the "real world". They have convinced the author that they put their computer knowledge to use in assisting family members and friends with tasks.

#### **4.4.3.2 Creating a Space in which Learning Opportunities can be Realized**

The pupils would like to see computer science as part of a full-time, academic curriculum. They agree that the present course is limited to learners of certain abilities only. Thus the need for course differentiation is implied. The pupils have also requested the inclusion of more application packages in the syllabus such as wordprocessing and database studies. This, too, offers differentiation possibilities within the syllabus for different pupil abilities.

Practical work and "hands-on" experience is essential; a fact agreed upon by the pupils. This implies a well equipped computer centre for each school offering the subject.

#### **4.4.3.3 Organized and Systematic Exercise on the Future**

The influence that the study of computer science has had on the participators is evidenced by the number of pupils who wish to follow a computer career (see question 3 results). Computer science puts pupils in touch with the "real-world". The subject develops skills, practical and mental, which will always be required in life situations - more importantly those skills of organizing, creating and problem solving.

#### **4.4.3.4 Exercising Meaningful Modes of Being Human in Secured Togetherness**

Pupils have realized the importance in the world today of computer literacy. Some need computer knowledge for their careers, while others have chosen a career in the

computer field. Computer science classes have influenced these opinions; it has had a bearing on their future. The subject requires them to design solutions to problems and make decisions. Pupils have become involved with family members and friends in designing "systems" to achieve goals using the computer. They have taken the lead in helping both senior and junior family members with tasks. There are indications of involvement with financial and organizational matters on the domestic level. These pupils have experienced a new way of relating to family and friends; a more "academic" way which, surprisingly, is enjoyable, challenging and enriching. They have been exercising meaningful modes of being human in secured togetherness.

#### **4.4.3.5 Mutual Interest between School and Home**

The comments of the pupils listed in 4.4.2.12.2 above reveal the integration of computer science knowledge with home and family affairs. The pupil becomes the leader or the partner as he assists with home finances, letter writing, school work and home-organization.

#### **4.4.4 SUMMARY**

The pupils' responses and the interpretations thereof indicate, beyond doubt, that computer science is a subject that can make valuable contributions towards fulfilling the requirements of the pedagogic school structure. The pupils had no idea of the sophisticated academic theory defined by LANDMAN *et al.*, (1982 : Scheme G) as he described the pedagogic school structure. Yet they (the pupils) identified these requirements (of the pedagogic school structure) unknowingly, as they answered the

questions pertaining to their experiences in the computer science classes. The pupils have illustrated the practical application of the theory of LANDMAN et al., concerning the pedagogic school structure and computer science. This will now be further revealed with a resumé of the interviews held with three pupils who have experienced computer science tuition as a seventh subject in the matriculation curriculum.

#### **4.5 INTERVIEWS CONDUCTED WITH THREE COMPUTER SCIENCE PUPILS**

##### **4.5.1 SELECTION OF THE THREE PUPILS**

Three pupils were selected and, thereafter, requested to discuss aspects relating to the influence that computers may have had on other lives. The pupils are Ryan, Roland and Kevin, and each was chosen for the following reasons:

##### **4.5.1.1 Ryan:**

Ryan is a computer "whiz-kid" who obtained six distinctions out of a possible eight in the matriculation examination at the end of 1991. Ryan has obtained a bursary to study computer science at the University of the Witwatersrand. His computer knowledge exceeded all expectations in class which indicated that he spent far more time investigating the potential of a computer than what the school syllabus demanded. The extent of the influence of computer activities in his life was of interest to the author.

#### **4.5.1.2 Roland:**

Roland was the lowest achiever in the local computer science matriculation class of 1991. He did not have a computer at home and often expressed the desire for one. He seemed to treasure a disk-holder which housed a collection of personal software which indicated that he had access to a friend's computer. Although his academic achievement in the subject was limited, he enjoyed the interesting challenge that a computer presented to him. He had a passion for literature and drama, which he often discussed with his classmates and the author. He obtained distinctions in both official languages in matric, but obtained a minimum passmark for computer science; an "E" on the higher grade. This failed to dampen his enthusiasm for the subject.

#### **4.5.1.3 Kevin:**

He matriculated in 1990, obtaining a B-symbol on the higher grade. He obtained one distinction in a technically oriented matriculation course. Kevin's interest in computers lay with the technology although his programming abilities were exceptionally good. He was able to get a somewhat basic machine to perform unexpected feats by adding parts and packages to the original console. He consulted magazines and subsequently ordered "systems" from abroad which enabled him to extract results from his computer that kept onlookers in awe of his mastery of the machine. While at school, "his life was a computer". He is studying towards a BSc (Computer Science) degree at university and obtained a first-class pass in computer science at the end of 1991. His all-round computer abilities gained him the admiration and respect of the author, who relied on him many times for assistance with her own

computer.

## **4.5.2 THE INTERVIEWS**

### **4.5.2.1 Ryan**

Ryan and his father, who is a business consultant, share computer knowledge, although Ryan feels that he helps his father more than what his father helps him. They are experts in different fields; his father has the commercial and business knowledge, while Ryan has the computer knowledge. Between the two of them they computerize businesses for various clients of the father, using spreadsheets, databases, wordprocessors and graphics. Ryan's father does not pay him for hours spent, but Ryan does notice that it is easier to get something out of his father if he (Ryan) has helped with a project!

Ryan has earned money using his computer knowledge. He earned R150,00 for entering, running and adjusting a series of programs required by the author for this thesis. He knows he can earn more money, but his scholastic results take priority. He was consulted several times at his school by the administration staff to assist with problems encountered with the school-pupil computer system. He assisted without any expectations of remuneration!

Ryan never felt isolated because of his unusual ability to work with computers. He did have an advantage over his peers when it came to presentation of projects and assignments. He was aware that there were many pupils who envied him his ability to master the computer. Although he enjoyed interacting with a computer, his choice

of activity for leisure time would certainly be "to watch a movie with friends". He has spent enjoyable times competing with friends using computer games, but not really utilizing the computer for academic purposes.

Ryan feels that computer literacy is as essential to progress as oxygen is to breathing!

#### **4.5.2.2 Roland**

Roland's mother works in a computerized office environment, but this does not facilitate a basis for any mutual discussion between them concerning computers. Her involvement with computers at work, however, did make him realize that there was an aspect to computers that he had not obtained at school; a knowledge of application packages. Roland has decided to attend the local technical college and complete National Certificates in Computer Practice which include courses in spreadsheets, databases, wordprocessors and operating systems. In this way, he hopes to become more user-orientated, although he does feel that the most important part of computer literacy is programming, as it demands insight and "mind stretching".

Roland does not understand how anyone can hope to progress through life without being computer literate. Hence his enthusiasm and drive to persevere with computers, even after passing matric. He hopes to register at UNISA next year for a degree in Law, but whatever he does, he knows that computer skills will be required.

He obtained part-time work at a video outlet while at school. This outlet is computerized and Roland feels that he was given the position because he was skilled in the use of computers. He realized that the shop-control-system had short-comings,

and suggested ways of improving the system with an additional program on an additional computer.

Roland explained his enthusiasm for the subject as "enjoying the race and not the prize". He enjoyed competing with his peers to get a program to run, and he especially enjoyed it when he could get a result before "the boffins" - although this was, he admitted, a rare occasion! He stated that once the typing started, the challenge started as well. The mere sense of achievement in seeing one's program work, was motivation enough for Roland to persevere with the course for three years at school.

#### **4.5.2.3 Kevin**

Kevin has two sisters who have no interest in computers at all. His parents are very interested in his computer hobby and career, and assist him to acquire whatever he needs, although they do not have any computer needs themselves.

One of the greatest advantages of the computer science course is that it taught him to approach solutions to problems, in any subject, in a logical manner. He sometimes felt alienated from peers at school as they did not share the same enthusiasm for computers as he did. This was because they did not have the same opportunities he had.

Kevin had earned money during his school days, copying software for friends and teachers. He is doing freelance programming for a company in Pretoria on a part-time basis while studying at university. He said that, in the past, he spent most of his

time "cracking systems" on the computer, but now that he has a girlfriend, he would rather spend the time with her!

Computers had become an integral part of his life and he seldom embarks on a task at university without involving the computer. Kevin described the rôle that the computer played in assisting his rehabilitation after a serious motor accident during his matric year. He lost the sight in one eye and this angered and demotivated him on an academic and personal level. He was, however, prepared to interact with his computer and it was during this intense period of computer activity, that he realized he had lost nothing more than the sight in one eye, and he rapidly regained an equilibrium on Life.

#### **4.5.3 SUMMARY**

These three interviews highlighted the impact that computers can have on the lives of participants other than mere acquisition of knowledge. Computer knowledge has facilitated the earning of pocket money, provided entertainment, improved self-concepts, encouraged further study and promoted parent-peer and peer-peer-interaction. The subject was not regarded as a means to a matriculation certificate, but rather a means to a career and a more meaningful future. The subject remains alive and permeates many aspects of the life of the learner. Learners feel that there is a purpose in studying the subject, but more importantly, they enjoy the subject to the extent that it is sometimes difficult to distinguish its academic nature from its recreation nature.

#### **4.6 CONCLUSION AND FURTHER PROGRAM**

Chapter Four has revealed the situation existing in the country (Natal excluded) with respect to computer science tuition in secondary schools. This evaluation revealed that there was a need to develop and further differentiate the subject in schools. Themes for differentiated school syllabuses have been presented in Chapter Four. The themes chosen have proved individually to fulfil various requirements of the pedagogic school structure, which, if they were consolidated into a secondary school syllabus, would ultimately ensure the harmonious path of the adolescent towards a meaningful and dignified state of adulthood. An evaluation of the pupils' responses to the questionnaires has confirmed that computer science, as it has been offered to date to these pupils, is a subject which is enjoyed, is challenging and fulfils specific requirements of the pedagogic school structure. There is a need for further differentiation and content variation and this has been attempted in the selection of content in 4.3. Interviews with pupils have confirmed that computer science is more than an academic subject at school; it has become an entity in the personal lives of learners.

With the validation, justification and exposition of computer science as a subject with abundant pedagogic relevance for the development of an adolescent into a thinking, creative, problem-solving, dignified and purposeful adult, now complete, it is necessary to embark on the final chapter which will attempt to bring all discussions of previous chapters into perspective. The implications of introducing computer science into schools will be addressed. Possibilities for further research emanating

from this investigation will be proposed and shortcomings of this research study will be identified in this forthcoming final chapter. The chapter will commence, after the introduction, with a brief consideration of the Education Renewal Strategy (ERS) document released in 1991 by the Committee of Heads of Education Departments (CHED). This document reveals important proposals for vocational and technological education in schools in the future.

## **CHAPTER FIVE**

### **5.1 INTRODUCTION**

This, the final chapter of the investigation, will encapsulate the research carried out in the previous chapters and thereby crystallize the findings concerning the discipline computer science as a school subject suitable for educating adolescents of the post 1980s, as they prepare for a meaningful existence in an overpopulated, highly competitive, technological world. The adolescent and his needs, the school and its mandate and computer science with its potential will be reflected in relation to the problem formulated in 1.3 and the hypotheses proposed in 1.5. This study has dealt essentially with the needs of the adolescent in the modern world and the expectations that are placed on the school in the community in order to meet those needs. Computer science has been revealed as a tool of the education system to address the demands of society while simultaneously actualizing the expectations of the learner as he finds himself in an environment of limited resources and costly tertiary education. In keeping with the futuristic character of this investigation, the author considers it necessary to refer to the Education Renewal Strategy (ERS) document compiled by a Committee of Heads of Education Departments (CHED) in South Africa. The proposals contained in this document are still (at the time of writing this thesis) under discussion by interested parties. The education desk of the African National Congress (ANC) and the Urban Foundation are two parties that have already questioned the composition of the CHED, saying that it was not a democratic representation of all

people in the country. Be this as it may, it does not detract from the relevance of some of the proposals in the document concerning the need for vocational education in schools. These pertinent intentions will, therefore, receive attention in 5.2 as they are a reflection of what the author has proposed throughout this investigation concerning relevant education for the future.

