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Editorial

IT and Socio-Economic Development?

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With this first SACJ special issue on IT and development, it may be meaningful, for a moment, to reflect on the very notion of development and its relationship (or not) with information technology. What do we mean by this concept of development? Can information technology play a role in it? And, what should this role be (if at all)? These are very fundamental questions that need to be addressed. I am of the opinion that if we were to neglect these questions developing societies may fall prey to a whole set of reductionist notions and mechanisms that may eventually have more 'costs' than 'benefits'. The questions raised above are complex and could surely not be resolved within the limits of an editorial, or even a single paper for that matter. However, I do believe it necessary to make some comments in order to highlight the issues and maybe propose outlines of possible answers.

The traditional (and commonly accepted) idea of development has a very Enlightenment twist to it. One may articulate it in the following manner. The fundamental idea of this type of development is the notion of progress that is one of the cornerstone values and assumptions of the Modernity movement [6]. In this paradigm the institutions of modern society must create the intellectual and physical artifacts for humankind to conquer Nature and in so doing control its own destiny. Development, according to the modernity view, is progress in degrees and levels of control. The modern, developed, person must be delivered from a contingent and haphazard existence into progressive modes of freedom, through progressive control. They, and society at large, must be the masters of their own destinies. Science and technology must provide the tools (material or conceptual artifacts) for control. Progress, and development as such, is defined by the variety of tools and tool application skills that an individual or a society has at its disposal to shape its own future. In this view then, information technology (and the associated skills to apply it) is seen as tools of development, as a way of increasing the variety to tools at the disposal of the less developed, tool impoverished society, in need of development. Development is for the modern developer synonymous with tool or technology consumption.

Information technology with its characteristics of relative low cost (due to large scale integration and economies of scale), flexibility (through software engineering methods) and ease of use (through sophisticated graphical user interfaces) is clearly an ideal host for the delivery of a wide variety of tools and technologies to a underdeveloped, tool impoverished, society. With the aid of IT a whole host of technological capabilities could be made available, for rapid socio-economic development, at a fraction of the cost of traditional means of delivery. Without too much thought one can provide many examples. For example, through computer assisted training, reading and writing skills can be taught reducing the demand for expensive human teachers. An expert system could be used for clinical diagnosis in the rural hospital reducing the need for expensive human medical experts. From this brief exposition it is clear why there are many who believe that IT, of all technologies, has an enormous potential to leapfrog the underdeveloped societies into the twenty first century.

What is the problem with this paradigm of development? I will briefly discuss three issues that come to mind. Firstly, technologically based progress will lead to the proliferation of instrumental reason [11–13]. Instrumental action is concerned with effect and is success-oriented. Its basis of validity is efficiency and effectiveness which are morally justified aims in modern society. In an instrumental society all things become objects to be manipulated in pursuit of effect. Instrumentality is at the heart of technology (technique) as seen in the definition of technology by Jacques Elull [4]:

> Technique is the totality of methods rationally arrived at and having absolute efficiency (for a given stage of development) in every field of human activity.

Instrumental action through technology is clearly by definition reductionist since the pursuit of efficiency and effectiveness are always specific, not general. The forces shaping the modern technological society assume that if technique is applied to every problem or domain then eventually the whole of society will become efficient. This is an illusion. It is well known from systems theory that the optimization of the parts does not necessarily lead to the optimization of the whole. What is efficient for the local (individual) is not necessarily efficient for the whole (society). The effects of sub optimization, such as environmental damage, pollution, poverty, crime, suicide, etc., that is so prevalent in modern society, bear testimony to this illusion.

Also, with technique it has become possible to achieve

ends without understanding the means or the relationship between the ends, the means and their context. This understanding is only in the head of the designer of the technique. Thus, holistic or hermeneutic understanding [10, 5] is substituted for technique. The context of creation is substituted with the context of application. This is the advantage of technique. Even if the context is not understood, the technique will still produce something. Technique is designed to create ends if applied. It does not require the applicator to understand 'why', it only requires him or her to know 'how'. This is a very powerful incentive in a society where results have become the norm. Thus, the developer must move with the utmost prudence and not merely mindlessly populate a developing community with technology, and the subsequent proliferation of instrumental reason. Especially when it is evident from modern societies of excess technology what ecological damage (and I am using this term in a very general sense) technology could bring in the long run.

Some may argue that the proliferation of instrumental reason (embodied in technology) may not be desirable but it is inevitable. However, they would argue, there is the benefit that the technology does increase the choices available to the individual (or society) and as such the freedom of the individual or society. Hence the benefit of increased freedom outweighs the cost of instrumentality. This may be true, but the whole notion of increased freedom is based on a very doubtful syllogism which may be stated as follows:

- Technology increases choices
- Increased choices leads to more freedom
- Therefore increased technology implies more freedom

It is true that access to technology can increase the choices available to me. For example there are many more places that I could choose to visit if I have a car as opposed to being on foot. Thus the access to a car increases my freedom of movement. But, this is only true in that one dimension of analysis. In another dimension, to have the access to a car, I may have to forfeit my leisure time to work so that I can pay for the purchase and maintenance of the car and in so doing reduce my choice (and freedom) in how I want to spend my time. Similarly, a mobile phone provides me freedom to make a call where and when I choose but, it may also reduce my choices in another dimension as people may expect me to be contactable whenever or wherever I may be. Thus, the syllogism is only true in a one dimensional space of analysis.

