NEW INFORMATION TECHNOLOGY AND QUALITY EDUCATION IN KENYA: THE POTENTIAL AND PROBLEMS OF COMPUTERS IN SCHOOLS

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ABSTRACT

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After a description of the context and particulars of the project, this paper presents preliminary research findings on the Aga Khan Foundation Computers in Education Project in Kenya. The project, which has sought to introduce the computer as an educational tool in the study of existing school disciplines, is shown to have achieved a degree of success. Data is discussed to show that computers are enhancing student learning as an active and individualised process, as well as encouraging peer interaction. With regard to teacher education, use of the technology is reported to be resulting in the development of pedagogical constructs which place the student at the centre of the teaching-learning transaction. A number of factors which are inhibiting the innovation are discussed, with the most important being identified as the existing school system; learning within this system is shown to be dominated by centrally developed curricula and examinations which tend to encourage the memorisation of facts dictated by the teacher. It is argued that a major outcome of the project should be widely-based moves, with or without computers, to make learning a natural process whose main objective is the development of problem-solving skills. In conclusion: (1) suggestions are made with regard to ways of improving the implementation of the project and planning for the post-project period; (2) because the Kenya economy and educational institutions are increasingly acquiring computers, it is recommended that the government planning process should fully take into account the new technology.

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INTRODUCTION

> "We are at the onset of a major revolution in education, a revolution unparalleled since the invention of the printing press. The computer will be the instrument of this revolution...By the year 2000 the major way of learning at all levels, and in almost all subject areas will be through the interactive use of computers" - Bork (1980)

In the developed north, the growth of new information technology (IT) - associated with rapid advances in microelectronics - is seen by many educationists as providing a golden opportunity for making fundamental changes in the processes of education (McLuhan 1964, Papert 1980, Bork 1980, Dwyer 1980, Suppes 1980, Postman 1980, Hawkridge 1983, Becker 1984, Norton 1985, Stonier 1985, Evans 1986, Bork 1987, Dede 1987). The new IT - defined to include computers, interactive video and telecommunication devices (Hawkridge 1983) - is seen as having the potential to enhance learning as an individualised and active process, which cumulatively builds on the experiences of the learner and develops in him or her problem-solving skills. Echoing current thinking in cognitive psychology, which underscores the need for educational strategies to take account of the development of the whole person, Norton (1985, p.17) maintains that understanding "in a media environment bypasses to a large extent the language and print dominated centres of the left brain and taps the more intuitive, pattern-seeking centres of the right brain...As the new information technologies tap both subjective feelings and objective abstractions, the purely logical world of science and the affective world of art and religion give way to interconnectedness." In agreement with Dwyer (1980, p.88) that "education is that which liberates human potential, and thus the person", Papert (1980, p.209) sees the computer as providing a base for reform of traditional curricular approaches: "I am proposing...to use the computer...not to coax the student along the difficult and unnatural path adopted by traditional curricula, but to open up a natural path along which the student can drive himself or herself." Becker (1984, p.27) sees the computer as having the "ability to create intellectually stimulating environments for students to explore subject matter generally foreign to the current curriculum, perhaps beyond the competency of the teacher, but important and useful preparation for the student's future life."

Current educational thinking and planning in Kenya, although not conceptualising IT as the base of improvement, define the direction learning should take in terms similar to those used by the above proponents of educational change in the developed world. In proposing reform in the Kenya school system, Ghai (1974, p.332) urges that "the method of instruction needs to move away from mechanical absorption of information towards greater emphasis on learning by doing and problem solving" and that "the content and process of education needs to be related to the local social and economic environment." A government committee set up in the mid-1970s to chart new directions in education recommended that educational institutions should "develop the intellectual, spiritual and physical potential of the country's human resources" (Republic of Kenya 1976, p.18). In the early 1980s another government committee which made proposals for the establishment of a second state university in Kenya, emphasized that the new university should "aim at producing graduates who interact with the people, live comfortably in their own society in the rural areas, are effective in serving all and are innovative, hardworking and committed" (Republic of Kenya 1981, p.37). Current school curricula have "been designed to offer varied experiences that may lead to an all-round mental, social and moral development" so that the learner develops self-reliance,self-discipline,integrity,adaptability, co-operation and patriotism (Republic of Kenya 1985).

This paper presents preliminary research findings on a Kenyan computers in education project funded by the Aga Khan Foundation (AKF). Borrowing from the thinking that the computer is a powerful tool that could be used to engineer fundamental changes in the learning process, the project is attempting to use microcomputers to create the sort of teaching-learning situation necessary for the attainment of Kenya's current school curricular objectives and goals.

Following a discussion of the context in which the Kenya project is being implemented, the paper highlights its successes to date, in particular, raised student motivation for learning, increased peer interaction among students, emergence of fresh professional constructs among teachers and improvements in school management. With regard to factors which are found to inhibit the innovation, data is presented to show that the problems encountered have arisen mainly from the way education is currently conceptualised and organised. It is argued that inadequate adaptation of the technology, teacher anxiety coupled with limited time to master the technology and resource constraints (with regard to implementation personnel, equipment and physical facilities) are to an extent inhibiting the innovation, but that the formal school system is the major inhibitor. In contrast to the project's thrust to make education

learner-centred, the school system - with its emphasis on authority and hierarchy - is based on centralised curricula and examinations which encourage teachers to approach teaching-learning as a teacher-dominated process characterised by the memorization of facts.

Bearing in mind that the computer is already part of the Kenya economy and that a number of schools have acquired computers, the paper recommends comprehensive planning for the technology in the whole economy as well as in education. It is concluded that, the project's approach to educational processes in schools is a pointer to what should be done - even in the absence of computers - to make learning the natural, individualised. active and goal-oriented process that it must be if the current curricular objectives and goals are to be realised.

THE CONTEXT IN WHICH COMPUTERS ARE BEING INTRODUCED IN FORMAL EDUCATION

Pressure From Industry and Society

An important aspect of computer technology in developed countries, particularly during the last decade, is that pressure for its introduction in schools has been exerted by society (parents, business and industry) rather than by the systems of education (Becker 1984, Wangberg 1985, Anderson 1985, Naiman 1987). This aspect has several implications, three of which carry important lessons for third world countries. First, it demonstrates that what goes on in the wider society has repercussions in schools and ought to be taken into account in planning education. Second, because school systems have been caught off guard by technological development, they have been ill-prepared to integrate IT into the teaching-learning process. By and large schools have had to cope with both hardware and software originally developed for non- educational uses: McClintock (1986) observes that "school computing environments...have been pieced together from available products that people found in the market-place and tried ad hoc to use for educational ends." Third, because changes in the technology are taking place at a rapid pace, school systems - already undersupplied in most countries - are unlikely to have the resources (both time and finance) to plan integration of computers using the latest equipment.