Change and innovations in education are generally daunting and costly exercises for those planning and implementing the new ideas and strategies. The introduction of computer science as a differentiated subject for all school pupils, is no exception, and the author will attempt in 5.4 to expose the implications of such an undertaking.

Research endeavours should never be final entities in themselves; possibilities for further research should be inherent in a dynamic investigation. The areas for further research emanating from this study will be presented in 5.5.

The author is aware that this investigation is not without shortcomings. An attempt will be made in 5.6 to enumerate those shortcomings that have become apparent as the research proceeded. The study will be concluded in 5.7.

## **5.2 THE EDUCATION RENEWAL STRATEGY (ERS) DOCUMENT**

### **5.2.1 INTRODUCTION**

A curriculum model for education in South Africa was released for discussion on 20 November 1991. The purpose of this document is to reveal the thoughts of the Committee of Heads of Education Departments (CHED) on how to make education

more relevant and accessible to the wider South African school-going public. At this stage this document is available only for discussion and interested parties have been invited to comment on aspects of the document. Comments of the interim science and technology group of the African National Congress (ANC), the Urban Foundation, the Science Education Forum and the Department of National Education may be included in the discussion that follows. These comments were recorded at a meeting of the Science Education Forum held on 3 October 1991 at the Rand Mines Training Centre, attended by representatives of the groups mentioned above.

### **5.2.2 VOCATIONALLY ORIENTATED EDUCATION**

The philosophy underlying the ERS document includes the provision that:

"... education shall be directed in an educationally responsible manner for the needs of the individual and those of society, and the demands of economic development, and shall take into account the personpower needs of South Africa" (CHED, 1991:7).

The CHED (1991:10) continues to stress that education should be formative and should prepare learners for life. Provision will, therefore, include generally-oriented, vocationally-oriented and vocational education. This shift towards the vocational field will ensure that learning opportunities are created so that learners can enjoy learning experiences with a view to trainability in the vocational world. The CHED further stresses that horizontal mobility must be possible within the education system, should a pupil wish to change his study direction. Amongst the vocational fields of study proposed by the CHED are:

- \* Engineering studies;

- \* Enterprise management;
- \* Arts education;
- \* Agricultural science;
- \* Home economics;
- \* Social service.

Computer science, as a vocationally oriented subject, is enjoyed by pupils to the extent that working with computers becomes a hobby for many pupils. The subject would allow horizontal mobility across the fields of engineering, enterprise management, agricultural science and home economics. Furthermore, computer science could appropriately be included within the general group of subjects together with biology, economics, mathematics, science, geography, history and biblical studies. Therefore mobility would be facilitated if computer science were included in the subject choice for the general subject curriculum as well as the vocationally oriented curriculum. Unfortunately, because of the small percentage of pupils in South African schools who are privileged to take computer science as a matriculation subject at present, the subject tends to be disregarded by curriculum planners such as the CHED. With time, however, it is hoped that educationalists of the correct persuasions will be included on curricula committees so that computer science may play the rôle it justly deserves within the general subject package and vocationally oriented package proposed for pupils in the secondary school phase.

The curriculum model is pleasing in that it has addressed the need for scientific and technologically oriented education. From grades 1 to 9 (up to the present standard seven) subjects such as mathematics, environmental studies (which includes

information technology), general science and technology (information technology features prominently) are compulsory for all learners. In grades 8 and 9 learners who choose a vocationally-oriented subject, related to science or mathematics, will receive further instruction in this direction. In grades 10 to 12 (the senior secondary phase) further options such as vocationally oriented mathematics, science and biology, as well as technology, engineering studies, mechanotechnology, electrotechnology and civil technology, are available to the learner. Within these domains of study, there is encouraging scope for the inclusion of computer science.

### **5.2.3 THE FIRST EXIT POINT AND ADULTHOOD**

The senior primary phase of education spans the 9 to 12 year age group. During this phase, the emphasis is still on general formative education, the vocational field of study still being unaddressed.

"Completion of this phase coincides with the completion of primary school education (grade 7/standard 5) and the possible completion of compulsory schooling. This is the first exit point from formal education ... . Possible school leavers are identified in grades 6 and 7 so that purposeful orientation and exploration regarding both the vocational and adult worlds can take place before completion of grade 7" (CHED, 1991:22).

This statement has alarming implications for the pedagogician : can a child who has not yet reached the age of 12 be orientated meaningfully in the adult world? The child will leave the structure of the school and will be "... taken up in a system of structured, non-formal education and training" within the employment field, should he have proved to be unsuitable for continued schooling. It is statements such as this

which could have prompted the ANC science and technology group to comment:

"... the suspicion remains that the prime aim of the ERS is maintenance of privilege for middle class and advantaged whites with co-option of a few middle class blacks" (ANC, 1991:5).

If an ideal situation existed wherein all teachers were good educators and all facilities were equally available to all educands, then potential school leavers could justifiably be identified according to common criteria. However, until such time as education is available "to each the same", enforced exit from schooling will be seen as a racially or social-class based phenomenon. Society will ultimately be the loser if children are forced to leave the formative and disciplined structure of the school before they have even stopped playing with toys. The question also arises concerning the likelihood of the workplace being able to absorb these early school-leavers with offers of meaningful hands-on training facilities.

#### **5.2.4 DIFFERENTIATION**

The CHED has acknowledged that it is a generally recognized principle that a curriculum for pre-tertiary education should provide for differentiation in terms of a learner's ability, interest and aptitude.

The model offers opportunity for horizontal differentiation (specialization) according to individual interest and aptitude. Vertical differentiation accommodates the intellectual abilities of learners and it is in this context that the CHED is not satisfied with the existing higher, standard and lower grade system. The CHED (1991:45) suggests that a unit syllabus for a course be designed and that content be selected and

structured in such a way that the teachers are enabled to differentiate didactically in their instruction and that further differentiation takes place regarding evaluation (examinations). The reader will have become aware that computer science content has been selected in this investigation to accommodate such a system or to propagate the existing system of intellectual differentiation. It has frequently been mentioned that the teacher may vary the assistance offered to, or the performance demanded from, individual pupils while they are grouped together in one class. Course content, according to the CHED, can also be modularized to facilitate differentiation according to academic abilities. Pupils of higher intellectual abilities would opt for more modules per subject than pupils of lesser abilities or different aptitudes. Once again, the course content exposed in this study could satisfactorily be modularized to facilitate this method of intellectual differentiation amongst learners. The exposition of the grades A, B and C as described in Chapter Three (3.5.3) has modularity inherent to its structure.

#### **5.2.5 SUMMARY**

The three aspects discussed above, highlighted from the ERS document, all have a bearing on the human dignity of the learner. Education for purposefulness in a technological and scientific world is essential for the majority of school learners today. A child of twelve years of age needs to remain within the security of an education system for several more years, regardless of his academic performance. Differentiated learning content is essential to foster and encourage maximum potential development amongst learners according to their individual abilities and aspirations.

The ERS is a comprehensive document and is certainly open to both criticism and praise. The aspect that is particularly relevant to this investigation is the emphasis that has been placed on vocational and technology education. This shift in education is what has been suggested throughout Chapter One and the findings of the investigation that followed, into the rôle of computer science in the education of the adolescent, can now be placed at the open door of future education in South Africa, should the curriculum model suggested by the CHED, or selected aspects thereof, become a reality.

### **5.3 SUMMARY OF FINDINGS OF EACH CHAPTER**

#### **5.3.1 CHAPTER ONE**

The situation analysis described in Chapter One revealed the need for a shift in education planning to include a matriculation certificate that would equip school leavers for employment while still fostering the dignity and interests of learners. Vocationally orientated subjects need to find their way into the secondary school curriculum. The existing school system demands that school-leavers receive post school education and training in order to be considered suitable for employment. This is a costly situation to be funded by parents and tax payers within a country suffering economic deprivation after decades of sanctions and seasons of drought. The number of school-leavers is going to reflect a top-down pyramidal expansion in years to come, and the school education system is obligated to produce pupils who possess marketable skills for employment on leaving school. Training for employment during the adolescent period raises the question in the mind of the pedagogician as to how the

gestalt of adulthood can be strived for if emphasis is placed on the employment needs of the community. The situation analysis revealed that computer science, as a matriculation subject, is available to only a very small percentage of the school population and that the subject content required further differentiation and expansion to accommodate learners of all intellectual abilities and interests. The problem arising from the situation analysis was formulated in terms of the school's obligation to prepare its wards for a dignified and meaningful future within an environment of economic instability, unemployment and fervent competition for social, financial and education resources. The subject computer science is seen by the author to have the possibilities to facilitate the task of educating the adolescent so that his full potential as social, spiritual, affective conative and cognitive being can be actualized. The problem was to reveal computer science as a true discipline of knowledge in relation to the aspirations of the adolescent within the education situation of the pedagogic school structure.

The formulation of the problem arising from the situation analysis resulted in the posing of the hypotheses in the form of "suspended" statements still to be grounded by investigation, research and reflection. These statements were concerned with:

- \* the possibility of designing differentiated computer science syllabuses for secondary school pupils of all levels of ability and interests;
- \* the necessity for the establishment of a true education situation comprised of educator, educand, syllabus content and computer;
- \* computer science as a bridge between the employment sector and school education;

- \* the potential of computer science to encourage and assist with further studies at tertiary level; and
- \* the utilization of Fundamental Pedagogic essences basic to education to reveal the education phenomenon within a world of changing entities.

Chapter One included the definition of concepts which needed thorough clarification in order to orientate the reader concerning the field of study. Particular emphasis was placed on Fundamental Pedagogics and the perspective of this science on the education situation. The author realized the challenge inherent in the task of successfully revealing the not-always-obvious relationship between the theories of Fundamental Pedagogics and the pragmatic experiences of teacher and pupil in the didactic situation of a technologically based subject such as computer science that permits a renewed educator-educand relationship as experienced by the author. The outcome of this challenge has indeed been revealing, as will be illustrated in the findings of Chapters Two, Three and Four.

### **5.3.2 CHAPTER TWO**

The contents of Chapter Two dealt with the adolescent, adulthood, the pedagogic school structure as it is concerned with the adolescent, computer science within the pedagogic school structure and the syllabus as it is related to the life world of the adolescent. The intention has been to reveal the interrelatedness of the school and academic subject content, as prescribed by the syllabus, as it influences the progress of the adolescent towards the desired state of independence and maturity.

The adolescent was revealed as a complex being with facets of existence which include the social, the physical, the intellectual, the emotional, the aesthetic and the conative. The becoming adult of the adolescent is dependent on the education he receives, and the education planners and implementers are obliged to consider all the modes of existence which contribute to the holistic and wholesome development of the educand. Educators and curriculum developers need to consider the spatiality of the adolescent in relation to the proximity of adulthood. The question to be asked when selecting learning content for the academic school programme is : what are the most relevant learning experiences that the adolescent can be exposed to in order to prepare him for a meaningful place in the technology dominated societies of the nineties? The discussion of the pedagogic school structure in relation to the nature of the adolescent, revealed that learning experiences for the adolescent must be purposeful in that he should be encouraged to exercise his own intellectual abilities without depending entirely on reproducing and imitating what the teacher or the textbook has to offer. The dependency of the educand on the authority of the educator should be allowed to diverge into a consultative relationship by prescribing appropriate learning content. The learning content should offer the adolescent a window on the future. Not only is it expected to enhance his possibilities of employment but it should subtly develop within him an adherence to rules and prescriptions characteristic of social existence. The learning content and the experiences it offers, should not isolate the adolescent from the reality of the working or tertiary environments, but rather, it should allow for opportunities to experience a range of emotions associated with responsibilities of team work and individual application, as well as exposing the realities of competitive

spirit amongst peers and colleagues. The adolescent should be able to see his knowledge in action at home, in the employment sector and in the wider realm of national and international relationships. He is, after all, a futuristic being and what he learns in the classroom must be in accordance with his plans for the future, otherwise his school education will appear to him to be futile. Learning content which initiates occasions for pupils to experience the actualities of the working environment with strategised co-operation between school and commercial and industrial management, will do much to satisfy the adolescent's need for occasional breaking away from the rigours of the school system. Such co-operation could be extended to include business personnel on curriculaing bodies, a suggestion included by the CHED in the ERS document (1991:28).