Technology always has a price attached to it. This is why modern, technology saturated, societies are often the most existentially 'repressive' type of societies. More often than not one hears the modern plea to "get out" of the rat race, to get "away" for a break, to "escape" to some holiday destination. What is it that we must "get out" from, get "away" from or "escape" from? Heidegger correctly argued that technology will always 'enframe' [7]. Unfortunately the cost of technology is not exposed with the same vigour as the benefits. Mostly this price is ignored by a reductionistic and instrumental approach to technology. For those who want to use (information) technology for development this must surely be a major concern. What will the cost of the technology be for the society in which it will be introduced? Is the cost known or knowable? Do the recipient society agree with this cost and are they willing to pay it? Who will benefit and who will pay? These are ethical and moral issues that are mostly ignored by the Enlightenment paradigm of development.

Finally, there is the issue of technology transfer. I will agree that I may be overstating the case but, it seems to me that many technology based development projects are less about development and more about mere technology 'dumping'. Technology dumping does not lead to development it leads, in fact, to an increase in ignorance as argued by Hobart [9]. The law of requisite variety states that a system can only control another if it has, for every state or condition that the system to be controlled can produce, a counter state or condition [3]. Thus, if one dumps technology on individuals or societies without providing the individual or society with the necessary knowledge, skills and infra-structure to deal with all the conditions that the technology can produce (such as breakdowns, error messages, menu options, buttons, input data, configurations, etc.), then the technology will control them and not the reverse. In such a situation the individual or societies will be placed in a situation of increased ignorance. In this manner developing societies, through reductionistic development, are increasingly been pushed into a world of increased ignorance and higher levels of dependence [2]. It seems, without sounding too dramatic, that 'primitive' societies are pushed by development through mass education systems into factories and innercity slums, into economic systems where they have the disadvantage and, in general, into a world they are wholly unprepared for. In such conditions they merely become objects of control since they do not have the required variety. This form of development alienates them from their traditional world that they know and understand. I am not suggesting that this is the conscious objective of many of those in the development field. I am merely suggesting that good intentions on a local level can, in fact, lead to big injustices in a more global sense. Also, it is clear that technology can not be haphazardly transferred. If it is transferred it must happen as a coherent whole and not as a part. This is what Amin refers to as delinking [1].

If one accepts that technology must be transferred in a holistic manner then the next issue comes into play, namely, the fact that technology is not value free. If we transfer a technology, particularly in this manner, then we also transfer a whole set of values with it (this is very clear in some globally integrated societies where there is a homogeneous "coke" and "hollywood" culture). These imported values may displace some of the local values. Are the recipient culture prepared to pay the price of this cultural imperialism? Are they aware of it? Or, is it only discovered after it is lost?

It is clear from the above discussion that the Enlightenment paradigm of development may create a whole lot of very difficult moral and ethical dilemmas for those involved. It also seems clear that a technology based de-

velopment intervention may have more 'costs' than the 'benefit' attached to it. It also seems to me that there is a need for a more holistic paradigm of development that is multi-dimensional in its efforts to develop [8]. A paradigm that is more than a mere converting of 'primitive' societies into modern societies. We in the field of information systems must not make the mistake to reductionistically 'drop' technology on individuals and societies. Due to the nature of our technology the urge may be big. We must, however, move with much caution and in a very transparent manner if we are to be seen as legitimate agents of development.

In this volume you will find a set of papers that, hopefully, is a move towards this type of holistic development? Decide for yourself.

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Computer-supported Cooperative Education to Support Development in South Africa

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Abstract

With the enormous educational backlogs in South Africa it seems that there is no choice other than searching for alternative, technology-based ways for improving the existing educational situation. This paper describes three case studies in which cooperative learning and computer-supported cooperative learning in support of education and training, are explored. The interest in computer-supported cooperative education is a potential vehicle for introducing information technology to support development through education and training in South Africa. It is argued, that with this information technology intervention, there exists a possibility to make a positive contribution to parallel development. The results of the presented case studies will surely not solve the educational problems in South Africa. However, the learning opportunities embedded in these cases could provide valuable insight in the eventual proposed framework for the implementation of computer-supported cooperative education on a national basis.

Keywords: *South Africa, education, information technology, computer-supported cooperative education, development*
Computing Review Categories: *K.3.1, K.4.0*

1 Introduction

According to Todaro [19], the well-known development economist, it is the human resources of a nation, not its capital or its material resources that ultimately determine the character and pace of its economic and social development. Hallak [10] relates human resource development to the education, training and utilisation of human potentials for social and economic progress. According to the United Nations Development Programme (UNDP) (*op. cit.*) there are five "energisers" of human resources development: education, political and economic freedom, health and nutrition, the environment, and employment. It is argued (*op. cit.*) that although "these energisers are interlinked and interdependent, (but) education is the basis for all the others."

Psacharopoulos *et al* [14] argued that education is not only a basic human right but definitely a basic component of social and economic development. Education as a human right [10] leads to individual creativity, improved participation in the economic, social and cultural roles in society, and hence a more effective contribution to human development.

The South African economy is currently characterized by economic underdevelopment and inhibited economic and socio-economic growth. In the Reconstruction and Development Programme [15] of the Government, five key programmes were identified. *The development of human resources* is one of these key programmes. Against the premises that education is generally regarded as the basis for all human resource development, as well as general acceptance that South Africa is a country with enormous educational backlogs, properly planned investments in education could pay great economic dividends. It is well-known that education contributes to economic growth in developing, as well as developed countries. Examples of *contributions of education to economic growth* – that is, in terms of the rate of return to human capital – are calculated by Psacharopoulos *et al* [14] using the methodologies of Denison [3] and Schultz [17] for various countries for the period since 1950. Table 1 shows some examples of these educational contributions to economic growth in developing, as well as developed countries.

Increased education of the labour force appears to explain a substantial part of the growth of output in both the developed and developing countries in Table 1. The lower contributions, as in the case of The Netherlands, could be ascribed to an already educated workforce, or to a probably too small investment in education, such as in the case of Mexico.