Computer Applications in Education

Integration of computers into school curricula has to an extent reflected perceptions of applications which are thought to be appropriate

preparation for the labour market. School systems have given emphasis to computer awareness, computer literacy and programming, with students thought to have aptitude and ability in mathematics and physical science receiving most attention (Hennessy 1982, Becker 1983, Maskowitz & Birman 1985). In the the third world, where concern for manpower development is acute, it is this vocational training concept of computers in education which has received most attention (Nag 1981, National Academy of Sciences 1986, Allotey 1986, Mwara 1986, Ndamagi 1986, Phamotse 1986).

In a study based on the USA, Levin & Rumberger (1983) present evidence that the vocational application of computers in education should not receive most emphasis because further development of the technology is likely to reduce the number of skilled positions in employment; they urge that educational institutions should use the computer to "strengthen the analytical and communicative skills of students, not because of the needs of high technology, but because such skills will help them deal with the changing political, economic, social and cultural institutions they will face in their adult lives."

According to Bitter & Camuse (1984), there are three curricular approaches to computers in general education: (1) computer-assisted instruction (CAI) i.e. teaching/learning through computers using subject-specific drill-and-practice tutorials and simulation programs, or computer games which do not relate to a specific subject but help students develop problem-solving skills (2) teaching/learning with computers i.e. using the computer as a tool - word processing (to prepare learning materials or to learn creative writing), classroom demonstration (e.g. of graphics in mathematics and science), statistical and mathematical applications, production of music or works of art, and testing (3) teaching/learning about computers i.e. understanding appropriate applications of the technology and its social implications, and learning computer programming. Within institutions computers can also be used in administrative spheres such as timetabling, organising subject options, student records, monitoring academic progress, attendance, careers, accounts and storekeeping (Bird 1984).

Debate on the Place of Computers in the Third World

The introduction of high technology (HT) - such as the computer - into third world countries is a subject of controversy. On one hand, the transfer of HT to third world countries is seen as a move not only necessary if these countries are not to lag behind the developed world (Papagiannis 1985), but also as a possible way of leap-frogging development stages

into new prosperity (Gupta 1981, Benmokhtar 1984, Allotey 1986, Smithson & Land 1986, Ilyas 1986, Nag 1987). On the other hand, it is argued that the transfer of HT may threaten jobs and indigenous cultures, perpetuate dependency on the developed world, and divert scarce resources from feasible and desirable development objectives, thereby exacerbating inequality (Stewart 1978, Khun & Kaiser 1982, Smithson & Land 1986, Lind 1986, Lallez 1986, Carnoy & Loop 1986).

The debate on the transfer HT is not taking place in a virgin situation: even the most vocal opponents of the move recognise that developing countries are acquiring computers and other HT equipment. Given this inevitability, a considerable number of scholars and planners are giving emphasis to ways in which the technology can be fruitfully adapted, rather than dwelling on the merits and demerits of the transfer. The starting point in sucessful adaptation is seen as the clear and detailed articulation of national policy (Allotey 1986, Verghese 1986, Akinlade 1986). Some of the wealthier third world countries are developing indigenous high technology industries and are succesfully manufacturing both hardware and software (Allotey 1986, Verghese 1986, Hobday 1986, Ramiszowski 1986). The potential for international co-operation in adapting HT is also being explored (Owolabi 1986, Pau 1986). In all countries where HT policy is being developed there is recognition that education and training must play a central part (Smithson & Land 1986, Nag 1986, Shaw 1986, Mwara 1986, Veasey 1986, Chan Kong Chan 1986).

The Kenya Context

Computers are not new in Kenya: mainframe computers were introduced into the country in the early 1960s (Mwara 1986). Since their emergence in the west in the late 1970s, microcomputers have been entering the Kenya scene in increasingly large numbers (Price Waterhouse Associates 1986). The existence of the East African Computer News (EACN), a privately published monthly journal now in its fourth year, is clear evidence that computers have become a part of Kenya society. To cater for the expanding home and business market, a local company, Kenya Microcomputers Ltd, began to assemble the IBM compatible Neptune in 1987 (EACN 1987, Machua 1987).

However, it is should be noted that computers remain part of the modern sector of the economy, mainly in urban areas. Most of rural Kenya where more than 80% of the population lives has yet to experience the computer, and mainly because of the high costs of the technlogy, most people in urban areas have also not been exposed to it. This is not an idle truism in that it suggests that in terms of diffusion of ideas on the computer's

potential in education, the majority of Kenyans are still ignorant and mystified by the technology. Lack of awareness of the technology's potential is an important consideration in any attempt to introduce computers in schools.

Although most likely not the main reason, a social context which is in general not much influenced by HT partly explains why only a few educational institutions in the country have acquired computers. Since 1984 Professor Scott of the Institute of Computer Science at the University of Nairobi has been compiling a directory of Kenyan educational institutions with computers. According to Scott's latest directory, the number of computers in all educational institutions in Kenya rose from a total of 205 in 1984 to 405 in 1987 (Scott 1987). Table 1 shows the number of institutions with computers during the two years.

Table 1. KENYAN EDUCATIONAL INSTITUTIONS WITH COMPUTERS[a], 1984 & 1987

	Number			
	1984	1987		
Level of Education		Government	Private	Total
Primary	3		5	5
Primary & Secondary	3		3	3
Secondary	12	7	10	17
Tertiary[b]	3	6	2	8
TOTAL	21	13	20	33

Source - Scott R J P (1987): *Directory of Computers in Educational Institutions in Kenya 1987*, Institute of Computer Science University of Nairobi.

Notes:

a A survey by telephone (January 1988) revealed that five secondary schools and one primary school, not listed in Scott's Directory, possessed a total of 40 microcomputers - acquired between 1984 and 1987.

b Departments within Nairobi and Kenyatta universities, which Scottpresents as separate institutions, have been aggregated.

The small number of schools with computers is in great contrast to the country's 13,000 primary schools and 2800 secondary schools, all with a student enrolment of over five million (Republic of Kenya 1986). As compared to the developed world, Kenya is at a very young age: a 1987 survey revealed that in the American state of California, with an elementary and secondary school enrolment of 4.2 million, the number of computers in schools increased by 17% from 115,000 in 1986 to 135,000 in 1987 (Electronic Learning Vol 7 No 2).