Having established how learning content can, and should, establish a mandate for the school to achieve the aims of educating the adolescent, the investigation was directed to the subject computer science, to ascertain whether this subject has the potential to provide the educator, the educand and the school with the necessary tools to achieve the ultimate aim of education, namely adulthood for the educand. The findings of this component of the investigation revealed that computer science has the potential to be differentiated to meet the needs of pupils of varying intellectual abilities and interests. The subject allows for mental creativity and individuality to be exercised within the framework of social and academic rules and regulations. The teacher, the pupil, the subject content and the computer constitute an education situation wherein there is welcomed opportunity for the adolescent learner to exercise his freedom, both socially and intellectually, and to test his capacities for problem solving and logical thought.

The subject has application beyond the classroom walls; the family, his peers, the community and the nation depend daily on computers for enhanced performances in work and recreation. The adolescent can, via his computer knowledge and skills, relate his schoolwork to the working environment providing him with a means to reach out to, and often venture out into, the world of the adult whilst still at school. The subject is modern. This does not imply that the knowledge constituting the discipline is new, but rather that it meets the requirements for educating the adolescent for adulthood in this rapidly advancing world of enhanced communication systems, data capture and data retrieval. Curriculators can no longer rearrange subjects of the traditional model of schooling into different packages and hope that the new arrangement will meet the needs of the individual and society. New subjects have to replace the old; technology will have to replace tradition.

As the curriculators embark on selecting learning content for a syllabus such as computer science, they should consider the characteristics of the target group for which they are curriculaing. A syllabus is not merely a statement of themes of knowledge; it is a reflection of the social orientation, the intellectual potential, the physical being, the affective goals and the future dispensation of the learner. The syllabus must be adapted regionally to conform with the demands of the employment sector of society. The content itself should be selected so as to minimize the absorption of facts, as the adolescent is urged by a yearning to exercise his own thoughts and ideas, and to satisfy this youthful need, opportunities ought to be provided.

Syllabuses should reflect a range of themes as well as adequate depth of each theme, so that courses may be differentiated to suit learners' varying interests and abilities. Scope for team work, personal research and community-based projects should be included in syllabuses for adolescent learners as these activities prepare them for the employment environment. The commencement of the nineties manifested a plethora of "bumper stickers", one of which stated: "Hire a teenager while they still know everything". While syllabuses should not be designed to try to prove to the teenager that he does not know everything, they should provide content that challenges the ability to solve problems and subsequently afford him opportunities to experience the emotions associated with success and failure. When the adolescent leaves school and enters the real world it is most important that his expectations relating to his own abilities to confront the world are realistic, otherwise his initial encounters with the adult world may be fraught with disappointment.

The adolescent is striving for adulthood. The school is obliged to prepare him for and guide him to this status. Learning content, structured within a syllabus, is the means that the school utilizes to achieve its goals. The learning content should, therefore, be appropriate and contemporaneous in order to facilitate the path of the adolescent to adulthood. Subsequent to the author's experience, inner reflection and literary studies, computer science has revealed itself as a subject with potential to successfully realize the essentials of the pedagogic school structure as it has been designated to assist the adolescent on his path to adulthood.

### 5.3.3 CHAPTER THREE

The syllabus was introduced in Chapter Two in relation to the adolescent. Chapter Three expanded on the syllabus design and the various claimants on the syllabus. A detailed discussion of the structure of knowledge and its relevance for curriculating was presented in Chapter Three. The ultimate theme in Chapter Three clarified the perspectives which guided the author to select themes for a computer science syllabus to ensure that the learner, within the school structure, was aptly directed towards the goal of adulthood.

Five claimants on the design of a curriculum were presented in Chapter Three: society, the learner, learning content, logistical provision and occupational man. As each was dealt with, in turn, it appeared that the particular claim on curriculum design was the most important consideration for a fair and sound education policy. The author intended, however, that the reader should consider the anti-pedagogic format education would assume if one claimant received priority over the others or if one were neglected to the advantage of the other four. The effect would be equivalent to indoctrination or neglect of the ultimate goal of education. Education has passed through stages of placing a concept at the core of the system; child-centred, society-centred and content-centred are adjectives that have described the nature of various education philosophies of the past. All five of the claims discussed in Chapter Three have the right to be considered when curriculums are designed. All five need to be integrated so that, ultimately, the school-leaver is prepared in such a way that he may reflect a social order, have gained a concept of self-worth and dignity and possess

skills and knowledge through exposure to pertinent learning content and learning aids. These characteristics will enable him to confront and subjugate the encounters of occupation and survival in the overpopulated world of the present and the future.

In order to choose learning content for a syllabus, the curriculumator is obliged to follow certain steps. These steps have been described in Chapter Three as the curriculum cycle. This cycle is never complete; it is ongoing while the subject is being offered at school. An evaluation phase links the termination of one cycle with the commencement of a new cycle's situation analysis. Computer science has been offered as a matriculation subject to a very small percentage (estimated at less than 1 pupil in every 800 pupils) of the secondary school population over the past eighteen years. Throughout this period, the author has witnessed learning content changing and learning experiences changing. There was a period up until 1988 when pupils completed a three year course without ever sitting in front of a computer! The author is of the opinion that a major change of attitude towards the subject is necessary. The present situation has been evaluated in this study, aims have been formulated for the subject and learning content has been selected. The learning experiences have not been specified as such, but many have been implied in the discussions that followed each topic in the selection of content (see Chapter Four). The primary concern of the author, which prompted this investigation, is that computer science should be differentiated so that it becomes available to all pupils at secondary school level in order to enrich and enhance their post school opportunities. The task was then to reveal the adolescent in his life world, the school and its aims concerning the actualization of adulthood for the adolescent, the potential of computer science as a

means for the school to achieve its goals and, finally, to reveal the actual content selected from the discipline of computer science.

Subsequent to the discussion of the curriculum cycle, a description of the relevance of the structure of knowledge to curriculum planning was embarked on. An understanding of the nature and structure of knowledge provides an important foundation for the curriculum planner. It will assist with decisions pertaining to what should be included in a syllabus, what logistical provision must be planned for and how individual differences amongst learners can be accommodated. Disciplined knowledge is in a teachable form and is acceptable to a learner, provided the learner perceives the relevance in the knowledge. Knowledge from a discipline does not imply retention of facts, but rather the acquisition of skills in order to solve problems, create something or produce a desired outcome. In order to master a discipline, an education situation is demanded so that the learner may work alongside a successful practitioner. Knowledge from a discipline should display analytical, synthesizing and dynamic qualities and possess, inherent in its content, methods of enquiry for discovering new knowledge. Substantive structures underlie a discipline and these facilitate new knowledge being added to the discipline without rejecting previous bodies of knowledge. Outdated and obsolete knowledge should retain its rightful place within the historical structure of the discipline. Computer science is in a teachable form, it is relevant to the learner, it requires retention of facts and substantial problem solving, synthesizing and analytical exercises. A qualified and experienced educator is essential for the educand's actualization of knowledge and the knowledge has an obvious dynamic character. Although the hardware and the software associated with

computers appears to be constantly changing, there are substantive structures that underlie the body of computer knowledge. An example of this would be the logic associated with programming and the skills associated with the use of a wordprocessor or a spreadsheet. The logic and the skills remain the same while the application thereof may require adaptations of a cognitive or psychomotor nature comfortably within the learner's manoeuvrability. Computer science is not an isolated body of knowledge. Its application transverses all fields of work and recreation. The knowledge itself draws on the disciplines of language, mathematics, electronics, accounting, typing, physics and chemistry. The knowledge acquired can be put to use by the learner using his knowledge for hobbies, entertainment, schoolwork and assisting with family tasks. He sees his parents using computers at work. Many of these claims for the disciplined structure of computer science have been illustrated in Chapter Four in which pupils' questionnaires have also been assessed and pupil-interviews recorded.

The final theme of Chapter Three described the criteria that would be used to validate the selection of content for computer science syllabuses. These criteria did not include the essences of the pedagogic school structure which had already been thoroughly discussed in Chapter Two. These essences were, however, included as criteria that influenced the selection of content in Chapter Four. Included in the description of these criteria was a discussion of intellectual activities demanded by the content. Bloom's Taxonomy of intellectual activities was used as a foundation to differentiate and structure the knowledge into three grades of learning activities: grades A, B and C. The differentiation was also influenced by the demands of the targeted end-user

of the knowledge. Grade C, for example, would accommodate knowledge required by pupils who, on leaving school, intended entering the employment field as computer application specialists.

The age of the learner is another important factor to consider when structuring knowledge for syllabuses. PIAGET'S four periods of intellectual development were described in relative detail and this classification was used in Chapter Four to guide the nomination of the age range for which the selected content is considered suitable. The senior secondary school pupil is of the age when abstract modes of thought are possible and are generally reaching sophisticated levels of manifestation. Learning content selected for pupils in this stage of schooling may, therefore, include themes involving intellectual activities ranging from rote learning and comprehension-application-type activities, to those demanding insight and originality from the learner. Computer science content reflects a range of themes which may demand purely practical skills of keyboard operation or discerningly creative logic associated with programming. The possibilities for differentiation are substantial and an illustration of this has been attempted in Chapter Four in which the selected content is presented. Learning content has been selected according to what this study has revealed to be relevant to the life-world of the adolescent. The author has taken into account the fact that the educator-educand relationship is diverging as the educand assumes independence and enjoys the challenges of testing his own intellectual abilities. Selected study material should, therefore, include potential for pupil expression and creativity.

Chapter Three has dealt, primarily, with the theories associated with the choice of content, illustrating the complex considerations necessary to ensure that the prime goal of education is targeted and attained. Syllabus designing is a scientific process to be carried out by experts in the fields of subject knowledge, education and didactics, and if possible, representatives from the employment sector of the community.

#### **5.3.4 CHAPTER FOUR**

Chapter Four circumscribed four themes which included an assessment of the recent situation pertaining to the tuition of computer science in South Africa. The results have been summarized in 4.2 and a detailed repetition thereof is not necessary. It appears that an effort is being made to encourage schools to introduce the subject of computer science as a full-time school subject in the Education Departments of the Transvaal, Cape and Orange Free State. The success of this move will depend on the school's ability to provide a computer science teacher and an adequately equipped computer centre. There is no development within the Department of Education and Training for computer science tuition and this Department's secondary school pupil population is by far the most prolific in the country. It would, therefore, be feasible to predict that the percentage of pupils who are afforded the opportunity of taking computer science as a matriculation subject is approximately 0,125% or one pupil in every 800. The subject as it exists at the moment is not sufficiently differentiated to accommodate learners of all academic abilities. There is an emphasis on programming which prohibits many pupils from mastering the content. The ERS document has proposed three major course groupings: a general-subject course, a vocationally-

oriented course and a vocational course. Computer science could appropriately be included in all three groups but each group would require a syllabus different from the other two in content or in the emphasis placed on the content components.

The second theme of Chapter Four presented the content that could be considered for a differentiated computer science syllabus. The classifications that followed each theme are intended to provide direction as to the type of course and the age group for which the learning material is suitable. Age and course type are clinical parameters and it is important to consider the human dimension when deciding on syllabus content. For this reason the content selected was validated in terms of the essential characteristics of the pedagogic school structure. The content was described according to its influence on the life-world and aspirations of the adolescent learner as he approaches the reality of adulthood.

The quantity of facts that a learner can accumulate over a period of tuition has negligible relevance compared with the type of mental and intellectual exercises that the acquisition of knowledge demands. A learner has acquired a meaningful education if he is able to exercise all mental faculties in order to solve problems and confront the challenges associated with being adult. The eleven themes presented for a differentiated syllabus have, inherent in their content, the three intellectual activities of memorization, comprehension-application and insight. The curatorator may emphasize the insight-type activities of one topic for Grade-A course while he may choose to emphasize the comprehension and application-type activities of the same topic for Grade-C course. The study material has possibilities of being developed into

a modular system wherein a theme is divided into modular units. Depending on the nature and content of the theme, the various grades would include a different number of modules from the theme, providing learners with the emphasis required for post school activities.