The educational system of South Africa is ill-equipped to support the demands for education and training of its exponentially growing workforce. This leads to "lost" opportunities for many individuals with serious implications on the development of human resources in this country. On average, during 1992–1994, one fifth of the national budget was invested in the traditional educational system of South Africa, with no significant improvement in the existing situation. It is a fact that educational problems in South Africa are not likely to be solved by means of the traditional remedy of simply increasing the investment in education and training. The educational backlog of disadvantaged people indirectly represents many problems for South Africa. This backlog manifests itself in different socio-economic dimensions.

In this paper it will be argued that CSCE[1] is a poten-

[1] CSCE can be described in terms of a system which consists of several

Table 1. The contribution of education to economic growth in various countries

Country	%[1]
Argentina	16.5%
Brazil	3.3%
Canada	25.0%
Ghana	23.2%
Japan	3.3%
Kenya	12.4%
Mexico	0.8%
Netherlands	5.0%
Nigeria	16.0%
Republic of Korea	15.9%
United Kingdom	12.0%
United States of America	15.0%

[1] Percentage contribution to the annual economic growth rate.
Source: Adapted from Psacharopoulos [13, p.337].

tial vehicle to introduce IT in the educational and training sector of South Africa. Three case studies are discussed which explore cooperative learning (CL) and computer-supported cooperative learning (CSCL) in the formal sub-sector of education and training in South Africa. The purpose of this paper is not to solve the educational problems in South Africa, but to gain insight from the learning opportunities embedded in these cases. The experience from these cases could be valuable when a framework for the implementation of CSCE on a national basis is eventually proposed.

2 Educational Realities in South Africa

As previously stated, the South African economy is characterized by economic underdevelopment and inhibited economic and socio-economic growth. One of the reasons for this situation is that the educational policy that has been practised in South Africa has been short-sighted for many decades in its one-sided allocation of resources. This resulted in unequal distribution of and unequal access to educational services according to ethnic group and social class. Education is currently at the very top of the priority ranking in Government resource allocations with, on average, one fifth of the national budget allocated to education during 1992–1994, and with similar expenditures in earlier years. Compared to international standards, these figures are very high and it is often stated that South Africa has reached the limit of what is possible in terms of the overall expenditure of its national budget. In 1992 the following comparative budget allocations were made internationally [20]: China (6%), Britain (11%), Japan (17%), South Africa (19%) and the United States of America (21%). Although on average, one fifth of the national budget had been invested in the traditional educational system of South Africa, there has been no significant improvement in the existing situation.

The fact that the growth in pupil numbers outperformed the economic growth of the country also aggravated the unsatisfactory economic state of the educational and training sector in South Africa. For the South African situation (at this stage with a limited national budget) there is no choice other than identifying alternative ways of using available resources more effectively, in order to improve the current situation. The South African situation demands a two-pronged approach: on the one hand the efficiency of investment in education must be increased, while on the other hand, the economic problem of increasing the gross national product has to be addressed simultaneously.

Education, together with the provision of housing and health services, is one of the fastest growing Government services in South Africa. For example, there is an annual increase in the number of pupils of *ca* 5.5%. The Black population growth rate is currently 2.8% per annum which implies that within the next 5 years an additional one million people will reach school-going age on an annual basis. The total adult functional literacy rate is estimated to be around 45%. These are just a few examples to show that the demands on this Government service seem to be almost impossible to meet. This situation is not going to change overnight. The attitudes of South Africans towards investment in human capital need to change. Although one can argue that it is the Government's responsibility to educate the country, the South African Government alone will not succeed in eliminating the educational backlogs in this country. Per capita spending on education, on average, for the non-white population is very low. For example, per capita expenditure for white South Africans was R4504 during 1991 compared to R1532 for black South Africans. The latter, it should be noted, represented 57% of the total population at that stage. For this reason it is important that individuals and communities also invest in their own future. South Africans need to establish a learning culture – a willingness to invest in education and training – to contribute to the enormous educational challenges facing the country.

3 Parallel Development

As argued earlier, the relationship between investments in education and economic growth is generally accepted. It could be deduced that economic growth alone can result in sustained parallel development[2]. However, in the past, many people were misled by the growth figures indicated for South Africa. Many people considered South Africa a rich country. Measured by GDP per head ($3050 in 1991), for example, South Africa ranked alongside Hungary and some of the better-off Latin American economies [6]. South Africans also easily outperform their African neighbours. Often growth in a country is only measured in the purely economic sense of the word and the fact that a large part

computer-supported cooperative learning environments. A computer-supported cooperative learning environment is where computer support is added to the cooperative learning environment.

[2] Parallel development refers to simultaneous economic and socio-economic development in a country.

of the population did not benefit from these advantages, were not taken into consideration. It seems that the problem in South Africa is not its overall wealth, but the distribution of that wealth. It is vital that growth measures are balanced and representative concerning economic and socio-economic development in the country.

Between 1981 and 1990 an average growth rate in real GNP of 1% was registered. During the same time the annual rate of growth of the population exceeded 2%. The net result of these factors was an increase in the unemployment rate and a decrease in the average per capita income. Job creation in South Africa dropped from 157 000 per annum (1960–1974) to 57 000 per annum (1974–1985) [7]. Dillman [4] said that of the more than 400 000 jobseekers who registered with the Department of Manpower in 1992, only 74 000 have been provided with jobs. Stals, the Governor of the Reserve Bank of South Africa, reckoned that in the second half of 1992 the economy produced 8 jobs for every 100 young people entering the labour market [6]. In 1993, almost no job creation occurred, in fact many jobs were lost. These facts are very important when education and training initiatives are considered: It is one thing to create a better equipped labour force, but the economy has to be able to absorb the additional workers.