Scott raises a number of important issues. First, in almost all institutions (including government-funded ones) the equipment has been supplied and is maintained through donations and other private funds. Second, in the institutions there are 25 different makes in 35 different models of computers. This situation militates against the development of organised maintenance and, due to incompatibility of hardware, the possibility of pooling use of software between different institutions. Third, the high costs of hardware and software, which most of the institutions complained about, are to a large extent associated with high rates of import duty and sales tax which makthe effective cost in Kenya 2.5 times the FOB cost. Fourth, apart from the schools in the AKF project, there is little in way of a clear policy towards the development of the computer as a centre piece of curricula. While the schools have courses which use the computer as the object of study, only a few courses (mainly in mathematics and the sciences) have made tentative attempts to integrate the technology in the rest of the curriculum. In terms of developing the potential of the computer as an interactive tool for learning, the schools have confined themselves to computer games played as part of clubs or in the students' free time. Further, use of the technology in the schools is reported to be the province of a few enthusiastic teachers, mainly expatriates, with the rest of the staff reported as being either "in the process of learning" or, more often than not, "not interested."

THE AGA KHAN FOUNDATION COMPUTERS IN EDUCATION PROJECT (CEPAK)

Origin, Objectives and Goals

CEPAK originated from a perceived need for Kenya to take cognisance of developments in the west associated with the mass production of microcomputers and their rapidly increasing introduction into schools (Makau & Wray 1987). Most likely responding to the same societal and business pressures as in the west, a considerable number of people involved in the Aga Khan educational system in Kenya felt that computers

should be introduced into one of the system's schools. As a consequence, in 1982 the AKF agreed to provide funds for the purchase and maintenance of equipment, and the remuneration of a project director with an appropriate background in both education and computing.

The Aga Khan Academy, a private day secondary school in Nairobi, was chosen as the site of the project. The equipment, consisting of five microcomputers and some software, arrived in May 1983 and the project got underway. Following signs of some success at the pilot school, the funding agency decided that the project should be expanded. In August 1986, with the agreement of the ministry of education and a generous donation of equipment from Apple Computers Inc. of the USA, five new schools - including four government-funded ones - were brought into the project. Table 2 shows the particulars of the schools in Phase II of CEPAK.

Table 2. PARTICULARS OF SCHOOLS IN CEPAK DURING 1987

Name of School	Enrolment	Student Gender	Number of Teachers	Source of School Funds	Town
Aga Khan Academy	430	Mixed	38	Parents & Community	Nairobi
Aga Khan Kenya Secondary School	420	Mixed	28	Parents & Community	Mombasa
Coast Girls High School	760	Female	46	Government, Parents & Community	Mombasa
Moi High School Kabarak	630	Mixed	40	Government, Parents, Community & Private	Nakuru
Ofafa Jericho High School	440	Mixed	38	Government, Parents & Community	Nairobi
State House Girls High School	500	Female	35	Government, Parents & Community	Nairobi

A number of features make CEPAK a unique project. First, the cost element, reported in the literature as a major inhibiting factor in developing countries (Ilyas 1986), has received careful consideration. A small number of microcomputers and selected software pieces, a threshhold package thought to be the minimum requirement for the attainment of the project's objectives, has been introduced into each

school. Initially the Aga Khan Academy received 5 computers (4 Apple IIs and a BBC), while in Phase II each of the new schools has been given 5 Apple IIs. The capital costs of Phase II are shown in Table 3.

Table 3. CAPITAL COSTS IN CEPAK PHASE II (US $)

ITEM	PILOT SCHOOL[a]	NEW SCHOOLS	PROJECT OFFICE	TOTAL
Computer hardware	9,300	54,000	12,600	75,900
Other imported hardware[b]	3,700	300	6,700	10,900
Software & reading materials	3,360	11,900	2,660	17,920
Freight costs[c]	1,440	5,600	1,140	8,180
Local equipment[d]	600	12,500	11,900	25,000
TOTAL	18,400	84,300	35,000	137,900

Source - Wray B F (1985): *Computers in Education Project Phase II, 1986-1988 - A Draft Proposal submitted by the Aga Khan Education Service (Kenya) to the Aga Khan Foundation,* August.

Notes

[a] Four microcomputers were added to the pilot phase threshhold package.

[b] Included: 2 video cassette recorders, a video camera, a photocopier, an optical reader, 3 overhead projectors, a micro-controlled slide projector, 2 class audio cassettes and miscellaneous accessories.

[c] An exemption from duty and sales tax was granted by the government.

[d] Included: a project car, furniture, electric cables, telephone and project office installation.

To guard against the tendency for donor-funded development projects not to make provisions for recurrent costs (Psacharopoulos & Woodhall 1985), the funding agency set aside funds for maintenance of the equipment and purchase of additional software, books, journals and magazines during the period up to December 1988, when Phase II will terminate. The project's central office recurrent expenditure for 1987 and 1988 is shown in Table 4.

Table 4. RECURRENT EXPENDITURE IN CEPAK DURING 1987 & 1988 (US$)

	1987	1988
EQUIPMENT		
Software for schools and project office	7,346	8,074
Educational materials for schools	5,872	6,459
Educational materials for project office	3,594	3,952
Maintenance of equipment in schools	6,201	6,823
Maintenance of project office equipment	1,550	1,703
Insurance (schools)	3,101	3,406
Insurance (project office)	775	852
Sub-total	28,439	31,269
SERVICES (project office)	4,680	5,156
TRAINING		
Local travelling & subsistence (project persnl)	11,239	12,619
Local travelling & subsistence (school staff)	9,689	10,658
Travel & subsistence overseas (project director)	4,240	2,202
Printing and stationery	1,292	1,421
Sub-total	26,460	26,900
PERSONNEL COSTS	24,194	26,413
GRAND TOTAL	83,773	89,738

Source - *CEPAK's Expenditure Records for 1987 and 1988 Budget.*

A second feature of CEPAK is the articulation of an educational philosophy. Rejecting the tendency in the west for computers in schools to be dominated by courses in computer studies or science or awareness or programming, CEPAK has introduced the computer as an educational tool which should enhance the quality of learning in the entire school curriculum. The computer is seen as a tool which enables the ordinary subject teacher to conceptualise the content and context of learning in new ways which emphasise active involvement of the individual learner and peer learning amongst students. The outcome is expected to be a stimulation of learning experiences which nurture the growth of creativity, initiative, problem-solving and reasoning skills. In pursuit of

this central goal, the project proposal specifies five objectives as follows:

"(1) to improve the quality of teaching by in-service teacher education using the microcomputers as a catalyst;
(2) to use the microcomputers as a teaching resource in appropriate school subject topics;
(3) to provide the pupils with a basic knowledge of new information technologies, both to aid them in their studies and to make them aware of their technological environment;
(4) to improve the quality of school administration through the use of appropriate information technology;
(5) to appoint such members of staff as required so that the school can maintain its level of educational information technology without the need for continued support of the project" (Wray 1985).