The learning content must be seen as a means for self-actualization of the adolescent as he strives to establish independence. The content selected for a computer science syllabus has taken into account the career-mindedness, the peer-group pressures, the desire to flex intellectual muscle, the often estranged family relationships, the social awareness, the diverging teacher-learner relationship and the sometimes subconscious need to be recognized as a promising contributor to the continuity of the community. These claims on the learning content may appear ambitious as subject knowledge of scientific disciplines is usually regarded as essentially cognitive in nature, but the pedagogic implications associated with each topic have been clearly validated in Chapter Four. The subject computer science has potential to contribute towards the actualization of all the aims of the pedagogic school structure as it prepares the adolescent for adulthood. The subject is, at the moment, a closeted giant in the secondary school education field. It needs to be revealed in terms of its true potential to develop in the learner feelings of selfworth, dignity and independence as he pursues either a general or vocational education.

The assessment of the pupils' questionnaires confirmed that the results of pedagogic reflection on the life-world of the adolescent, are pragmatically what the adolescent lives out from day to day in his relationships with the school, the teachers, his peers,

his family and his fellow citizens. The reasons why pupils study computer science as an extra subject ranged, with varying emphasis, amongst all the options proposed. Pupils included influences of parents, careers, personal status, university requirements and enjoyment. The present computer science syllabus is challenging and often difficult for the pupils who study the subject, even though these are pupils with above average abilities. This indicates that radical differentiation and reconsideration of course content needs to be made if the subject is to be accommodated in the general school curriculum. Most pupils recognize the need to introduce computer science into schools as a full-time subject, although not in its present form. Although the pupils who answered the questionnaire have considerable intellectual prowess, they urgently request that training to use application packages, such as wordprocessors and databases, be included in the syllabus. No matter how well one's cognitive faculties serve one, there is a spontaneous need to develop the psycho-motor as well. Pupils recognize the necessity for psycho-motor skill development within their education. The pupils confirmed that computer science demands that they exercise all the intellectual faculties of memorization, comprehension, application, insight and creativity. These are not only cognitive functions but are activities for Life. They form the foundation of coping with life's encounters associated with people, work, religion, nature and politics. Pupils have assumed leadership at home and amongst friends when assisting with computer-dependant tasks. Some pupils have assisted parents with computer applications associated with businesses. The subject has facilitated family and peer relationships, as well as affording status to the adolescent in the working and adult worlds.

The interviews conducted with three pupils consolidated the importance for learners to be able to relate to a school subject other than in a purely cognitive way. The subject afforded them status amongst family and peers. Ryan and his father particularly, had a rewarding father-son relationship via the computer. All three are sociable young men, but they derive enjoyment and satisfaction from computer tasks at home, even though there exists an affiliation to schoolwork. Ryan and Kevin had been able to earn money using their computer expertise, granting them a degree of financial independence. Kevin had experienced an emotional setback after losing the sight in one eye after an accident. This period of his life was emotionally uplifted by constant computer practice at home. Roland did not excel at computer science but he recognized the need to be computer literate and continued with computer education after passing matric. The interviews illustrated that computer science is a subject that extends beyond school walls : it may become part of family life, social life, emotional life and financial life. It permeates the being of the adolescent in most realms of his existence.

#### **5.3.5 SUMMARY**

This study has revealed the adolescent as an agent of change and as a victim of change within the unpredictable world of political furore, technological manifestations and overpopulation. The school's obligation will always remain the same - it must prepare its inhabitants for independence, functionality and dignity within the incumbent social structure. The means that the school utilizes to achieve its goals must keep pace with the needs of the adolescent as he is situated within the changing world. Subjects

offered at school ought to be reviewed if traditional, and researched if modern, to ascertain their structure, disciplinarity, applicability and pedagogic implications for the learner. This study has utilized Fundamental Pedagogic essences to reveal computer science as a structured discipline of knowledge, with potential for differentiation, which the school structure can utilize for the complex task of bringing the adolescent to the status of being emotionally, intellectually and potentially financially independent in the most enjoyable and meaningful way.

#### **5.4 STEPS INVOLVED IN A CURRICULUM CHANGE**

Anyone dealing with curriculum updating in the form of the introduction of a new subject or a new range of subjects, is aware of the fact that this is a slow and lengthy process. Besides the determination of learning content, the process must take into account budgetary problems, selection and purchase of equipment and the human factor. ADERETH *et al.*, (in: Barta & Raab *eds.*, 1984:25) list four major phases of curriculum updating and each will receive a brief exposure henceforth.

##### **5.4.1 CURRICULUM DEVELOPMENT**

This phase involves the selection of learning content following a situation analysis and the setting of aims and objectives. Once the learning content has been selected, the learning experiences determine the materials needed by pupils and staff. Textbooks, required to be written in at least two languages in South Africa, software with comprehensive instruction manuals, computers, printers and secondary storage media such as floppy discs would be required by teachers and pupils alike. One textbook

per standard would not be feasible for the proposed syllabus differentiation, as it is envisaged that the three courses (grade-A, grade-B, grade-C) would differ considerably in content and not reflect a watered-down type of differentiation. Special venues to house expensive computer units would require attention to security and dust-free environments. The academic and logistic planning for computer education is expensive and specialized, but the long-term rewards would be financially, socially and humanly advantageous to the nation.

#### **5.4.2 TRAINING OF TEACHING AND SUPERVISORY STAFF**

The tuition of computer science requires a teacher renewal strategy. Teachers do not assume the rôle of a source of knowledge that is to be disseminated in a predetermined form. Computer teachers work with open situations. They promote activities that are not ruled by the aim of achieving a predetermined outcome. Instead, they encourage pupils to identify obstacles and to reach original solutions not foreseen. Teachers of computer science are, according to NEMIROVSKY (1987:53):

"... teachers who are question posers, rather than sources for answers, who foster quests that go beyond obvious and stereotypical solutions, and who are critical thinkers capable of encouraging students to think critically in turn".

The computer science teacher must portray a particular sensitivity for each learner and look for the meaning that a learner attaches to an individual idea or problem. The present matriculation system has not escaped criticism of its ability to produce matriculants with exceptional results who are thereafter not able to cope academically

or emotionally with university standards. The school system has evidence of pupils with intelligence quotas (I.Q.s) in the 140 range who become disenchanted with schooling and often fail a standard or leave school prematurely (CEFT, 1985a:6). Such situations could be a result of the imposition of facts and stereotyped solutions by the teacher, instead of encouraging original thought and critical thinking.

The introduction of microcomputers must follow serious discussion of when, where and how it should be done. For the machine to be adequately introduced it is clear that the teacher must be qualified emotionally, theoretically and practically. Courses have begun at in-service training colleges associated with White education and in some pre-service training colleges, but if the subject is to be introduced on a large scale in the suggested differentiated form, then the necessity for wide-range initial training and continued training of teachers and administrators must be emphasized. This aspect of curriculum renewal is perhaps the most costly. Its planning and implementation opens an avenue for further research.

#### **5.4.3 SELECTION, PURCHASE AND INSTALLATION OF EQUIPMENT**

Computer science education has been successfully introduced in countries such as Great Britain, the Netherlands, the United States of America, Austria, Germany and Finland (Barta & Raab eds., 1984:various papers). When computer education is updated or introduced in a country it is hoped that any mistakes made by those countries already functioning successfully in the field will not be repeated by the developing country. Factors requiring consideration when installing a computer centre

include initial costs, maintenance costs and personnel, environment and power requirements. Establishing a computer centre is no different from any other furnishing endeavour; the wallet rules in the long run. The ultimate decision rests with the rand amount in the bank and the rand value on the overseas market. This study is not concerned with the processes required to make a decision concerning the make of computer, what size of memory, what speed of access, what peripherals and what software are suitable. These aspects are, however, important and the reader is urged to consult PANTIEL & PETERSEN (1985:185-201) for valuable worksheets to complete prior to deciding on where the best value for money can be obtained when purchasing computer hardware for school centres. The key to being happy with the purchase is to carefully follow certain steps before succumbing to the sales pitch of a computer dealer.

"In short, just as with software, you have to do your homework. The more information you have, the better the chance of getting the right computer to answer your needs" (Pantiel & Petersen, 1985:185).

Assume that one workstation, including printer, would cost in the region of R4 500 (in 1992) and forty such stations are required per institution. This cost, including a library of software, would total R200 000 as an initial outlay. Each year an amount must be budgeted for maintenance costs, updating of software and facilities and insurance premiums. It is clear that the undertaking is initially prohibitively expensive for a school to embark on and also the ongoing expenses are financially intense. The solution lies with community involvement and State assistance. Neither the school nor the community nor the State can be expected to fund such an undertaking singularly,

but a joint venture could make the proposition a reality. The community and the State would need to be assured of the cost-effectiveness of the introduction of computer science into all senior secondary schools, rather than being daunted by the cost of it.

#### **5.4.4 IMPLEMENTATION OF CHANGE WITHIN THE SCHOOLS**

The computer science teacher has been mentioned in 5.2 above but the remainder of the teaching staff of a school has to be addressed as well. At the time that most of today's teachers (1992) were being educated, technology in general, and computer technology in particular, were not being taught. The prototype teacher is used to pen and paper techniques and box-filing systems. The entire population needs to shed their computer phobias and enjoy what this exciting field of organization has to offer. The entire school staff needs to be orientated to regard the computer room as much their own as the staffroom is. The computer room must be scheduled for use by pupils and staff. For this reason, the computer room would possibly need to stay open under supervision until 17:00 every weekday. This would require consideration of academic staff-hours or the appointment of a centre-supervisor to control computer activities at all times. A community-pupil liaison officer (a computer science teacher?) would assume the task of liaising with industries and businesses in the area to accommodate the senior pupils during research projects. Every teacher would need to consult with the computer science teacher as to how their subject may be integrated into computer assignments. The computer centre may also be permitted to offer recreational facilities in the form of competitive computer games for staff and students, on a controlled schedule, of course.

The author envisages the computer centre as a source for a different perspective on the education situation. Pupils may take the initiative in orientating their various subject teachers in the use of the computer to create data bases, write subject-specific programs, create question-banks for examination and tests and use the wordprocessor for the typing of tests and examinations. If pupils acquire these skills in class, then it would seem logical that they should pass these skills on to the computer-phobic teacher. Pupils may even offer to maintain marksheets of teachers by entering new sets of marks whenever the need arises. Such pupil-teacher interaction on an academic level should provide new enthusiasm for the interdependence of educator-educand in the education situation.

A new life in the corridors and classrooms will accompany the large-scale introduction of computer science in the schools. The implementation thereof is hardly a matter of choice; it must be done and experts must be appointed to effect the change. It would be unrealistic to contemplate a sudden appearance of the subject on a large scale in all secondary schools. What is feasible and suggested, is the implementation of the subject in phases over a period of several years, each phase witnessing the introduction of the subject into a predetermined number of schools. In this way the training of teaching and supervisory staff, the financial implications and the expectations of pupils and parents can be anticipated and planned for.

## **5.5 POSSIBILITIES FOR FURTHER RESEARCH**

As this investigation proceeded, certain ideas have manifested which suggested the need for further research, reflection and investigation. Not all have an obvious

Fundamental Pedagogical nature but the perspective of the researcher would influence the character of the investigations.

One area identified by the author for further research would be an assessment of the value of introducing computer science to physically disabled people. Writing programs, data capture and wordprocessing tasks appear to be perfectly suitable for people who have limited physical mobility but who are motivated by the challenge to produce something worthwhile, exciting and useful for the community. The author envisages a research project in which a computer science educator prepares a sample of physically disabled people with skills in the computer field that are required by local businesses. The effect that the acquired computer knowledge and skills may have on the self concept and dignity of the physically disabled person could be investigated over a period of one to two years.