According to Todaro [19], development is a multifaceted process involving the reorganisation and reorientation of the entire economic and social system. Too often development is described as a purely economic phenomenon. In fact, development specifically in the developing world, has to manifest and result in much more than economic growth, *inter alia*, decreased unemployment, improved life-sustenance, enhanced self-esteem and increased freedom to choose to name a few socio-economic factors.

This concept of parallel development can possibly be achieved through education in the appropriate areas. There seems to be a dialectic relationship between education and growth, since education facilitates growth and growth enables education. Therefore, a reductionistic aim for pure economic or pure socio-economic development can be very limited.

4 Information Technology for Education

Technology can be seen as a viable alternative to expedite the addressing of educational demands in South Africa, although one must be careful not to take an instrumental or functional approach in selecting a technology intervention. It is important to understand that the introduction of technology is a very delicate process, and that technology itself cannot achieve anything without human agency. On the positive side it is certainly true that any developing country should take cognisance of the following statement by the OECD [12]: "... those who cannot compete for first place can at best follow along and make the most of their capabilities. But even these are far better off than those who are not running. No one wants to stand still; most are convinced that they dare not...".

If technology is accepted as an alternative for educational development, the most suitable IT intervention must be identified. CSCE is an example of such an IT intervention which can support education and training. As stated above, technology cannot achieve anything without human agency. In the education and training environment this implies that any successful (information) technology intervention must involve both teachers and learners. Of these, teachers hold the key to success. In fact, many technology interventions have been discouraging failures because they alienated the teachers instead of supporting and involving them [20, 32,52,55]. Teachers should be seen as the starting point in addressing educational problems in South Africa through CSCE. Teachers should first improve their own skills and through personalised success, teacher preference could ensure that CSCL diffuses throughout the educational system. When connecting schools with a network to which teachers have access, CSCL and Computer-Supported Cooperative Work (CSCW) can be merged to create new forms of interaction between the world of learning and the world of work for teachers, by allowing interaction with other teachers. Thus, in-service training in the use of group learning techniques becomes possible without disrupting the teacher's work life and the educational process. Although South Africa has a well developed telecommunication network, it needs to be expanded to the benefit of various disadvantaged communities to enable, for example, the connection of different schools. However, it is important to note that it is already possible to implement CSCE in South Africa with minor expansion of the existing infrastructure.

Using Local Area Networks (LAN) and Wide Area Networks (WAN) one has the advantage that both time and space barriers can be overcome. This could be very effective when addressing educational problems as it increases the availability and affordability of education and training. The availability is increased by people having access to the network, while the affordability is improved because resource sharing can take place. This in turn increases the efficiency of any investment in education and training by bringing educational and training opportunities to disadvantaged communities and individuals faster than the traditional approach is able to. Networking softens physical and social boundaries, which could support Todaro-like development.

A CSCE environment has the additional benefit that it holds the potential to prepare the student better for the world of work than the traditional classroom. In the world of work there is an increasing emphasis on cooperative work and organisational learning often takes place within an environment of distributed cognition. The environment of CSCE would, it seems reasonable to expect, prepare students better for a world that will increasingly require distributed work habits from workers – at least on the intellectual level. Yet, even though a student might not enter the world of work as a so-called intellectual worker, his/her learning experience in a CSCE environment could achieve what sometimes simply does not happen in the traditional

classroom setting, i.e., capture his/her attention and imagination.

Goldman [8] implemented a set of computer-supported environments in a science classroom. Some of her conclusions were that children are capable of accomplishing work with each other, they can also work on their own terms, and their social interaction is not counterproductive to the accomplishment of their science work, but may even be a necessary prerequisite. Another interesting conclusion was that environments with multiple resources are the most promising for cooperative learning because when students are engaged socially, they consult each other and also occasionally the teacher – a very positive finding implying that students relieve the teacher from routine teaching tasks. This leaves the teacher with more time to invest in other teaching tasks which could add value to students' learning on a higher level. Later in this paper, results from three case studies where CL and CSCL environments were implemented in South Africa, present a preview of how successful this approach to learning can be in the South African context.

Riel [16] describes computer networking as a mechanism for developing cooperative learning among students in distant locations and at the same time facilitating the professional development of teachers within the classroom environment. It was found that teachers who participated in learning circles [18, see Slavin, Sharan, Kagan] acquired knowledge, developed new instructional strategies, increased their self-esteem and developed professional and personal relationships with their peers. One factor that must always be taken into consideration, is that the transformation of traditional classrooms into CSCL classrooms is a very complex process. The main reason for this is that teachers are familiar with the traditional model of teaching and/or training and do not necessarily have the inclination to create a cooperative learning environment. The teacher no longer has total control over the lesson and joins the class as a learner as well as a problem solver. Some teachers might enjoy this unexpected learning opportunity, but others might be intimidated about their status change.

With the CL approach teachers and learners help each other to solve problems, learn from one another, and share cultural perspectives. Surprisingly, teachers rank their own learning and not the learning by their students as the most important benefit of educational networking [16]. This is very relevant if teachers are considered as the starting point when introducing CSCE in the educational and training system of South Africa.

With CSCE one is not only advocating a more efficient learning process, but also a more effective one. This approach could, as argued above, eventually open the world of learning for the majority of learners and set them free on the road to inner development. This, in the final analysis, is what it is all about: to be, as Todaro [19] has described it, emancipated "from alienating material conditions of life and from social servitude to nature, ignorance, other people, misery, institutions, and dogmatic beliefs. Freedom involves the expanded range of choices for societies and their members together with the minimization of external constraints in the pursuit of .... development". W. Arthur Lewis, as quoted by Todaro (*op. cit.*) stressed the relationship between economic growth and freedom from servitude when he concluded that "the advantage of economic growth is not that wealth increases happiness, but that it increases the range of human choice".