Implementation Strategy

The implementation of CEPAK has relied a great deal on staging teacher education (as opposed to training) in-service activities. The project director (PD) has attempted to play the role of teacher advisor rather than trainer: by exposing teachers to the technical aspects and educational implications of computers, he has expected the teachers to conceptualise and develop new teaching approaches. The idea has been that the teachers should be guided to "discover" for themselves, rather than relying on didactic "telling" by an expert. In Phase II this strategy is symbolised by the setting up of a project office which is not in daily contact with any of the project school staffs. The role of the project office, in addition to organising in-service activities, is to give the schools support by responding to teacher requests for software and reading materials from the project library, and acting as technical and maintenance back-up.

Three stages are discernable in the dissemination of the technology from the PD, through teachers, to the students. First, the delivery of the threshhold package of equipment was accompanied by three start-up workshops - organised in Nairobi, Mombasa and Kabarak - in which all teachers (not just the mathematicians and scientists as has tended to be the case in the west) were given hands-on experience and, in general, exposed to pertinent educational ideas. Each of the start-up workshops exposed teachers to the innovation for about 70 hours. The start-up workshops have been followed by specialised workshops for school managers and administrators (headteachers, teachers appointed to co-ordinate the innovation within the schools, and bursars), and subject teachers. Two-day workshops for heads were conducted in December 1986,

September and November 1987. School media co-ordinators have had two workshops (10 days each) in December 1986 and August 1987; and school bursars were given a two-day workshop in November 1987. Between May and October 1987, one or two subject teachers from each school attended two-day/subject workshops in all main disciplines in the curriculum; on return to their respective schools, the participants were expected to share what they had learned with the rest of the teachers in the subject department.

A second stage in the implemantation has been visits to individual schools by the PD. Between September 1986 and June 1987, the PD spent two days per month in each school during term time; beginning September 1987, the visits were reduced to one/school/month. During these visits, the PD gave technical support and was available for professional discussions with teachers. The third stage, the use of the technology with students, has been left entirely to decisions by the headteachers or individual teachers; thus there has been no imposition from the PD as to when a school should begin to use the technology with students.

RESEARCH IN THE PROJECT

In recognition of CEPAK's attempt to develop a fresh approach to the teaching-learning process, the International Development Research Centre and the Rockefeller Foundation have joined hands with AKF to fund systematic research by a team of three educationists and an educational economist. The research effort is expected to decipher and record the extent of changes, associated with the introduction of the technology, which occur in the teaching-learning transaction and the management of the schools, and, equally important, to study the cost implications. However, the study is not confined to the mere evaluation of the project: in addition to analysing the particulars of the project, the research team is expected to use salient themes to abstract into and make suggestions on the improvement of educational processes in Kenyan schools even if the new technology could not be introduced on a wider scale.

Bearing in mind recent literature to the effect that reality in social phenomena, such as education, is best approached and understood through the simultaneous application of quantitative and qualitative methods (Cook & Reichhardt 1979, Dockrell & Hamilton 1980, Patton 1980, Miles & Huberman 1984, Yin 1984), the research team's modus operandi is the collection and analysis of both quantitative and ethnographic data.

At the initial stages the research team, which launched the study at the beginning of July 1986, concentrated on collecting and analysing data to

establish the schools' baseline status at the beginning of Phase II. Five sources of data were tapped, namely: (1) re-analysis of data collected during the evaluation of the pilot phase at the Aga Khan Academy (2) survey data obtained through written questionnaires administered to 75% of teachers and about 97% of forms 1, 3 & 5 students in the five new schools (3) verbal interviews of headteachers and a selection of subject teachers (4) collection and content analysis of school documents - such as school magazines, student admission letters and school regulations (5) observation of 218 lessons covering all subjects in the schools' curricula. A baseline report (Makau 1988) was prepared and submitted to the agencies funding the research.

Subsequent to the the establishment of the baseline status, the research activity has consisted in. (1) observations and interviews at all CEPAK-organised workshops (2) observations and interviews in the six schools - between March and October 1987, 70 lessons (43 in which computers were used) were observed, 58 students were interviewed and 244 staff (including non-teaching staff) interviews were carried out (3) observation at meetings of school computer clubs (4) examination of school records on the use of the computers (booking systems on the use of computer rooms, records of software and reading materials, teacher/student computer files and printed products, and school management documents such as notices, correspondence and accounts records) (5) examination of CEPAK's central library records and evaluation of software (6) interaction with the PD: quarterly reports prepared by the PD and the research team have been mutually subjected to critical discussion, and after visits to schools careful debriefing has been undertaken. In all cases, data collection activities were immediately followed by detailed computer-processed reports by the researchers involved.

PRELIMINARY FINDINGS

As both the implementation and study of CEPAK are continuing, the findings presented here are interim. At this stage of the project, seven desirable outcomes are discernable:

(1) In the six schools the technology has been introduced to some students. Students - seen using the computer to play games, view CAI programs and make use of general application software particularly graphics programs - have been observed to be excited and keenly interested in the technology. A number of teachers have testified that the computer greatly motivates students. Interviews of students have yielded statements such as:

"Learning does not always have to be serious"; "The computer is interesting. You pay attention to it"; "When you use the computer, you can go at your own speed and you can make mistakes and correct them without any problem". The increased student motivation seems to be associated with the fact that use of the computers is enhancing learning as an individualised and active process. In preparation for a Form V biology lesson on human energy expenditure, the teacher had asked each of the six students in the class to collect data on the foods s/he ate as well as the activities s/he undertook in the course of a week. During the lesson, each student was given an opportunity to enter his or her data into a computer program which worked out energy values in relation to the foods eaten and the activities undertaken. As the computer screen with data on each student was discussed, it was observed that there was sustained excitement and interest, with the teacher frequently making comments such as: "If you wish to keep slim you must eat less bread!"

(2) The technology has been observed to be enhancing peer interaction among the students. Echoing the views of several others, a student interviewed (October 1987) in one of the new schools stated: "Discussing things when using the computer helps you learn things from your friends. After all, that's the way you learn after school." The potential of peer interaction as an effective learning strategy is exemplified by the organisation of a computer club in one of the new schools. It was observed that a student, who had had exposure to computers in his previous school, administered the club with little intervention from the school staff and that he aimed at sustaining members' interest by choosing "activities which are different from normal classroom lessons."

(3) The computer is being used in the management of schools. With varying degrees of success, the new schools are emulating the pilot school's use of the technology in the administration of finance, production of management documents, management of students' personal data and monitoring students' academic progress.

(4) In the pilot school, in addition to the introduction of an IT course through which students are acquiring computer awareness, some success has been achieved in integrating the new technology in the normal curriculum. A mathematics teacher in the school was observed to have succesfuly integrated the electronic spreadsheet and CAI programs into her teaching, whlie two other teachers have learned PILOT, the teachers programming language, and have used it to produce CAI software in Physics and Chemistry. The resource centre (RC), which houses the computers and related technologies, is being used for most of the school day: the main activities are the conduct of formal lessons - in the main

ing CAI programs, production of learning materials by teachers, playing computer games and after class activities under the auspicies of the mputer club. By the end of 1987, ten teachers in the school (26% of tablishment) were regularly using computers in normal lessons - mainly the sciences, mathematics, art, english, french and history.