Another area of research would involve an investigation into the influence that computer science, as a matriculation subject, has had on the careers of pupils who pursued the subject until the end of standard 10. The extent of the use of the acquired knowledge and skills and the resulting effect on the lives and the successful realization of adulthood by a sample of pupils, could be researched. This project is feasible only after computer science, in a differentiated form, has been made available to school pupils of all levels of intellectual ability. The value of the subject could be compared with other subjects in the matriculation curriculum. This investigation, as well as that suggested for disabled persons, could assume a Fundamental Pedagogic character.

An investigation into the life-worlds of pupils who are "computer fanatics" or

"computer boffins" is seen by the author to be a challenging field of research. Education should aim to produce a "well balanced" child who has developed appropriately in the intellectual, physical, social and spiritual domains. Would a child, who spends many hours of his free time in front of a computer, exhibit "well-balanced" characteristics? What effect would this have on his socialization and interaction with peers? Such investigation could be conducted using Fundamental Pedagogical structures as a foundation for research.

A renewal strategy for teacher-training for computer science is yet another area of research identified by the author. It has been mentioned in 5.4.2 that the traditional teacher who prepares pupils for anticipated questions in a forthcoming examination, is most unsuitable for the teaching of computer science. Teachers of today are being trained by educators of the traditional kind and the training-teachers, themselves, have passed through the South African school system which is "examination orientated" instead of being "thinking orientated". A strategy to produce teachers who do not have a spoon in their hands but other means to motivate creativity and original thought, is an exciting and challenging area of research for the tertiary didactician.

It is assumed that much research has already been conducted concerning the learning strategies of boys and girls. The author has experienced that girls are frequently more reserved about expressing their ideas freely and tend to prefer to be instructed in the exact ways and means to arrive at a solution to a problem. Boys, on the other hand, have been observed by the author to be generally more enthusiastic about their strategies to derive an answer and, unlike girls, are not unduly embarrassed by

unsuccessful attempts. The effect of the subject computer science on the learning strategies and resulting self concepts of a sample of pupils, is perceived to be a field of study of interest to a didactician or a Fundamental Pedagogician.

These five suggestions for further research emanating from the present investigation have, on no account, exhausted the possibilities for further research. The reader is reminded that vocational education in schools is anticipated to influence the South African education system dramatically in the near future. It is anticipated that computer science will assume an important position in this vocational program and the fields of investigation arising from this will be numerous.

## **5.6 SHORTCOMINGS OF THIS INVESTIGATION**

### **5.6.1 INTRODUCTION**

No research project can claim to be perfect; imperfections may arise in the literature study, the methods of investigation or the evaluation instrument. The researcher may become aware of shortcomings in the evaluation instrument after members of the sample have already completed it. A research project or a thesis, such as this one, may take more than two years to complete. Such a time span may see new knowledge or new developments in the researcher's field of study, which would influence the original hypothesis formulation or problem recognition. Most shortcomings arise from the manifestation of new situations or new knowledge, not anticipated by the researcher for acceptable reasons. These imperfections need not alter the findings of the investigation, provided the researcher identifies the imperfections and the extent

to which the findings need to be manipulated or addressed to compensate for those imperfections. The shortcomings of this investigation have been identified by the author and now receive attention.

### **5.6.2 THE EVALUATION INSTRUMENTS**

The author commenced this study in 1989 with the compilation of the questionnaire that was sent to the various Departments of Education to assess the current situation in South Africa concerning tuition of computer science in secondary schools. By the end of 1992 when this research project was finalized, tuition situations could have changed across the country and certainly did change in the region where the author teaches computer science. Fortunately, a question was included in the evaluation instrument which requested a projected plan for the subject for the future. It was possible, therefore, to comment on changes that had certainly taken place and assume those changes that were anticipated to occur within Departments. In this way the information on presentation is as current as possible.

The author designed the pupils' questionnaire at an early stage in the proceedings. The first group of pupils to complete the questionnaire was the 1989 matriculation class after they had written their final examination. It is impossible to anticipate pupils' responses and it transpired that pupils were providing responses that necessitated further investigation. Three questions were added to the questionnaire before the remaining two groups completed it. This constituted a shortcoming in the evaluation instrument, but not to the extent that the results were affected. The change was adequately compensated for in the counting procedures.

### 5.6.3 SYLLABUS CONTENT

The content selected and presented in this study by no account exhausted the possibilities for a differentiated computer science syllabus. The content exposed is, however, extensive and incorporates the essentials of a computer science course. There are two areas which the author repeatedly reflected on, contemplating inclusion, but ultimately decided were, perhaps, too commercially specific and might have introduced a misconception that computer science is "padding" its syllabuses with content blatantly belonging to another discipline. The two areas which could find appropriate applications in specifically vocationally oriented computer syllabuses are "Office Procedure" and "Industrial Accounting". The two themes would have particular relevance for the Grade-C course, as each theme is vocationally oriented. The male pupils could embark on the Industrial Accounting course while the female pupils could study the Office Procedure theme. These two themes may provide the Grade-C learners with specific vocational skills necessary to be able to compete for an employment position on leaving school. Their status of adulthood and independence may certainly be enhanced if their computer science achievements include these vocationally specific themes. Both themes could be incorporated into a computer science syllabus using appropriate application packages to support their content. Guidelines for the content of both themes are to be found in syllabuses of Technikons offering tuition in these modules.

#### 5.6.4 THE THREE INTERVIEWEES

Motivation for choosing Ryan, Roland and Kevin was detailed in 4.5.1. The author does, however, acknowledge that all three are males and, perhaps, at least one female pupil should have been interviewed. There is a tendency for computer classes to be dominated in numbers by males. This is illustrated by the following male : female ratios of the classes presently being taught computer science by the author:

- \* Standard 8 : 16 : 0
- \* Standard 9 : 12 : 1
- \* Standard 10 : 10 : 2

This year's ratios are not unusual. Male pupils tend to be challenged by problem solving and opportunities to think freely. Female pupils, on the other hand, appear to be intimidated by the idea of free expression and often prefer to be guided in the direction of action by reliable steps and rules which support and direct their decision making. The choice of three males was neither a prejudiced nor a sexist decision. It was the less inhibited characteristic of the male pupil that prompted the spontaneous choice.

The shortcomings discussed above needed to be clarified but have had no apparent effect on the findings of this study. All that remains to be done is to encapsulate the reasons for undertaking this investigation and to resolve the findings in relation to those reasons.

## 5.7 CONCLUSION

Computer science, syllabuses and the teaching-learning activities of the classroom milieu are practical expressions of the education situation. They are real, tangible and observable entities which have been recognized and subsequently probed and described within the context of the influences that technology and overpopulation have on education. Generalizations about the adolescent and his strivings for the state of adulthood within the pedagogic school structure were investigated from a Fundamental Pedagogic perspective which assumed essentially theoretical descriptions. Initially, the task of synchronizing the practical of computer science education with the theoretical of Fundamental Pedagogics appeared to be unrealistic and the author despaired that "n'er the twain shall meet". As the study proceeded, however, the theory revealed itself in the practical situations and the practical experiences of computer science teaching and learning found expression within the Fundamental Pedagogic essences. The author is confident that success has been achieved by utilizing the theory of the pedagogic school structure to reveal how differentiated computer science courses can assist the school in its vital task of raising the adolescent, in an exciting and a dignified way, to Life's echelon of adulthood.

Parents and teachers constantly remind their wards of the importance of education in these highly competitive times of unemployment and overpopulation. Education is perfunctory if its relevance is not addressed. Many pupils obligingly and relentlessly pursue the academic curricula offered at school, only to find they lack the relevant knowledge and skills required for Life. Man will not voluntarily discard that which

is meaningful from his life. Since the Soweto uprisings of 1976 wherein thousands of Black secondary school children took to the streets and burned textbooks and destroyed school property, many such protests and unrest activities have sporadically manifested in Black residential areas across the country. Politicians and educationalists question the obvious reasons for the classroom boycotts without questioning why these secondary school pupils are so easily enticed out of their classrooms, often at times when tuition and application should be at a premium. The author suggests that the traditional education offered to the vast majority of Black pupils in secondary schools is neither meaningful for nor relevant to what society needs and demands. A matriculation certificate comprising three languages, history, biology and biblical studies is hardly conducive to a dignified and useful existence in a technological society. The author is of the opinion that, if education held the promise of a challenging and purposeful life after school, then the school offering such education would be regarded by pupils, parents and society with the respect it deserves. If education systems of the future do not free themselves from traditional type education, as is being offered to the majority of Black pupils of South Africa who constituted 65% of matriculants in 1988 (Schrire, 1991:17), a possible educational backlash founded in meaningless education may result. It is not possible to make a definite prediction in this respect, but it would appear as if inappropriate education, to which pupils have difficulty in attributing significance, may be as insidious a cause of student unrest as the "political unrest" of the media reports.

Education may neglect neither the needs of the learner nor the demands of the society. This study has utilized the discipline of computer science to illustrate the importance

of considering the needs of the adolescent as he is, and will be, situated within society, when selecting learning content. The learning content should link the adolescent to the reality of life beyond the school. Education is not a matter of knowing something but rather knowing how to deal with something that matters. The greatest gift that one generation can pass onto the next is a meaningful education.

"As individuals learn to use electronic networks, they will be able to acquire information from new sources related to the solution of self-defined problems; to define with the aid of other computer network members, technical and social problems and to seek solutions to these problems, and to develop with others new knowledge, products and proposals. The power of computers to change society will surely have more far-reaching effects on the purposes of education than on the means of instruction (Culbertson, in: Culbertson & Cunningham eds., 1986:125).

This opinion of CULBERTSON is consolidated by DAVIES & SHANE (in: Culbertson & Cunningham, 1986:19):

"The newly developed body of microelectronic resources epitomized by the computer has an imposing array of brilliant potential solutions for a number of our personal-social problems. It is up to us, as educators, to establish priorities as we address the problem of effective teaching and learning. In this way, we will best be able to utilize our newest resources to prepare learners for successful living in the new millennium which is close at hand".

Having analysed, conceptualized and reflected on the contents of this study, the reader should now consider the message conveyed by these two quotes to epitomize educational sense for the "new millennium", which has, in fact, already arrived.

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## **APPENDIX A**

**Questionnaire sent to Departments of Education to assess the recent situation  
pertaining to computer science education in South Africa.**

**QUESTIONNAIRE FOR  
NATIONAL EDUCATION DEPARTMENTS  
TO ASSESS THE STATUS OF  
COMPUTERS IN SECONDARY SCHOOLS.**

This questionnaire consists of four sections: A, B, C, D. Throughout reference will be made to "Computer Science" (CS) and "Computer Education" (CE).

\* CS refers to the formal, academic subject, guided by official syllabi, offered over a period of several years to secondary-school pupils, culminating in an external examination at the end of the matriculation year.

\* CE refers to the informal courses designed by, and offered by, individual schools as a pupil-enrichment endeavour to promote computer-literacy.

The aim of this study is NOT to compare the functioning of the various Education Departments with respect to CS, but rather to assess the importance of, the popularity of, the demand for and the progress of the subject COMPUTER SCIENCE in the various provinces.

Most questions require only an "X" in an appropriate block, but there are questions that require a numerical grading, while others may require more than one "X" for adequate specification.

**SECTION A**

1. Within this department is...

\* CS offered as an examination subject up to Std 10 level?

Yes	No

\* CE offered in at least 20% of the secondary schools?

Yes	No

2. Within this Department, is there a centrally-situated structure that controls the development of CS as a school subject?

Yes	No

3. If the answer to Q2 is "Yes", for how many years has this structure been functional?

--

4. How would you describe the present functioning of CS in this Department? (Mark with an X).

Non-Existent	Developing slowly	In operation but problematic	Established and successful	Established, successful and still growing



2. When is the subject offered?

\* During normal school hours.


\* After normal school hours.

3. Select the option which most closely describes the situation within this Department.

The subject is offered to...

\* all pupils at most schools.

\* selected pupils at most schools.

\* all pupils in a few schools, depending on the availability of computers and competent staff.

\* selected pupils in a few schools, depending on the availability of computers and competent staff.