Traditionally, computers were used by individuals in their daily working environment. With networking technology it is possible for groups to use computers to facilitate, expand and redefine social interaction in a CSCW environment. This is also applicable to the CSCL environment. Although it is simply not cost-effective to provide every learner with a computer, access to a computer is vital. Unfortunately, an intervention like this could easily fail because of insufficient financial resources. For this reason it is important to encourage key figures to buy in on this effort.

South Africa must learn to manage technology in a way that satisfies its unique social and economic needs by addressing the deep-rooted educational problems of South Africa. An intervention of IT in education and training can be used to address some of the educational and development realities mentioned earlier, with a view of eventually achieving not only educational and training objectives, but also specific economic and especially socio-economic objectives.

5 Implementation of CSCE: Case studies

In the process of investigating the contribution IT can make to support development in South Africa three case studies were executed. The use of case studies as a qualitative action research approach enables the researcher to learn from practice.

Case Study One

In the first case study a cooperative learning environment was implemented in a first-year university course as part of the formal syllabus on the analysis of Information Systems at the University of Pretoria [2]. It was done in normal class sessions with a multi-cultural student group with differing perspectives and reference frameworks. All the students registered for this course were involved in the case study. This case study illustrates an alternative model of learning, namely cooperative learning. According to Adams *et al* [1], cooperative learning is one of the organisational ideas that can change the educational process, engage the minds of students and connect schooling to the world of work. A cooperative learning environment which can be seen as a first step towards the eventual implementation of a CSCL environment was created in the first case study.

The Jigsaw cooperative learning method was used to study three syllabus units of the first-year course. The topic under discussion was an introduction to the analysis of Information Systems. Students enroled for course 170 in first-year Informatics at the University of Pretoria

participated in the case study. Three classes consisting of respectively 40, 70, and 39 students were used, a combined total of 149 students. Students were both Afrikaans and English-speaking. The classes consisted of students from different ethnic groups, although they were predominantly white.

The Jigsaw cooperative learning method was implemented as follows:

1. *Assemble needed materials:* The lecturer assembled reading material on the different subtopics, as indicated in the paragraph on materials needed. Some of the reading material was stored on a hypertext system, called SuperText, for retrieval by the students as needed.
2. *Divide into groups and do group-building exercise:* The lecturer utilized already established groups which were initially selected by dividing students in a random fashion into different groups of approximately five members each. This ensured that the students knew each other as they had worked in the same groups on a previous assignment, although not necessarily in the same learning environment.
3. *Explain to students the idea of group work:* The theory behind an effective group was explained to the students. Extensive use was made of the book by Johnson *et al* [11]: *Joining Together. Group Theory and Group Skills.* The elements of cooperative learning, and the dimensions of an effective group were discussed.
4. *Explain the goal and the task:* The lecturer explained the objectives of group work as an approach to learning, as well as the objectives pertaining to the investigation of the study topic.
5. *Work in groups to obtain key concepts/subtopics:* Students were given ten minutes to identify the key concepts of the topic to be covered in their group. They had to reach consensus on the five most important subtopics.
6. *Lecturer review:* The lecturer reviewed the subtopics and with the help of the groups determined five subtopics that had to be investigated by all the groups. The subtopics were: The modern systems analyst; three building blocks of information systems (people, data and activities); three building blocks of information systems (people, technology and networks with one constant in comparison to the previous group, i.e., people); principles of systems development and the systems development life cycle.
7. *Groups decide:* The groups assigned one student per group per subtopic.
8. *Meeting of expert groups doing the same topic:* The members from the different groups addressing the same subtopic met and discussed the topic. The study material on the subtopics was made available to the expert groups via the network on SuperText. Students were also encouraged to link into the library system to find more information on their subtopic and to consult the extra journal articles reserved in the library. They also had access to word processing facilities. A list of objectives to be met on the subtopic, were given to each expert group. Expert groups were advised by the lecturer to meet outside the normal class sessions for further discussion. A questionnaire was completed bythe students on their experience within/of the expert group. Students also had to write down their contribution to the collective knowledge gained by the expert group.
9. *Report back to groups:* Students reported back to the original group on the individual subtopics they have studied. The five subtopics within one group were then combined into one written (word-processed) report that constituted a mark for the entire group. An observation list was completed by the observer for one group per class. Tape recordings were also made of the discussions of three groups.
10. *Report back to class:* The lecturer called randomly on any group and any member of the group to report back to the whole class.
11. *Lecturer summarises:* The key points were summarised by the lecturer to enable all the students to study the topic for examination purposes.
12. *Evaluation:* A short, unprepared, computerised multiple choice class test and questionnaire were given to all students. The questionnaire was divided into five parts:
    - **Part A:** Questions on the student's behaviour in the group
    - **Part B:** Questions on the level of acceptance of the student as a group member
    - **Part C:** Questions on group cohesion
    - **Part D:** Questions on group work in general
    - **Part E:** General information and open-ended questions

    The observation lists were evaluated and summarised by the observer. Informal interviews were conducted with groups to clarify uncertainties.
13. *Final evaluation:* A prepared, computerised multiple choice class test were written by all students. Their total mark for this topic consisted of the written group report, the unprepared class test plus the prepared class test.

Steps 1 to 5 of this procedure were done during the first class period of fifty minutes. Steps 6 and 7 took up the second period. Step 8 was done during the third period. Step 9 was completed during the fourth period. Step 10 was done in a fifth period. Step 11 was completed in the sixth period. Step 12 was done in the evaluation period in the computer laboratory, using a computerised test. A separate test period was used to complete the final evaluation (step 13). This case study was completed over a period of four weeks.