) In the 5 new schools, a number of teachers have attempted to learn and e the computers in teaching: in one school two teachers have used the preadsheet to teach aspects of mathematics and english; the rdprocessor has been used to produce handouts and other teaching aterials; on several occasions commercially produced CAI programs have en used in teaching a fair cross-section of subjects; and in each of the hools one or two teachers have tried to use PILOT to develop their own AI programs.

) In all the schools, the innovation has helped some teachers to develop w perceptions of their job. In CEPAK workshops, teachers have generally en exposed to discussion of teaching and learning approaches which seek make educational processes child-centred and geared to the velopment of problem-solving skills. There is evidence that some achers are developing new constructs: in a discussion with three achers at the pilot school in October 1987, a history teacher who does t use the computer much criticised non-imaginative uses of technology y arguing that he would like to see computer-assisted lessons "where achers and students don't just gaze at the screen and simply punch keys move on, but where students listen, talk, discuss, write something in air note books, ask and answer questions, and get assignments."

) Some peer learning between teachers has been stimulated by the troduction of the technology. Several knowledgeable teachers have been served assisting others in how to use the technology and during 1987 e pilot school as well as one of the new ones organised in-school rkshops on the computers without the involvement of the project office.

However, the salutary effects of the innovation are counterbalanced by six emingly negative aspects in the learning situation:

1) With regard to enhancing child-centred learning, the introduction of e technology does not seem to have made the majority of lessons any tter than those observed during the pre-innovation stage in Phase II. Even in computer-assisted lessons - including activities aimed at mparting computer awareness - lectures, notes and questions from the acher continue to dominate. Fresh constructs on pedagogy, arising from e innovation, do not appear to have as yet been translated into the

methodology of the majority of the teachers: as demonstrated by the efforts of some teachers to learn PILOT in order to produce traditional tests, teachers still regard their job as passing on to students chunks of knowledge rather than nurturing problem-solving skills in the learners.

(2) Certain school and teacher practices have curtailed the enjoyment that students could derive from using the computer for learning. In most of the schools, the playing of computer games is seen as diverting students from "serious study" and as a consequence the activity is restricted. The choice of what students should do at the computers is mainly that of the teachers, some of whom have been observed to choose repetitive or boring activities. In a form 5 mathematics lesson in the pilot school RC (observed in October 1987), as students wandered from one screen to another many grumbled saying, "we have seen all these things before." One student whispered to his friends, "the man has nothing to teach", another student responded, "again?" After a lot of mumbling, one student addressed the teacher: "Sir, we would rather go back to class and work on the important maths for the test." After some silent reluctance - indicated by a frown - the teacher agreed and the students trooped back to their normal classroom. A number of students who use the computers regularly have indicated that they are beginning to be bored by teacher-chosen activities based on academic programs, or in which database and spreadsheet programs are used to process hypothetical test scores. One student remarked, "these are too much like normal classes."

(3) Use of computers has exacerbated inequity in the learning situation by making some students, particularly girls in mixed classes, totally passive. In the majority of computer-assisted lessons observed, it has been noticed that few teachers have ensured that all members of a group at a microcomputer have an opportunity to operate the keyboard and have their views listened to by others; thus many students would probably agree with one of their peers who argued that "the computer is only interesting when you are operating the keyboard, otherwise it is boring."

(4) In some lessons, use of the computers has been observed to be detrimental to learning as a focused activity. Some teachers have been observed to abandon students in the RC or to simply hand over CAI programs to their classes, allow random grouping and leave the students to do what they like. The result has been uncontrolled noise and aimless movement between groups, a situation most likely militating against systematic learning. One student interviewed criticised use of the computers as follows: "Discussion at the computer disturbs those who like doing quiet work on their own."

5) There is ambivalence in systematically integrating the technology into teaching schemes. In the second term of 1987, one of the new schools attempted to get all form 1 and 2 teachers to use the computers with their classes, but the effort was abandoned before the end of the term. In the new schools, the tendency has been for the technology to be used more with small classes - particularly in upper school - where numbers do not pose major class management problems.

6) In four of the new schools, the number of teachers attempting to master the technology or to use it with students seems to have declined in the course of 1987: in mid-July 45 teachers (32% of total establishment) were reported as users of the technology, but by mid-October the number had dropped to 20 (14%).

DISCUSSION OF THE FINDINGS

Cognitive Psychology and the Innovation

The excitement and interest noted among students when using the computer indicate that the preferred mode of learning expressed in the baseline data is deeply embedded in the human personality. In the baseline survey, students were asked to rate eight learning strategies in terms of the extent of "understanding" and "enjoyment". The responses on "understanding" and "enjoyment" were correlated. The coefficients of correlation in five of the learning strategies are shown in Table 5.

Table 5. CORRELATION BETWEEN UNDERSTANDING AND ENJOYMENT IN FIVE LEARNING STRATEGIES

N = 5 Schools (1,535 students)

Learning Strategy	Coefficient of Correlation	Nature of Activity
1. Listening to teacher (lecture)	.4776	Listening
2. Writing teachers' notes	.5870	Copying
3. Answering teachers' questions	.6450	Answering
4. Exchanging views with the teacher	.6580	Discussing
5. Working with apparatus	.7964	Active exploration

It is significant that the positive correlation between understanding and enjoyment increases as the learning strategies become more

learner-centred. The highest coefficient of correlation is reported for a learning strategy which involves the student in active exploration.

The foregoing data which point to the student's preference for learning situations which excite and make him active and autonomous, confirm the findings, common in the literature on current learning theories, that learning is an innate, active, constructive and goal oriented process in which every individual is involved and in which the cognitive and emotive parts of the human brain are engaged in a complementary manner (Piaget 1955, Mueller 1974, Wittrock 1974, Anderson 1983, Dale 1985, Hemming 1986, Larsen 1986, Shuell 1986, Yarlot 1986, Pratt 1987). In contrast to the behavioural orientation which focusses on behavioural changes requiring a predominantly passive response from the learner to various environmental factors, Shuell (1986) points to the cognitive psychology view, which dominates current learning theory, that the learner is actively involved in three mental activities: (1) metacognitive processes such as planning and setting goals (2) active selection of functional, as opposed to nominal, stimuli (3) attempting to organise the material being learned even when the material has no obvious bases of organisation. This view maintains that learning is based on the individual's mental schemata (organised, structured and abstract bodies of information) of what the learner already knows and which he brings to bear on learning new material, and that three hierarchical psychological processes are involved in learning the new material: (1) selective encoding - sifting relevant information from the irrelevant in the stimulus environment (2) selective combination - integrating selected information in a meaningful way (3) selective comparison - integrating newly encoded information with information already stored, resulting in the development of new schemata.