\* to all (any) pupils at centrally situated venues.

\* to selected pupils at centrally situated venues.


4. If only selected pupils are offered the opportunity of studying CS, how are these pupils selected? They are selected by virtue of their...

\* mathematics averages.

\* language averages.

\* course averages.

\* proven interest in computers.

\* choice of Natural Science subjects.

\* choice of commercial subjects.

\* choice of Electronics as a subject.

\* results obtained in an aptitude/selection test.


Any other criteria, please specify.

---

---

---

---

5. During what standard(s) is CS offered as an official (internal or external) examination subject?

Standards	6	7	8	9	10

6. How many hours per week (approximately) are prescribed for CS in each standard?

Standards	6	7	8	9	10

7. What differentiation occurs within the subject? CS is offered on the...

Grade	Higher	Standard	Lower	Functional

8. Does this Department provide in-service training courses for teachers of CS on a regular basis?

Yes	No

9. A table appears on the following page. Indicate what topics are dealt with during the CS course, in the specific standards as indicated. Please specify the programming language(s) studied and the software packages used (if any). Only the nature of the package is required eg. Wordprocessor, spreadsheet. Space is provided at the end for any topics not specified.

TOPIC	STANDARDS				
	6	7	8	9	10
Programming Language					
Programming Language					
Programming Language					
History of Computers					
Computer Architecture					
Basic Electronics					
Modern Technology					
Number Systems					
Boolean Algebra					
Circuits & Networks					
Software Packages					
Software Packages					
Software Packages					
System Designing					
Hands-on Experience					







**APPENDIX B**

**Questionnaire completed by pupils of computer science.**

QUESTIONNAIRE FOR STD. 9 AND STD. 10 PUPILS OF COMPUTER SCIENCE.

The questions that follow must be answered honestly and as accurately as possible to facilitate a valid and reliable assessment of the pupil-subject relationship in the computer science environment. Most questions require an X in an appropriate block to indicate your answer. If an explanation is required, please convey the idea as lucidly as possible.

-----

1. What standard did you complete at the end of 1990?

9	10
---	----

2. For what reason(s) are you attending the computer science classes? If you have more than one reason, use a 1 for the most important reason, a 2 for the next most important reason..., and so on.

- \* To facilitate university entrance.
- \* My parents desire it.
- \* I enjoy computer work.
- \* A 7-subject matric has extra status.
- \* It is a privilege awarded to me.
- \* The classes are enjoyable and sociable.
- \* I recognize the need to be computer literate.
- \* I intend making computers my career.
- \* I need computer knowledge for my chosen course/career.


3. The following questions deal with your future career.

3.1 Do you intend pursuing study in computer science at a university or technikon on leaving school?

YES	NO
-----	----

3.2 Whatever your answer to 3.1, describe the career you have in mind on leaving school.

---

---

---

3.3 What factors influenced your choice of career?

---

---

---

3.4 Has the study of computer science influenced your choice of career?

YES	NO
-----	----

4. You have seven subjects in your school curriculum.

4.1 List the subjects in order of preference as you ENJOY the subjects. Do not let your marks, or who will read your reply, influence your choice.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_

4.2 Now consider the marks that you receive for the seven subjects. Place the subjects in the blocks so that the subject with the highest marks is in block one, proceeding to block seven for the lowest mark. Alongside each, indicate the average mark that you attain for that subject.

1. \_\_\_\_\_
2. \_\_\_\_\_
3. \_\_\_\_\_
4. \_\_\_\_\_
5. \_\_\_\_\_
6. \_\_\_\_\_
7. \_\_\_\_\_

5. The following subjects compare the DIFFICULTY of computer science with other subjects. Use a 1 for the most difficult subject, a 2 for the second most difficult subject and a 3 for the least difficult of the group. Complete only those groups relevant to your curriculum.

5.1

COMPUTER SC.	MATHS.	SCIENCE

5.2

COMPUTER SC.	MATHS.	1st LANGUAGE

5.3	COMPUTER SC.	MATHS.	BIOLOGY
5.4	COMPUTER SC.	MATHS.	HIST./GEOG.
5.5	COMPUTER SC.	MATHS.	TECHNICAL SUBJ.

6. If computer science were available as a full-time school subject...

6.1 would you have chosen computer science as part of a six-subject curriculum?

YES	NO
-----	----

6.2 which subject, if any, would you have omitted from your present six-subject, full-time course to accommodate computer science?

7. Do you think that the content of the present course as you pursued it, is suitable for...

7.1 All high-school pupils?

7.2 Higher-grade pupils only?

7.3 Both higher- and standard-grade pupils?

7.4 Mathematically-proficient pupils only?

YES	NO

8. If you could advise planners on the content of a computer science course for schools, what topics would you exclude (if any) from the present course? Where possible, briefly state your reasons.


9. If you could advise planners as above, what topics would you include in a computer science course, other than those that were

available to you?


10. All subjects have certain mental activities associated with them, together with skills of a more practical nature that need to be mastered. Some of these activities and skills are mentioned below, together with the subjects computer science, maths and science. If you feel that the particular skill under consideration is necessary for any of the three subjects, then place an X in the appropriate block.

SKILL	COMP. SC.	MATHS.	SCIENCE
Memorizing of facts.			
Thinking in steps.			
Designing solutions to problems.			
Manipulation of numbers.			
Using rules/laws to solve problems.			
Use of home language.			
Being creative.			
Relating to the "Real World".			
Hand-eye co-ordination.			
Hand-mind co-ordination.			
Development of neatness.			
Development of accuracy.			
Organizing of thought-patterns.			

Q. Have you ever assisted a member of your family by doing work for him/her on a computer?

Q. If you have answered "yes" above, please give details.


10. Did you find a seventh subject a strain on your mental and physical capabilities in...

	YES	NO
STD. 8?		
STD. 9?		
STD. 10?		

11. If there are any ways or means whereby you think the present computer science education system can be improved, please specify here. Your comments may apply to you specifically, to the course in general or to the physical facilities offered by "hands on" experience.

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---

---

12. Do you have a computer at home? \_\_\_\_\_

13. If the answer to 12 is "yes", who uses it and for what reason?

---

---

---

14. Do you ever exchange computer knowledge with any member of your family?

---

15. If you answered "yes" to 14, specify the members of the family (relationship) and the nature of the knowledge exchanged (Age).

---

---

---

16. Do you ever exchange computer knowledge or computer games with friends? If "yes", please give a brief description.

---

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THANK YOU FOR YOUR CO-OPERATION.

## **APPENDIX C**

**Letters sent to Departments of Education, Universities, Colleges of Education and  
Technikons requesting computer-related syllabuses.**

REPUBLIEK VAN SUID-AFRIKA



REPUBLIC OF SOUTH AFRICA

Verw. Nr./Ref. No:

NAVRAE/INQUIRIES: J.P. VAN HEERDEN/rm

Tel. No. 736-3702/5501

KANTOOR VAN DIE-OFFICE OF THE

EAST RAND COLLEGE OF EDUCATION  
PRIVATE BAG X52  
SPRINGS  
1560

Dear Sir/Madam

The attached letter confirms that I have been appointed to design syllabi for computer studies as a major subject for teacher-training colleges of the Department of Education and Training. The prescription for this course is that it attains a standard equivalent to 1½ years on university or tertiary level. To achieve this, I would be grateful if you could forward to me the syllabi that are at present in use for the first year and second year courses. If I can secure the co-operation of several tertiary institutions, I hope to succeed in designing appropriate syllabi for this "new" subject to be implemented at Black Colleges of Education.

Thanking you in anticipation of your co-operation.

Yours faithfully

(Mrs.) J.P. van Heerden



Verw. Nr./Ref. No.

NAVRAE/INQUIRIES: J.P. VAN HEERDEN/rm

Tel. No. 736-3702/5501

**KANTOOR VAN DIE-OFFICE OF THE**

EAST RAND COLLEGE OF EDUCATION  
PRIVATE BAG X52  
SPRINGS  
1560

Dear Sir/Madam

One of the attached letters confirms that I am a bona-fide student studying for a doctorate degree at UNISA. Part of my research involves an investigation into the present situations existing in the various Education Departments in South Africa with respect to computer education at schools. I would be very grateful if you could assist me by completing the enclosed questionnaire and returning it as soon as possible within the enclosed envelope.

The other letter confirms that I have been appointed by the D.E.T. to compile syllabi for teacher-training courses at colleges of education for the implementation of computer science as a major subject. I would appreciate it if you could forward to me any syllabi that your department is using at present in schools or teacher-training institutions. If I am able to obtain such syllabi from all the different Education Departments, I hope, also, to establish, by means of my doctorate studies, some uniformity of content, standard and approach to computer education, amongst all departments in the country.

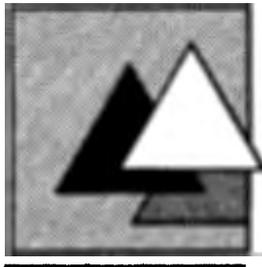
I thank you in anticipation of your cooperation.

Yours faithfully

(Mrs.) J.P. van Heerden

**APPENDIX D**

**Letter from Manchester City Council Education Department confirming program for visits to three institutions to observe the development in information technology education.**



# EDUCATION DEVELOPMENT SERVICE

Education Development Service,  
South District Centre,  
Royal Oak Infant School,  
Royal Oak Road,  
Wythenshawe,  
Manchester, M23 8EB.  
Tel: (061) 998 5256  
945 4846/7

Senior District Inspector:  
MONICA TIMMIS

District Manager:  
JENNY ANDREWS

EDS/PM/MC  
20th December 1989

Mr M Saperia  
6 Singleton Lodge  
Cavendish Road  
Manchester

Dear Mr Saperia

Apologies for the delay in responding, the 'flu' bug caught up with me last week. However, I am able to confirm arrangements for the visit of your colleague Joan Van Hiliden from South Africa to two schools in the City of Manchester. In addition I have arranged for my colleague Mr P Murphy who is head of the Micro Electronics Development Unit to host her.

The programme for Tuesday 9th January 1990 is as follows :

9.15am                    Micro Electronics Development Unit

Contact :                Mr Paul Murphy

Tel :                      061 226 9154

10.00am                Trinity C of E High School

Headteacher            Mr M Evans

Contact :                Mr Tony Leach

School tel :             061 226 2272

1.30pm                 Parrs Wood High School

Headteacher :         W.G. Stone

Contact :                Mrs Margaret Burgess

School tel :             061 445 8786

Cont.....

 **EDUCATION DEVELOPMENT SERVICE**

I trust that these arrangements are suitable and hope that your colleague has a useful visit to the City.