The following are some of the positive observations made during the first case study: An enthusiasm amongst students about interacting with fellow students; an increased respect for diversity, implying that students learn to appreciate and respect one another; highly motivated students; increased self-confidence and self- esteem; an

initial horizontal learning curve which later changed into a steep learning curve; a willingness to be successful; a growing interest in the subject; and an awareness of the working world, where teamwork is essential. Very few negative observations emerged: No group cohesion in a few groups; preference for individual, lecture-driven studies; free-rider effect (although this applied to only about 7% of the students); and too time- consuming from a student perspective.

The questionnaire results showed that students have high expectations about co-operation between group members, as well as their own cooperation within a group. At the beginning of the case study, the lecturer observed an unwillingness amongst students to participate in group work. However, their attitude changed during the case study, as they showed increasing willingness to express their thoughts, feelings and reactions to the rest of the group. Secondly, although the students were briefed about the purpose and advantages of group work, it is interesting to note on conclusion of the case study, that the majority now firmly believe that group work prepares them for the working world. Thirdly, it is also interesting that very few students remarked on the fact that group work may involve less work for them, while most of them liked the social interaction in a group. A factor analysis was done and five significant factors were found. Although these factors are not described in full detail in this paper, careful consideration should be given to them to ensure the eventual successful implementation of CL as well as CSCL environments.

Case Study Two

In the second case study [9] the main purpose was the comparison of individual learning approaches with the learning approaches of groups, where both were supported by a computer. This case study was implemented with a group of teachers structured around a course on word-processing. Thirty percent of the teachers indicated that they had previously worked on a computer, although their experience had been limited in most cases to the administration system of their school. From this information one can conclude that nearly the whole group started as computer illiterates.

Forty-three teachers attending the course were divided into two main groups. Of these, the one group followed the course as individuals, while the other group was divided into smaller groups, functioning as such.

The two main groups were structured as follows:

Individual group

Teachers in this group functioned individually. Ten teachers joined this group consisting of seven black and three white teachers.

Cooperative group

Teachers in this group functioned as members of a smaller group. A total of thirty-three teachers were divided into eight smaller groups consisting of teachers from different ethnic groups.

In total there were twenty-four black and nineteen white teachers who followed the course. The ability of the teachers, in terms of their individual levels of computer literacy (which were nearly zero) and word-processing skills, were taken into account when the groups were formed.

There exist three widely used learning approaches, namely individual, competitive and cooperative. The focus of this case study was placed on the comparison between individual and cooperative learning approaches. A short overview of the different approaches follows as applied in this case study.

The individual group followed a classroom approach, using traditional teaching methods. This included the individual use of a computer for computer-based training (CBT) and word-processing. Each individual was provided with extracts from the WordPerfect manual. An explanation of the WordPerfect functions was given by the course leader. The content of the course was the same for the individual and the cooperative group.

Circles of learning (or learning together) was chosen as the cooperative learning method. This method was developed by Johnson *et al* [11] and is structured around a group goal; the sharing of ideas and materials; a division of labour when appropriate and rewards given to the group. The following steps were identified by Johnson *et al* as essential for the successful implementation of this method:

1. Clearly specify instructional objectives. These objectives were given in the description of the course content.
2. Limit group size to no more than six, but if the group members are new to cooperative learning, groups should be smaller to ensure that everybody participates. The group members in this case study had no or very little previous experience of group work and were therefore, divided into groups of three or four members.
3. Structure groups to achieve heterogeneity in terms of ability, sex and ethnicity. Due to the specific aim of this case study, all the groups were not heterogeneous, as explained in previous paragraphs.
4. Arrange groups in a circle to facilitate communication. The use of computer support made the use of half circles in front of the computer essential.
5. Use instructional materials to promote interdependence among students. Each group of students had only one computer to work on, only one photocopy of the different WordPerfect functions and only one copy of the CBT lessons [5]. Each group member had to study one part of the WordPerfect functions and was given only the relevant pages.
6. Explain the academic task. At the beginning of the course, the learning objectives of the course were explained as well as the aims of group work and cooperative learning. The five basic elements of cooperative learning were discussed and implemented in the following ways:
   (a) Positive goal interdependence, which occurs when learners undertake a group task with a feel-

ing of mutuality. This was achieved by having the group produce a single assignment at the end of the second session, constituting a group mark. They also had to complete the tests incorporated in the CBT lessons as a group.

(b) Face-to-face promotive interaction, which occurs when a verbal interchange takes place where learners explain how they obtained an answer or how a problem may be solved. Learners each had to study certain WordPerfect functions and explain and demonstrate them to the other group members.

(c) Individual accountability, which means taking responsibility for learning material. An individual test was given at the end of the course to test their ability to use the word-processing functions.

(d) Social skills, which involves knowing how to communicate effectively and how to develop respect and trust within a group. The group members were given time to get to know each other. Each group member received an opportunity to explain some word- processing functions to the other group members.

(e) Group processing to reflect on how well the group is working and to analyse their effectiveness and how it may be improved. The behaviour of the groups was monitored continually by the course leader. Assistance was given when necessary in the form of clarification of instructions, answering of questions, encouragement and teaching of academic skills.

7. Provide closure to the course. At the end of the course a summary of the functions used were given by the course leader.
8. Evaluate the students' work. This was done by means of a group assignment, CBT tests done as a group and an individual test.
9. Assess group functioning. This was done through ongoing observation while the groups were busy with the course, as well as by the completion of a questionnaire by each individual at the end of the course.

The contents of the course can be divided into the following five main topics: creating a document, editing a document, formatting a document, printing a document and storing a document. The course was completed in three two-and-a-half hour sessions. The following is a detailed layout of these sessions:

Individual group

Session One

- The learning objectives were explained.
- Each individual worked through the following CBT lessons:
  - Layout of the keyboard
  - An overview of a computer system
  - Word-processing in general.
- An informal test was written on the computer as part of the Overview of a computer systems lesson. A crossword puzzle was completed after the Word-processing lesson.
- Study material for the following session were handed out to each individual.
- The teachers had to prepare the study material for the next session.