The emphasis cognitive psychology gives to the importance of what one already knows as the basis of learning new material has been validated by observations that, in the project schools, teachers and students with pre-innovation exposure to computers have not only shown more interest in the technology but also have made more rapid and meaningful advance than their peers in developing various applications. A case in point was a Form 1 student in one of the new schools, who in his last year in primary school had the opportunity to play a mathematics game on his aunt's Atari computer. On being introduced to the Apples in the project, he quickly mastered how to operate them and, with obvious excitement, was able to demonstrate applications of a CAI mathematics program, Graphing Equations, at a level claimed by many teachers to be too advanced for Form 1.

Complementarity of the cognitive and affective parts of the brain is both argued to be real and as constituting the linch-pin in meaningful learning.

In way of proof of the reality of complementarity, Yarlot (1986, p.241) states:

> "It simply does not make sense...to speak of the left hemisphere (of the brain) taking the literal meaning, and the right hemisphere the emotional tone, when, in interpreting a work of literature, verbal and emotional operations take place, surely, as a single, simultaneous and virtually indivisible process."

Larsen (1986, p.333) refers to a study in which it took a class less time to learn poetry than was the case with regard to prose of similar length, because "the passages of poetry possibly activate memory functions of a non-semantic character more frequently than do prose passages, and thus relate the content more directly to imagination and recollection of prior experiences of the learner." In arguing that the primary needs of the learner are for growth and self-actualization, "being needs" for all individuals, Pratt (1987, p.55) maintains that curricula conceptualisation should take into account that "psychological and social health depends on recognition and integration of the many different aspects of being, including the cognitive, the affective, the social, the somatic and aesthetic. These include not only areas of objective knowledge, but also areas which are irreducibly subjective, such as the spiritual." In advocating for learning experiences closely related to life outside the institution, Hemming (1986, pp.59-60) sees complementarity of the cognitive and affective as enabling the individual to make his or her brain:

> "We are far from understanding the details of how the brain is laid down and wired up, but it is beginning to look as if, to a considerable extent, we make our own brains by the way we interact with the world and subjectively evaluate the experiences we generate. The richer our relationships with the world, the more complex our brains become."

Hemming (p.63) makes the point that, it is this making of one's brain which is the essence of attitudinal development towards self-reliance - currently emphasised in Kenyan school curricula:

> "Now that employment is uncertain, well-built up personal motivation is especially important. It is the starting point from which individuals may make opportunities for themselves."

The relationship between school and the wider environment as a sound basis for learning is being demonstrated in the project. Many of the early adapters of the technology among the teachers have explained their interest in terms of their new expertise providing them with an escape

route to further education and/or more lucrative career outside the teaching profession. At the pilot school, where most students come from families engaged in business, it was observed that in one week (October 1987) two business education games, StokMak and Price Elasticity, were almost exclusively played by most of the students who worked with the computers outside class time. One student, who had been observed to play StokMak on seven different occasions, explained: "The computer games that you find in the arcade machines at the Sarit Centre are all about these aliens and rockets which zoom in space. But the stock market games refer to the life of business in the world which I am interested in. These games have given me a deeper understanding of the economic concepts which the teacher dealt with in class and which I have read in books." Another student, who was observed to have concentrated on the graphics program, Mousepaint, said that he was working for a career as a designer.

Perceptions of Problems in the Implementation

In spite of the potential for change in the learning process offered by CESAK and the fact that some success has been achieved, it is obvious that the six project schools are a long way from offering a scheme of learning which enables the student to fully grow along the lines advocated by proponents of current cognitive psychology. The professional staff in the six schools regularly mention five reasons for cautious adoption of the innovation: (1) lack of time (2) inadequate mastery of the technology (3) inadequate and/or innapropriate software (4) small size of RCs in relation to large classes (5) small size of the threshhold package.

With regard to lack of time, the majority of teachers point out that they do not have the time to cover the prescribed syllabuses and carry out their normal school duties, as well as learn how to use the computers. This claim is not without substance. Asked why she did not use her non-teaching periods to learn how to use the computer, an english teacher in one of the new schools argued. "Practice on the computer requires time so that you can concentrate, but time is never there. It is no good going to the computer in isolated free periods as by the time you get back to it you will have forgotten what you had learnt." The research team has evaluated some of the software and has found that the reading of the manuals, familiarisation with programs while using the computer and the development of imaginative integration of the technology in normal teaching-learning are time-consuming tasks. This finding has been collaborated by a mathematics teacher at the pilot school who said that, in spite of coming to the school with a masters degree in computer science, she had only been able to systematically integrate computers into her teaching scheme because, on joining the staff the headmaster

deliberately encouraged her and for a term assigned her a reduced teaching load of nine periods per week.

Inadequate mastery of the technology is a catch all phrase. It includes unfamiliarity with the typewriter keyboard (quoted and observed as an inhibiting factor for most of the teachers attempting to use the computers), fear of damaging the hardware and software (confirmed for some of the teachers by incidents of damaged disk drives and corrupted computer disks), and claims that both the centrally organised CEPAK workshops and intended learning from knowledgeable colleagues have not fully met expectations in terms of both the technical operations and professional applications of the computer. When questioned about the effectiveness of the centrally organised workshops, several teachers have responded as follows: "Too much was covered and I could not follow most of it"; "Too little of too much was covered"; "It was too technical for me"; "The time was inadequate"; "There was not enough hands-on experience".

The commercially produced CAI software provided by CEPAK is seemingly not tailor made for the Kenya syllabi. Where topics are covered by some of the programs, the teachers point out that the class levels at which the software could be used range from form 1 to form 6, and as a consequence it is not easy for a teacher to use the courseware with a particular class. Another claim by teachers and for some programs, validated by the research team's evaluation, is that most of the CAI software is suitable for consolidation and testing, rather than for introducing new topics. Cultural bias (Lallez 1986) is also an issue, for instance in the sphere of language, it has been noted that American as opposed to British spelling which Kenyan students are used to - e.g. 'sulfur' instead of 'sulphur' in a chemistry program - has on occasion caused confusion. Most of the available CAI software is in mathematics and the natural sciences and as a consequence, teachers of languages and humanities feel that the innovation is not fully catering for their disciplines. In some cases lack of information and unavailability of software has been claimed in relation to insufficient documentation and irregular supply from the central library.