Yours sincerely

*Peter Millington*

**Peter Millington**  
**District Inspector**

**P.S.** : Maps enclosed showing location of schools and the Micro Electronics Development Unit at Birley High School

**Copies for information to:**

E Milroy	Senior Inspector
M Timmis	Senior Inspector
P Murphy	MEDU
J Andrews	District Manager

## **APPENDIX E**

**Programs written to evaluate the responses of the pupils to the pupil-questionnaire  
(appendix B).**

```

program QUEST2;
(* Question 2 deals with reasons for attending Computer Science classes *)

uses crt,printer;

var
  opt          :array[1..9] of string[31];
  i,j,k,dum,award,pt,q :integer;
  sum          :array[1..9] of integer;
  dumdee       :string[31];

begin (* Question 2 *)
  for i:=1 to 9 do
    sum[i]:=0;
    opt[1]:='Facilitate University Entrance';
    opt[2]:='Parents Desire it';
    opt[3]:='Enjoy Computer Work';
    opt[4]:='7-Subject Status';
    opt[5]:='Privilege';
    opt[6]:='Enjoy/Social Classes';
    opt[7]:='Need for Computer Literacy';
    opt[8]:='Follow Computer Career';
    opt[9]:='Need Literacy for Career';
    clrscr;
    write('Type in number of questionnaires ');
    readln(q);
    for K:=1 to q do
      begin
        clrscr;
        writeln('Start now with questionnaire ',k);
        write('Which option is marked? (0 for none) ');
        readln(i);
        while i<>0 do
          begin
            write('Type in points awarded to option ',i,' ');
            readln(pt);
            award:=10-pt;
            sum[i]:=sum[i]+award;
            write('Next option marked? (0 for no more options)');
            readln(i);
          end; (* while i *)
        end; (* for k *)
      clrscr;
      writeln(lst,'The sorted scores for QUESTION 2 are :');
      for i:=1 to 8 do
        for j:=i+1 to 9 do
          begin
            if sum[i]<sum[j] then
              begin
                dum:=sum[i];
                sum[i]:=sum[j];
                sum[j]:=dum;
                dumdee:=opt[i];
                opt[i]:=opt[j];
                opt[j]:=dumdee;
              end; (* if sum *)
            end; (* for j *)
          writeln(lst);
          writeln(lst,'OPTION                               SCORE');
          writeln(lst,'-----');
          for i:=1 to 9 do
            writeln(lst,opt[i],sum[i]:40-length(opt[i]));
          writeln(lst);
          write('Press 'ENTER' ');
          readln;
        end. (* Question 2 *)

```

```

program QUEST3;
(* Question 3 deals with Computer Science and Careers *)

uses crt,printer;

var
  Q,k,i,ctype,flag,carcount,infcount :integer;
  car,inf                             :char;
  loopbaan                            :string[30];
  career                               :array[1..80] of string[30];

begin (* Question 3 *);
  clrscr;
  writeln('Question 3 is now being processed. ');
  write('Type in number of questionnaires ');
  readln(Q);
  infcount:=0;
  ctype:=0;
  career[1]:= '';
  carcount:=0;
  for k:=1 to Q do
    begin
      clrscr;
      WriteLn('You are now processing questionnaire ',k);
      write('What is the answer to 3.1 ? (Y or N) ');
      readln(car);
      car:=upcase(car);
      if car='Y' then carcount:=carcount+1;
      writeln('What career is nominated in 3.2?');
      readln(loopbaan);
      flag:=0;
      for i:=1 to ctype do
        if loopbaan=career[i] then flag:=1;
        if flag=0 then
          begin
            ctype:=ctype+1;
            career[ctype]:=loopbaan;
          end; (* if flag *)
        career[ctype+1]:= '';
      writeln;
      write('What is the answer to 3.4 ? (Y or N)');
      readln(inf);
      inf:=upcase(inf);
      if inf='Y' then infcount:=infcount+1;
      write('Next questionnaire; Press 'ENTER');
      readln;
    end; (* for k *)
  clrscr;
  writeln(lst,'The results fo QUESTION 3 reflect that ...');
  writeln(lst);
  writeln(lst,'1. There are ',carcount,' pupils who intend persuing a career');
  writeln(lst,'    in computers. ');
  writeln(lst);
  writeln(lst,'2. ',infcount,' pupils have been influence in their career cho');
  writeln(lst,'    ice');
  writeln(lst,'    by the study of COMPUTER SCIENCE. ');
  writeln(lst);
  writeln(lst,'3. Some of the careers desired are:');
  for i:=1 to ctype do
    writeln(lst,career[i]);
  writeln(lst);
  write('Press 'ENTER');
  readln;
end. (* Qustion 3 *)

```

```

program QUEST4;
(* Question 4 deals with pupils' academic achievements *)

uses crt,printer;

var
  q,i,flag,diff,enjoy,pointps,pointmt,pointcs      :integer;
  posencs,totencs,possymcs,posemnt,possymmt,symvalcs,symvalmt :integer;
  haimt,haics,negcs,countncs,totcs,totmt,avecs,avemt,heimt  :integer;
  heics,totheimt,totheics,poscs,countpcs,avediff,pointns    :integer;
  symcs,symmt,avesymcs,avesymmt                    :char;

begin (* question 4 *)
  flag:=0;
  enjoy:=0;
  totencs:=0;
  haimt:=0;
  haics:=0;
  negcs:=0;
  countncs:=0;
  totcs:=0;
  totmt:=0;
  avecs:=0;
  avemt:=0;
  heimt:=0;
  heics:=0;
  totheimt:=0;
  totheics:=0;
  poscs:=0;
  countpcs:=0;
  avediff:=0;
  pointns:=0;
  pointps:=0;
  pointmt:=0;
  pointcs:=0;
  avesymcs:= ' ';
  avesymmt:= ' ';
  clrscr;
  write('Please enter the number of questionnaires ');
  readln(q);
  for i:=1 to q do
    begin
      clrscr;
      writeln('You are now busy with questionnaire ',i);
      writeln;
      write('Position of Computer Science on ''Enjoy-table'' :');
      readln(posencs);
      totencs:=totencs+posencs;
      write('Position of Computer Science on ''Symbol-table'' :');
      readln(possymcs);
      write('Symbol achieved for Computer Science :');
      readln(symcs);
      symcs:=upcase(symcs);
      write('Position of Mathematics on ''Enjoy-table'' :');
      readln(posemnt);
      write('Position of Mathematics on ''Symbol-table'' :');
      readln(possymmt);
      write('Symbol achieved for Mathematics :');
      readln(symmt);
      symmt:=upcase(symmt);
      case symcs of
        'A':symvalcs:=85;
        'B':symvalcs:=75;
        'C':symvalcs:=65;
        'D':symvalcs:=55;
        'E':symvalcs:=45;
        'F':symvalcs:=35;
      end; (* case *)
      case symmt of
        'A':symvalmt:=85;
        'B':symvalmt:=75;
        'C':symvalmt:=65;
        'D':symvalmt:=55;
        'E':symvalmt:=45;
        'F':symvalmt:=35;
      end; (* case *)
    end;
  end;
end;

```

```

writeln(1st,'than their achievement in the subject. ');
writeln(1st);
writeln(1st,'There are ',countpcs,' pupils who achieve higher in Computer
;
writeln(1st,'Science than what they tend to enjoy the subject. ');
writeln(1st);
enjoy:=totencs div q;
writeln(1st,'On average Computer Science is the ',enjoy,' th most enjoyed
;
writeln(1st,'subject at school. ');
readln;
clrscr;
if countncs>0 then
begin
pointns:=negcs div countncs;
writeln(1st,'The average difference between those who achieve higher
r');
writeln(1st,'marks in relation to enjoying Computer Science is ');
writeln(1st,pointns,' point(s). ');
end; (* if countncs *)
writeln(1st);
if countpcs>0 then
begin
pointps:=poscs div countpcs;
writeln(1st,'The average difference between those who enjoy Compute
c');
writeln(1st,'Science more than their achievement in the subject is
);
writeln(1st,pointps,' point(s). ');
end; (* if countpcs *)
writeln(1st);
writeln(1st,'There are ',heimt,' pupils who enjoy Mathematics more than');
writeln(1st,'Computer Science. ');
writeln(1st);
writeln(1st,'There are ',heics,' pupils who enjoy Computer Science more');
writeln(1st,'than Mathematics. ');
if heimt>0 then
begin
pointmt:=totheimt div heimt;
writeln(1st);
writeln(1st,'The difference between those who enjoy Mathematics mo
e');
writeln(1st,'than Computer Science is ',pointmt,' point(s). ');
end;
if heics>0 then
begin
pointcs:=totheics div heics;
writeln(1st);
writeln(1st,'The difference between those who enjoy Computer Scien
e');
writeln(1st,'more than Mathematics is ',pointcs,' point(s). ');
end;
writeln(1st);
readln;
end. (* question 4 *)

```

```
program QUEST5;  
(* Question 5 deals with the comparative difficulty of Computer Science *)
```

```
uses crt,printer;
```

```
var
```

```
  i,j,csc,math,othr,q      :integer;  
  totc,totm,toto,avec,avem,aveo,grt,sml :real;  
  pgrt,psml                :string[17];
```

```
begin
```

```
  totc:=0;
```

```
  totm:=0;
```

```
  toto:=0;
```

```
  clrscr;
```

```
  writeln('Question 5 is to be processed');
```

```
  write('How many questionnaires ? ');
```

```
  readln(q);
```

```
  for j:=1 to q do
```

```
    begin
```

```
      clrscr;
```

```
      writeln('You are busy with questionnaire ',j);
```

```
      for i:=1 to 5 do
```

```
        begin
```

```
          writeln('You are now on block ',i);
```

```
          write('Type in the value assigned to Computer Science ');
```

```
          readln(csc);
```

```
          write('Type in the value assigned to Mathematics ');
```

```
          readln(math);
```

```
          write('Type in the value assigned to third subject ');
```

```
          readln(othr);
```

```
          csc:=3-csc;
```

```
          math:=3-math;
```

```
          othr:=3-othr;
```

```
          totc:=totc+csc;
```

```
          totm:=totm+math;
```

```
          toto:=toto+othr;
```

```
        end; (* for i *)
```

```
      end; (* for j *)
```

```
      avec:=totc/(5*q);
```

```
      avem:=totm/(5*q);
```

```
      aveo:=toto/(5*q);
```

```
      grt:=avec;
```

```
      sml:=avec;
```

```
      pgrt:='COMPUTER SCIENCE';
```

```
      psml:='COMPUTER SCIENCE';
```

```
      if avem>grt then
```

```
        begin
```

```
          grt:=avem;
```

```
          pgrt:='MATHEMATICS';
```

```
        end;
```

```
      if avem<sml then
```

```
        begin
```

```
          sml:=avem;
```

```
          psml:='MATHEMATICS';
```

```
        end;
```

```
      if aveo>grt then
```

```
        begin
```

```
          grt:=aveo;
```

```
          pgrt:='OTHER';
```

```
        end;
```

```
      if aveo<sml then
```

```
        begin
```

```
          sml:=aveo;
```

```
          psml:='OTHER';
```

```
        end;
```

```
      clrscr;
```

```
      writeln(lst,'The results of QUESTION 5 reflect that ... ');
```

```
      writeln(lst);
```

```
      writeln(lst,'The subject considered most difficult is ',pgrt);
```

```
      writeln(lst,'The subject considered least difficult is ',psml);
```

```
      writeln(lst);
```

```
      writeln(lst,'(This is comparing COMPUTER SCIENCE to Mathematics and one other subject)');
```

```
      writeln(lst);
```

```
      write('Press ENTER');
```

```
      readln;
```

```
end. (* question 5 *)
```

```

diff:=symvalcs-symvalmt;
if diff<0 then haimt:=haimt+1 else haics:=haics+1;
diff:=posencs-posenmt;
if diff>0 then
begin
    heimt:=heimt+1;
    totheimt:=totheimt+diff;
end
else
begin
    heics:=heics+1;
    totheics:=totheics-diff;
end; (* if diff *)
diff:=posencs-possymcs;
if diff<0 then
begin
    negcs:=negcs-diff;
    countncs:=countncs+1;
end
else
begin
    poscs:=poscs+diff;
    countpcs:=countpcs+1;
end; (* if diff *)

totcs:=totcs+symvalcs;
totmt:=totmt+symvalmt;
end; (* for i *)
avecs:=totcs div q;
avemt:=totmt div q;
case avecs of
    80..89:avesymcs:='A';
    70..79:avesymcs:='B';
    60..69:avesymcs:='C';
    50..59:avesymcs:='D';
    40..49:avesymcs:='E';
    30..39:avesymcs:='F';
end; (* case *)
case avemt of
    80..89:avesymmt:='A';
    70..79:avesymmt:='B';
    60..69:avesymmt:='C';
    50..59:avesymmt:='D';
    40..49:avesymmt:='E';
    30..39:avesymmt:='F';
end; (* case *)
avediff:=avecs-avemt;
flag:=0;
if avediff<0 then
begin
    avediff:=0-avediff;
    flag:=1;
end; (* if avediff *)
clrscr;
writeln(lst,'The results of Question 4 reflect that ...');
writeln(lst);
writeln(lst,'The average symbol for Computer Science is ',avesymcs);
writeln(lst);
writeln(lst);
writeln(lst,'The average symbol for Mathematics is ',avesymmt);
writeln(lst);
writeln(lst,'There is a ',avediff,' percent difference in the average');
writeln(lst,'marks obtained in Mathematics and Computer Science. ');
writeln(lst);
if flag=0 then
begin
    writeln(lst,'The average for Computer Science is higher than that');
    writeln(lst,'for Mathematics. ');
end
else
begin
    writeln(lst,'The average for Mathematics is higher than that for');
    writeln(lst,'Computer Science. ');
end; (* if flag *)
writeln(lst);
writeln(lst,'There are ',countncs,' pupils who enjoy Computer Science more');
);