Session Two

- A lecture was given on the contents of the study material.
- An assignment was handed out to the teachers to be completed individually.
- A WordPerfect tutorial was available for on-line help.
- At the end of the session the assignment was handed in.

Session Three

- The evaluated assignments were handed back to the teachers.
- Errors and indistinct issues were discussed with the lecturer. The lecturer also gave a summary of the course contents.
- A document had to be typed by the teachers for individual evaluation.
- Finally a questionnaire was completed.

Cooperative groups

Session One

- Teachers were introduced to each other and did a group-building exercise.
- A short introduction was given on group work and the learning objectives were explained.
- Groups worked through the following CBT lessons:
  - Layout of the keyboard
  - An overview of a computer system
  - Word-processing in general.
- An informal test was written by the group on the computer as part of the Overview of a computer system lesson. A crossword puzzle was completed after the Word-processing lesson.
- Study material for the following session were handed out. The topics were divided amongst the group members.
- Each teacher had to prepare his or her specific topic for the next session.

The topics were divided as follows: creating, printing and storing a document; editing a document; formatting a document (character format) and formatting a document (paragraph and page format). Each group member had to prepare one topic for the following session.

Session Two

- Each group member demonstrated the prepared topics.
- An assignment was handed out to the teachers to be completed as a group, rotating the physical execution of the assignment.
- A WordPerfect tutorial was available for on-line help.
- At the end of the session the assignment was handed in.

Session Three

- The evaluated assignments were handed back to the teachers.
- Errors and indistinct issues were discussed firstly in the groups and then by the lecturer. The lecturer also gave a summary of the course contents.
- A document had to be typed individually by the teachers for evaluation.
- Finally a questionnaire was completed.

Materials

The following materials were used in the course:

- Three computer-based training programs [5].
- WordPerfect manual – extracts from this source.
- WordPerfect tutorial.
- Articles on group work – extracts from this source [11].

The most remarkable result from the questionnaire completed by teachers (in the cooperative groups) was the fact that when they had problems assimilating the course material, they received help from the group members. Another interesting result was the idea that computer skills will open new opportunities in teachers' careers. This can be very positive from two points of view: firstly it can be seen as providing increased self-esteem for teachers and, secondly, the strong possibility of the diffusion of this approach in the education and training sector as complementary to the traditional system.

Teachers continuously, throughout the questionnaire, expressed their enjoyment of the group work, the value of sharing ideas and feelings, and the motivation and support they experienced in their groups. The positive experience of group work resulted in an average mark of 71% for cooperative groups on the course, in comparison with 55% for the individuals. With the individual word-processing test there was even a bigger difference in marks: 54% for cooperative groups in comparison with 34% for the individual learners. The course dropout rate for individuals was 40% compared to 24% for the groups. It is clear from these results that in this case study the implementation of CSCL was much more successful than the traditional individual learning approach. Results of this case study also indicated that teachers in the cooperative groups had a better understanding of the study material and that they learned quicker. From this one can argue that this approach to learning can shorten the educational life-cycle of a learner, which means that more learners can use the system over a shorter period of time.

One factor relating to group work that was disliked by many teachers was the pace of the group, which was either too slow or too fast. It is therefore very important in the composition of groups to try as far as possible to minimize the variation in ability between group members. This can result in a more effective group.

Apart from this, teachers were in general very positive about group work. However, it is difficult for them to see the long-term benefits of such an approach in the school environment. This can be a result of the existing educational system. Most of these teachers have been a part of the traditional system for years and it is therefore very difficult for them to imagine any other approach to education. Nevertheless, teachers expressed a willingness to implement a cooperative learning approach in their schools if they were appropriately trained.

Any attempt to increase the efficiency of investment in education through technological support requires an indispensable component, the full support of teachers. Training in the technology used to support them only addresses part of the problem. If teachers do not accept the concept of technological support, no amount of training will make the particular attempt successful. This case study clearly showed teachers' enthusiasm about the concept of group work and of computer support thereof. One can expect positive results from employing CSCL to remove educational backlogs and to support development in South Africa.

Case Study Three

In the third case study CL and CSCL environments were structured around a matric lesson in English for a group of school children whose second language is English. The content of the lesson was part of the prescribed syllabus for secondary education in South Africa. This case study was a follow-up on the previous two case studies executed during 1994. In this case study virtual CL environments as well as virtual CSCL environments were implemented for two schools. One school group was from a white community, the other from a black community. In both cases the virtual environments were created in laboratory conditions, using existing infrastructure at the University of Pretoria. This was necessary because of the current lack of infra-structure at both schools. Various CL and CSCL environments for both schools were implemented and these cooperative groups were enabled by the computer support to communicate, firstly with children from their own school and then with children from the other school.

The teachers from both schools prepared the lesson as a cooperative teacher group. Teachers were trained by the researcher how to use the cooperative learning approach in teaching. They were also familiarised with the computer technology necessary for the execution of the lesson. The technology included the WordPerfect thesaurus as well as the use of electronic mail. The researcher facilitated the process and first met separately with the teachers from the different schools. During these sessions each teacher group decided on the content of the lesson. The teachers confirmed the content of the lesson with the researcher via facsimile.

For the first meeting between the teachers from different schools the teachers had to study papers on groupwork and the two case studies mentioned earlier. They also had to prepare a poem (City Johannesburg – MW Serote), as well as possible vocabulary questions and other questions which could form part of the lesson. It was important for teachers to prepare all the above-mentioned to be able to have a valuable discussion with the teachers from the other school. After the researcher introduced the teachers to each other the researcher did a group building exercise with the

teachers. Although they were initially very uncomfortable with each other, they acted after a while as colleagues in a successful team with a unified purpose. After two sessions the preparation of the lesson was completed and various exercises, worksheets and tests were prepared.