Since only a small number of computers are provided, CEPAK has encouraged the schools to concentrate the equipment in a special room (RC) to which teachers should bring classes or groups of students. Out of the six schools, only the pilot school has a large enough RC (the size of two normal classrooms) to comfortably accommodate classes of 40+. As a consequence, many teachers in the new schools claim that they do not wish to split a class such that one group remains in the normal classroom while the teacher works with the other in the RC. Concentrating the equipment in one room is also inhibiting in that teachers may be kept out

of the room if the RC is heavily booked for formal lessons: complaints to this effect have been registered at the pilot school.

Some of the teachers have complained that their attempts to master the technology is hampered, and the students' actual time at the computer keyboard limited, by the small number of computers relative to the staff establishment and student enrolment. This complaint, noted by Gakuru & Karlukl (1986) in their evaluation of Phase I, has featured prominently in disagreements between the teachers in charge of the RCs and the rest of the staff. With the increase of the volume of products printed, particularly in the pilot school, issues have also arisen with regard to the limited quantity of computer stationery provided under the project and the inability of normal school funds to meet the balance. Some teachers have been quick to latch onto the statement (excuse or fact?) that they would not want to master the technology "since the innovation is only an experiment which the schools could not sustain beyond project funding."

The School System and the Innovation

Although there is considerable validity in the foregoing explanations for teacher reluctance and caution in adopting the technology, there is evidence that there are other more subtle causes. Some of the teachers who have complained about lack of time have weekly teaching loads of less than 20 (out of 45) and some have been observed sitting in the staffroom chatting with their friends during free periods. The use of time by teachers is a sphere which could be improved. It could be argued that most of the time the teachers claim they spend marking students' written work could be more effectively used if less homework was given and the teacher took longer to plan better sequenced and more interactive lesson activities. The opportunities provided by the computer innovation should be of assistance in such endeavours. Some teachers who complain about the inappropriateness or lack of software have been found to have viewed none of the CEPAK programs or, in spite of a regularly updated software list in all schools, to say what programs there are in their subjects. The CEPAK library has a useful collection of books and magazines on the role of computers in the learning process but, in spite of encouragement, very few have been borrowed by teachers. Observations at the RCs of the five new schools, by and large, have revealed that for most of the day the computers are not being used with classes, but that few teachers venture in.

The perception of CEPAK by the school heads provides a clue to understanding some of the underlying causes of ambivalence or even cynicism in relation to the innovation. In none of the institutions is there

a clearly articulated school policy on the integration of computers in the curriculum. In a meeting (November 1987) between representatives of the funding agency and the heads, the latter clearly stated the potential of computers in school management and production of back-up materials by teachers. but were vague on "exposing students to the technology" and "development of teachers through the innovation": the heads were silent on use of the computers in lessons. With the exception of one, the heads do not personally use the technology. The one head who is a user - both in school management and in her teaching - has weakened the force of her example by not insisting that the teachers use the technology in their lessons: in May 1987 she argued, "I do not want to challenge teachers later in the year as to why they had not covered the syllabus, only to be told that they had wasted time with the computers." The project researchers have noted the tendency for most of the heads to avoid detailed discussion of the innovation: on arrival at the head's office the researcher is rapidly handed over to "Mr or Ms so and so who knows the details of what is happening with the computers." One head who is vocal about his efforts to facilitate the overall growth of students in his school has not attended any of the CEPAK workshops organised for heads.

Interviews with the staff in the project schools reveal that the model of school, which Kenya shares with other countries and is to a large extent imposed by society (Buckman 1973, Bowles & Gintis 1976, Giroux 1983, Keesbury 1984, Apple & Teltelbaum 1986, Shor 1986, Cuttance 1987, Edelstein 1987, Tornvall 1987), is not fertile ground for the germination of innovative educational ideas. such as CEPAK is attempting to plant. The school is perceived as an instrument for the mass acculturation of youth, with the main features of the process being the implementation of centralised curriculum and certification based on results obtained in content-specific state-wide examinations. In order to achieve the perceived objective, the Kenyan school system has been developed as an orderly and authoritative institution characterised by a hierarchical organisation: the head receives the curriculum and instructions from the ministry of education, he in turn is looked upon as the source of authority by the teachers and, at the bottom of the ladder, the students are expected to receive knowledge from the teachers. This authoritarian and hierarchical organisation influences the teacher's perception of his position and approach to the job, and adversely affects learning as a natural process.

In the baseline survey 51% of the teachers indicated that the status of school teachers in Kenya is low. In common with other countries, the low status of the teaching profession is partly explained by the role society prescribes for teachers. Addressing the issue, Piaget (1970) states

"What the schoolteacher lacks, in contrast to (other professionals), is a comparable intellectual prestige. And the reason for this lack is an extraordinary and rather disturbing combination of circumstances. The general reason is, for the most part, that the schoolteacher is not thought of, either by others or, what is worse, by himself, as a specialist from the double point of view of techniques and scientific creativeness, but rather as the mere transmitter of a kind of a kind of knowledge that is within everyone's grasp."

Observations at CEPAK workshops and discussions with staff in the schools indicate that the teachers have internalised the prescribed role. Attempts to encourage the teachers to think in terms developing their own curricula beyond the ministry of education's published syllabuses have been countered by responses such as: "Curriculum development is the responsibility of the Kenya Institute of Education"; "We have strict instructions from the education inspectorate to follow the specified order of curriculum content coverage." In their September 1987 workshop, the heads of the project schools expressed themselves as almost powerless to deal with the professional problems facing their schools and indicated that they prefer to wait for central authority to provide substance and direction to the education they make available to their students. It should not be unwarranted to extrapolate from the foregoing that the school staff do not see the innovation as central to the school since it has been initiated from without the ministry of education.

Given a climate in which staff feel controlled by an authoritarian and a hierarchical school system and in which individuals tend to keep trade secrets to themselves, collegial interaction - which CEPAK assumes as an important tenet in the implementation of the innovation - has been limited. Used to judging colleagues in terms of their position in the official hierarchy, teachers in the project schools do not visualise the emerging position of computer media co-ordinator (CMC) as capable of enhancing peer interaction and guidance. With some justification - such as limiting their colleagues' access to the hardware, software and stationery - most of the teachers designated as CMCs have been accused by their colleagues as being empire builders who are using the innovation to make a niche for themselves and ingratiate themselves with the heads and other school authorities. To a large extent, this belief explains complaints that the CMCs, who CEPAK has exposed most to the innovation, have not done much in helping fellow teachers to master the technology.