```

```

                                program QUEST6;
(* Question 6 deals with Computer Science as a 6th or 7th subject *)

uses crt,printer;

var
  chct,subct,q,i,k,flag :integer;
  subject                :string[20];
  vak                    :array[1..30] of string[20];
  percnt                 :real;
  choice                 :char;

begin
  for i:=1 to 30 do
    vak[i]:= '';
  clrscr;
  writeln('Question 6 is being processed');
  write('How many questionnaires? ');
  readln(q);
  chct:=0;
  subct:=1;
  vak[1]:= '';
  for i:=1 to q do
    begin
      clrscr;
      writeln('You are busy with questionnaire ',i);
      write('Would Computer Science have been chosen? (Y or N) ');
      readln(choice);
      choice:=upcase(choice);
      if choice='Y' then
        begin
          chct:=chct+1;
          write('Input subject to be dropped : ');
          readln(subject);
          flag:=1;
          for k:=1 to subct do
            begin
              if subject=vak[k] then
                begin
                  flag:=0;
                  k:=subct;
                end;
            end; (* for k *)
          if flag=1 then
            begin
              subct:=subct+1;
              vak[subct]:=subject;
            end; (* if flag *)
          end; (* if choice *)
        end; (* for i *)
      clrscr;
      writeln(1st,'The results of QUESTION 6 reflect that ... ');
      writeln(1st);
      writeln(1st,'The percentage of pupils who would like to see COMPUTER');
      write(1st,'SCIENCE as part of a six-subject matric is : ');
      percnt:=chct/q*100;
      writeln(1st,percnt:3:3,' percent. ');
      writeln(1st);
      writeln(1st,'The subjects which would be omitted would be : ');
      writeln(1st);
      for i:=1 to subct do
        writeln(1st,vak[i]);
      writeln(1st);
      write('Press ''ENTER'' ');
      readln;
    end. (* Question 6 *)

```

```

program QUEST7;
(* Question 7 deals with the suitability of Computer Science for different
grades *)

uses crt,printer;

var
  q,i,suitct,hgct,hsct,mct :integer;
  suit,hg,hsg,mabl       :char;

begin
  clrscr;
  writeln('Question 7 will be processed');
  write('How many questionnaires? ');
  readln(q);
  suitct:=0;
  hgct:=0;
  hsct:=0;
  mct:=0;
  for i:=1 to q do
    begin
      clrscr;
      writeln('Now processing questionnaire ',i);
      write('Suitable for all high school pupils? (Y or N) ');
      readln(suit);
      suit:=upcase(suit);
      if suit='Y' then suitct:=suitct+1;
      write('Suitable for Higher grade only? (Y or N) ');
      readln(hg);
      hg:=upcase(hg);
      if hg='Y' then hgct:=hgct+1;
      write('Suitable for Standard and Higher grade? (Y or N) ');
      readln(hsg);
      hsg:=upcase(hsg);
      if hsg='Y' then hsct:=hsct+1;
      write('Suitable for Mathematic abilities only? (Y or N) ');
      readln(mabl);
      mabl:=upcase(mabl);
      if mabl='Y' then mct:=mct+1;
    end; (* for i *);
  clrscr;
  writeln(1st,'The results of QUESTION 7 reflect that ... ');
  writeln(1st);
  writeln(1st,'The number of pupils who think that the course is suitable for
... ');
  writeln(1st);
  writeln(1st,'CHOICE                                NUMBER');
  writeln(1st,'-----                                -----');
  writeln(1st,'ALL High School pupils is                    ',suitct:10);
  writeln(1st,'HIGHER GRADE pupils only is                        ',hgct:10);
  writeln(1st,'HIGHER AND STANDARD grade pupils is                ',hsct:10);
  writeln(1st,'MATHEMATIC PROFICIENT pupils only is                ',mct:10);
  writeln(1st);
  write('Press 'ENTER' ');
  readln;
end. (* Question 7 *)

```

```

program QUESTB;
(* Question B deals with topics to be excluded from present syllabus *)

uses crt,printer;

var
  i,q,k,j,dpct,flag:integer;
  excl      :string[30];
  drop      :array[1..20] of string[30];

begin
  clrscr;
  writeln('Question B is being processed');
  write('How many questionnaires? ');
  readln(q);
  drop[1]:= '';
  dpct:=1;
  flag:=0;
  for k:=1 to q do
    begin
      clrscr;
      writeln('You are now on questionnaire ',k);
      writeln;
      writeln('Type in topic to be excluded from curriculum');
      readln(excl);
      IF excl= '' then flag:=1;
      for j:=1 to dpct do
        begin
          if excl=drop[j] then
            begin
              flag:=1;
              j:=dpct;
            end; (* if excl*)
        end; (* for j *)
      if flag=0 then
        begin
          dpct:=dpct+1;
          drop[dpct]:=excl;
        end; (* if flag *)
      flag:=0;
    end; (* for k *)
  clrscr;
  writeln(lst,'The results of QUESTION B reflect that ... ');
  writeln(lst);
  writeln(lst,'The topics suggested for EXCLUSION from the course are : ');
  for i:=1 to dpct do
    writeln(lst,drop[i]);
  writeln(lst);
  write('Press ENTER ');
  readln;
end. (* question B *)

```

```

program QUEST9;
(* Question 9 deals with topics to be included in syllabus *)

uses crt,printer;

var
  q,i,j,vgct,flag:integer;
  voegby      :array[1..20] of string[30];
  incl        :string[30];

begin
  clrscr;
  writeln('Question 9 is now to be processed');
  write('How many questionnaires? ');
  readln(q);
  voegby[1]:= '';
  vgct:=1;
  flag:=0;
  for i:=1 to q do
    begin
      clrscr;
      writeln('You are now on questionnaire ',i);
      writeln;
      writeln('Type in topic to be included ');
      readln(incl);
      if incl=' ' then flag:=1;
      for j:=1 to vgct do
        begin
          if incl=voegby[j] then
            begin
              flag:=1;
              j:=vgct;
            end; (* if incl *)
          end; (* for j *)
        if flag=0 then
          begin
            vgct:=vgct+1;
            voegby[vgct]:=incl;
          end; (* if flag *)
          flag:=0;
        end; (* for i *)
      clrscr;
      writeln(1st,'The results of QUESTION 9 reflect that ... ');
      writeln(1st);
      writeln(1st,'The suggested topics for INCLUSION to the course are : ');
      for i:=1 to vgct do
        writeln(1st,voegby[i]);
      writeln(1st);
      write('Press ENTER ');
      readln;
    end. (* question 9 *)

```

```

program QUEST10;
(* This program evaluates question 10 of the pupil's questionnaires *)

uses crt,printer;

var
  i,j,k,tot,dumsum,domsom,q :integer;
  ct                          :array[1..13] of integer;
  ave                         :array[1..13] of real;
  skill,sub                   :array[1..13] of string[30];
  skct                        :array[1..3,1..13] of integer;
  percent                     :array[1..3,1..13] of real;
  ans                          :char;

begin
  skill[1]:='Memorization';
  skill[2]:='Thinking in Steps';
  skill[3]:='Designing Solutions';
  skill[4]:='Number Manipulation';
  skill[5]:='Rules for Problem Solving';
  skill[6]:='Home Language Use';
  skill[7]:='Creativity';
  skill[8]:='Real-world';
  skill[9]:='Hand-Eye';
  skill[10]:='Hand-Mind';
  skill[11]:='Neatness';
  skill[12]:='Accuracy';
  skill[13]:='Organisation of ideas';
  sub[1]:='Computer Science';
  sub[2]:='Mathematics';
  sub[3]:='Science';

  for i:=1 to 3 do
    begin
      ct[i]:=0;
      for j:=1 to 13 do
        begin
          skct[i,j]:=0;
          percent[i,j]:=0;
          ave[j]:=0;
        end; (* for j *)
      end; (* for i *)
    tot:=0;
    clrscr;
    writeln('Now processing Question 10');
    write('Please enter the number of questionnaires ');
    readln(q);
    clrscr;
    for i:=1 to q do
      begin
        clrscr;
        writeln('You are now on questionnaire ',q);
        for j:=1 to 3 do
          begin
            writeln;
            writeln(sub[j]);
            writeln;
            for k:=1 to 13 do
              begin
                write(skill[k],' ');
                readln(ans);
                ans:=upcase(ans);
                if ans='Y' then
                  begin
                    skct[j,k]:=skct[j,k]+1;
                    ct[j]:=ct[j]+1;
                    tot:=tot+1;
                  end; (* if ans *)
              end; (* for k *)
            end; (* for j *)
          end; (* for i *)
        for i:=1 to 3 do
          begin
            ave[i]:=ct[i]/q;
            for j:=1 to 13 do
              percent[i,j]:=skct[i,j]*100/q
            end;
          end;
        end;
      end;
    end;
  end;

```

```

end;
(* Print Results *)
writeln(1st, 'The results of Question 10 reflect that ...');
writeln(1st);
readln;
for i:=1 to 3 do
begin
  clrscr;
  writeln(1st, 'The Percentage of pupils who identified each skill
being');
  writeln(1st, 'pertinent to the relevent subject is :');
  writeln(1st);
  writeln(1st, sub[i]:30);
  writeln(1st);
  writeln(1st, 'SKILL':30, 'PERCENTAGE':15);
  writeln(1st);
  for j:=1 to 13 do
    writeln(1st, skill[j]:30, percent[i, j]:15:2);
  readln;
end;
clrscr;
for i:=1 to 3 do
begin
  writeln(1st, 'The Average Number of skills nominated by a Single
Pupil for ', sub[i], ' is : ', ave[i]:6:2);
  writeln(1st);
end;
readln;
clrscr;
writeln(1st, 'The Percentage Nomination of skills per Subject is :');
writeln(1st);
for i:=1 to 3 do
  writeln(1st, sub[i]:20, ct[i]/tot*100:10:2);
readln;
end. (* Question 10 *)

```

```

    program QUEST12_16;
    (* Questionnaires 1 to 23 only for these questions *)

    uses crt,printer;

    var
        comp,fam,friend           :char;
        i,comptot,famtot,friendtot:integer;

    begin
        comptot:=0;
        famtot:=0;
        friendtot:=0;
        for i:=1 to 23 do
            begin
                clrscr;
                writeln('Question 12');
                writeln;
                write('Is there a computer in the home? (Y or N) ');
                readln(comp);
                if upcase(comp)='Y' then comptot:=comptot+1;
                writeln;
                writeln('Question 14');
                writeln;
                write('Is computer knowledge exchanged amongst family? (Y or N) ');
            );
                readln(fam);
                if upcase(fam)='Y' then famtot:=famtot+1;
                writeln;
                writeln('Question 16');
                writeln;
                write('Is computer knowledge exchanged amongst friends? (Y or N) ');
            );
                readln(friend);
                if upcase(friend)='Y' then friendtot:=friendtot+1;
            end; (* for i *);

        clrscr;
        writeln(1st,'The results of QUESTIONS 12 - 16 reflect that ... ');
        writeln(1st);
        writeln(1st,comptot,' pupils have computers in their home. ');
        writeln(1st,'This represents ',comptot*100/23:6:2,' percent. ');
        writeln(1st);
        writeln(1st,famtot,' pupils share computer activities with members of their
        family. ');
        writeln(1st,'This represents ',famtot*100/23:6:2,' percent. ');
        writeln(1st);
        writeln(1st,friendtot,' pupils exchange computer knowledge with their friend
        ds. ');
        writeln(1st,'This represents ',friendtot*100/23:6:2,' percent. ');
        writeln(1st);
        write('Press ENTER ');
        readln;
    end. (* question 12-16 *)

```