The following are some of the positive observations made during the implementation of the teacher cooperative group: A mutual respect for input from each other; an increased respect for diversity; a willingness to differ from each other, mainly with the intention to better their understanding; an initial structuring of the discussion session by the facilitator which later changed to teachers structuring the sessions for themselves; an increased enthusiasm about the poem, realising its cultural relevance and appropriateness with respect to the current transitional period in the country; well-prepared teachers for each discussion session. A few negative observations emerged: An initial uneasiness amongst teachers with each other as well as with the situation; experiencing the preparation as too time-consuming - however, teachers added to this remark that they definitely ended up with a very well prepared lesson which could be used again; teachers not always arriving on time for discussion sessions which wasted the time of the rest of the teacher group; a difficulty for some teachers to attend the discussion session because of the physical location of their schools (some teachers had to travel approximately 200 kilometres for each discussion session). The overall conclusion about the cooperative teacher group, is that it can be described as being successful in preparing teachers for CL and CSCL environments.

At the end of the lesson, children from both schools completed a questionnaire which showed a general positive attitude towards group work. Black children were on average more positive than white children (who were themselves quite positive) about group work. The children continuously, throughout the questionnaire, expressed their enjoyment of group work, the value of sharing ideas and the motivation and support they experienced in their groups. They were also very positive about how easily group members accepted each other. Black cooperative groups expressed a greater acceptance of their group members than white cooperative groups.

Results on group cohesion show that the black group members definitely tried harder to ensure that other group members enjoyed being part of their group as well as to make group members feel valued and appreciated. This was very interesting as everybody from the white school had worked in groups before, while only 70% of black children had worked in groups before. On average, the black children rated the value they got from the exercise much higher than the white children. Black children indicated that they would definitely use a similar facility, if available near their school or home and also believed that this approach could be successful in adult education. They said that they would encourage their teachers to use this approach to teach pupils in their school. In conclusion: the black children believed that this approach to learning could support their own development.

Children from both schools used the WordPerfect thesaurus very successfully according to the worksheets they handed in. Although only 15% of black children had previously worked on a computer, they managed to use the thesaurus effectively. Of the white children 64% had worked on a computer before, which definitely influenced the pace of working. The black children accordingly used more time to finish the thesaurus exercise.

In the third case study the learning curve for the researcher about CL and CSCL was not that steep. The most valuable part of this case study from the researcher's perspective was the experience in training teachers how to prepare for CL and CSCL environments. It is clear from the exercise that well-trained teachers hold the key to the successful implementation of CSCE. A very important ingredient of the framework for the eventual implementation of CSCE on a national basis is a well designed "training package" for teachers.

6 Conclusions

Against the background of enormous educational backlogs in South Africa, and given that education is widely regarded as the basis for all human resource development, CSCL has been explored in three case studies as a potential vehicle for introducing IT to support education and training in South Africa. Although the formal sub-sector of education has been used as a starting point in proposing a framework for the eventual implementation of this on a national basis, it is anticipated that it will diffuse to not only the formal sector of education, but also to the non-formal and informal sectors. CSCE can only diffuse if it is first adopted by, for example, the government, educational investors communities, aid organizations, etc. The idea is now to plan and then implement several similar pilot projects to further develop the concept.

The above case studies lead to the following conclusions from a development perspective, keeping in mind that one wants to achieve first (and perhaps small) objectives, whilst having a broader picture in mind:

- The cooperative learning approach was successfully implemented in three case studies in the formal education and training subsector.
- The cooperative learning approach to education and training can be used as an alternative or a supplement to traditional learning approaches.
- Educational success was experienced with this approach amongst students, which has a positive influence on course dropout rates as well as on the self-confidence and self-esteem of students, teachers and children.
- The productivity of learning increased, as evidenced by an initial horizontal learning curve which changed into a steep learning curve.
- The increased productivity of learning, when properly exploited, can address problems such as low efficiency of investment in education and training.

- The increased efficiency of investment in education and training can set resources free which can imply that problems like the availability and affordability of education and training can be addressed.
- A positive spill-over of the increased productivity of learning could be a decrease in the enormous educational backlogs. An increased throughput of learners could create opportunities for the growing demand to be satisfied, and could set teachers free to attend to other training needs.

These conclusions show that the cooperative learning approach can result in chain reactions in which the required snowball effect of diffusion could eventually lead to parallel development. With this alternative technology-based approach to education and training, the competence of teachers, their effective and efficient employment, and through that, the output of the educational system could be improved.

To conclude this paper some implications, derived from the results of the case studies will be outlined. These can be used in the eventual proposal of a framework for the implementation of Computer-Supported Cooperative Education on a national basis:

- A good understanding as well as a true acceptance of the cooperative approach to learning is an essential prerequisite for the implementation of CSCL.
- Cross-cultural and interpersonal communication techniques should be an integral part of the process, because of the importance of communication for group-cohesion.
- Previous computer experience is not as essential as was initially expected, but computer literacy could have a very positive impact on the learning pace of the group.
- Composition of groups are very important in order to try to minimize the variation in ability of group members to ensure a more effective group. Large variation can have a negative impact on the stronger student as well as the other group members, because it may encourage, often unintentionally, free-riding.
- The complete supporting teaching infrastructure such as curriculum, evaluation, etc. will have to be revised, if a CL approach is considered.
- Teachers are the key entering point for the diffusion process. They must accept and take ownership of such an approach to learning.
- CSCL in isolation cannot be successful in economic terms. It is only when resource allocation and utilization across systems (schools, teachers, etc.) are experienced that the economy of scale benefit becomes apparent.

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