In spite of well articulated educational objectives and goals, centrally

developed curricula and examinations tend to encourage the view that learning is the acquisition of knowledge selected and delivered by the teacher (Somerset 1982, Mekau 1985, Apple & Teitelbaum 1986, Doyle 1986, Haywood 1986, McNeil 1987). Because society holds school staff accountable for students' performance in examinations, teachers seek to control the teaching-learning transaction and to narrow coverage to the syllabus areas which are examined, more often than not, as discrete facts. Referring to an American school district english course aimed at developing creative writing and appreciation of literature, McNeil (1987, p.117) states that the amount of student writing and the time spent in analysing works of literature was found to be limited because "the students would have to take a proficiency test on grammar, spelling, sentence structure and other components of grammar and composition. Since these would be presented on a multiple-choice test at the end of the semester and recorded by the district as part of the teacher evaluation policies of the district, many teachers felt that the first priority was to get their students through the tests." Conscious of regular public teacher baiting in relation to poor examination results, teachers in the project schools have been observed to be unanimous that equipping students with the facts required in public examinations is top priority. Learner-centred education which is geared to the development of problem-solving skills, such as CEPAK is advocating for, is sidelined.

The CEPAK baseline survey data in the five new schools show that most time in formal lessons is taken by teacher-centred methods (Table 6).

Table 6. STUDENTS' RATING OF THE LENGTH OF TIME SPENT ON FIVE LEARNING STRATEGIES

N = 5 Schools (1,535 students)

	PERCENTAGES OF STUDENTS					
	Most				Least	No
	1	2	3	4	5	Data
Listening to the teacher	45	29	17	3	1	5
Writing notes given by teacher	40	22	17	10	5	6
Working with apparatus	25	13	18	14	14	8
Answering teacher's questions	20	27	31	12	4	6
Exchanging views with the teacher	13	21	29	23	7	7

In spite of their preference for natural learning approaches (Table 5), students are not averse to accepting teacher-centred methods because

they have been cajoled into believing that good performance in examinations - the gateway to future high socio-economic status (Somerset 1982) - is best achieved in this way. Students' responses to an item in the baseline questionnaire imply that the teacher is more useful as a source of facts than a facilitator of learning (Table 7).

Table 7. STUDENTS' RATING OF THREE DIFFERENT TYPES OF TEACHERS

N = 5 Schools (1,535 students)

	PERCENTAGES OF STUDENTS					
	Very Helpful			Not Helpful		No Data
The teacher who:	1	2	3	4	5	
(1) tells you all the facts	54	22	9	6	4	5
(2) encourages you to collect real things	49	26	14	4	2	5
(3) encourages you to obtain new knowledge on your own	38	18	16	11	12	5

The predominant mode of teaching-learning, revealed in data obtained from the baseline survey and subsequent observation of lessons in the six schools, is not unique to them nor to Kenyan schools (Keller 1980, Beeby 1979, Sirotnik 1983, Goodlad 1984, Nelsen 1985, Dillon 1986, Strahan 1986). In most countries there would appear to be a wide chasm between the child's natural desire to learn and the way in which societies go about organising formal education. Reporting findings of a study based on classroom observations in American schools, Sirotnik (1983, p.29) paints a picture almost identical to the one emerging from research into CEPAK:

> "Consider...the modal classroom picture presented here: a lot of teacher talk and a lot of student listening, unless students are responding to teacher's questions or working on written assignments; almost invariably closed and factual questions; little corrective feedback and no guidance; and predominantly total class instructional configuration around traditional activities - all in a virtually affectless environment. It is but a short inferential leap to suggest that we are implicitly teaching dependence upon authority, linear thinking, passive involvements, and hands-off learning."

CONCLUSION AND RECOMMENDATIONS

CEPAK demonstrates that NGO initiatives can play a useful role in adaptating technology to revitalise educational processes. However, the foregoing discussion on the factors inhibiting the adaptation of computers by schools points to the need for fresh thinking and planning to be given to the implementation strategy and the post-project role of the innovation. Given the current teacher-centred pedagogical approaches, a deeply entrenched authoritarian and hierarchical school system, teacher anxiety about the technology and a social context not much influenced by computers, it would appear that the expectation that school staff should "discover" how computers could be integrated into the curriculum should be re-thought. The project should benefit from the point made by Polya (1957, p.1) that expecting "discovery" to take place in a situation where the learner (in the case of CEPAK, the teacher) is totally ignorant is unrealistic:

> "The student should acquire as much experience of independent work as possible. But if left alone with his problem without any help or with insufficient help, he may make no progress at all."

Armed with research findings to date, the implementors need to devise systematic approaches aimed at convincing the teacher that the computer could be used to improve the quality of his work. Among measures the implementors should take are: (1) systematic written review of key software (2) showing teachers how and where the technology could be adapted for Kenyan syllabi (3) highlighting for teachers the advantages of using the computer as opposed to current approaches, for instance where the computer could save time in covering syllabi or where use of relevant CAI programs could lead to deeper understanding through simulation of processes which cannot be practically undertaken in the laboratory (4) helping teachers to overcome their fear of the technology by working with them in their own school environment, for instance the implementors could plan and deliver lessons using the computer in order to demonstrate how CAI programs could be used or how new class management methods (e.g. grouping) could be applied. These suggestions imply that more professional implementors should be recruited to work with the PD. In turn, this means raising the personnel costs of the project. It is suggested that in view of the post-project needs of the country, a number of Kenyan teachers should be recruited and trained to work with the the current director, with a view to their continuing to man the innovation beyond the expiry of NGO funding. The provision of additional implentation personnel is an area in which the government and other funding agencies should play

a role.

The relationship between NGO initiatives and government policy on IT and education is an important area. Inter alia, this paper indicates that because of the complex nature of the introduction of high technology in third world countries and formal educational practices entrenched in the society over a long period, an NGO initiative seeking to employ IT to nurture salutary change in the learning process can achieve but limited success if the government is not actively involved. Policy statements - made at the highest level of government - on the desirability of introducing modern technology into Kenya's educational and training institutions, need to be translated into detailed planning. At the macro-level of the economy, the role to be played by IT needs to become part and parcel of development planning: rationales, which take into account that modern technology is changing rapidly, are needed over issues such as (1) the potential for an indigenous high technology industry, (2) import of finished products as opposed to local assembly, (3) the potential for standardising IT equipment to a few makes, (4) local development of software, (5) taxation of IT goods imported for educational and research purposes, (6) optimal use of IT in an educational system already faced by financial constraints (7) the possibilities of bilateral and multilateral co-operation.

At the micro-level of educational planning and development, the integration of the computer - rather than making it the object of study - into the normal curriculum is but one way of translating the high ideals promulgated in the 8-4-4 curricula into novel teaching-learning practices. Whether or not computers are being used in schools, there is need to make learning the natural, individualised, active and goal-oriented process that it should be. The teacher should cease to be a dispenser of facts and become a facilitator of student learning. The challenge is, how does society make this possible? There is obvious need for improvements in the spheres of educational management, teacher education programmes, curriculum development, and the evaluation of student learning.

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