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ABSTRACT
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rationales for introducing computers into schools and universities in
African countries and compares these rationales with those being
advanced in industrial countries. Part 1 asks whether developing
countries in Africa need computers and why, and supplies some
answers. Part 2 looks critically and in detail at the main rationales
for putting computers in schools. Lastly, part 3 looks at the
experiences of four African countries: Botswana, Kenya, Lesotho, and
Zimbabwe. This review leads to two questions: what should happen next
regarding computers in African schools and universities and what is
going to happen next? A 50-item reference list is included.
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RATIONALES AND FUTURES FOR COMPUTERS IN AFRICAN SCHOOLS AND UNIVERSITIES

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Abstract

This paper examines rationales for introducing computers into schools and universities in African countries and compares these rationales with those being advanced in industrial countries. It is ir hre parts. The first asks whether developing countries in Africa need computers and why, and supplies some answers. The second looks critically and in detail at the main rationales for putting computers in schools. The third part draws on the experience of several African countries, leading to the two questions: What should happen next regarding computers in African schools and universities? What is going to happen next?

The paper is based partly on a recently completed international cooperative study of computers in Third World schools, led by the author and funded by the Harold Macmillan Trust.

DO AFRICAN COUNTRIES NEED COMPUTERS?

Are computers needed to satisfy the social and economic needs of African countries? Why have many of these countries decided that computers are essential? Computers entered the economies of industrial nations rapidly and pervasively. Are African countries merely being forced to follow suit, or do they have their own reasons for using computers?

'Creative gales of destruction' are sweeping the economies of industrial countries, according to Schumpeter 's (1939) classic study. These storms are accompanied by radical changes, particularly in the technological foundations of industry and commerce. The latest gales to batter industrial economies are those of information technology, a combination of developments based on computers but including communications. Information technology is pervasive: it penetrates all sectors of these economies, creating new jobs and destroying others, obliterating many activities and enhancing many, requiring less energy than older technologies and using new materials. Such changes demand changes in organisations and structures throughout the economy: if problems of adapting to new conditions can be overcome, there are opportunities for employment-generating investment as well as labour-saving productivity gains. So runs the theory.

Information has always been a source of power and control, but never more so than in the modern world. Individuals and governments are using it to gain political and economic advantage. Industrial countries are seeking, through information technology based on computers and electronic communications, to exert greater control over their competitors and over developing countries. To protect their own interests, all countries are being obliged to respond by stepping up their capacity to access and process information. All governments are developing policies, in the light of conditions in each country, with the aim of maintaining or gaining a competitive position. Governments of many industrial countries are assuming that a principal source of economic development will be production and consumption of information, which will significantly increase demand for higher levels of skills (Carnoy, Daley and Loop, 1987). Computers are at the heart of this revolution because they are very fast information processing machines.

As industrial countries survive these gales and prosper, almost all have undertaken a drive to teach their children about computers, to make them aware of the new technology and its implications for their lives.

Must governments of African countries follow the example of industrial ones? In a poor country with many illiterates, few skilled people, high unemployment, disease, malnutrition and even starvation, should scarce foreign exchange be spent on importing computers? If that country also suffers from uncertain electricity supplies, a humid or dusty climate and a chronic shortage of spare parts for anything electronic, is money spent on computers wasted, because they will be out of order in a few months?

Nationally, and internationally, much is at stake. Can African countries afford to employ information technology? Can they afford not to? Are they untouched by the 'creative gales of destruction'? It looks as though information technology is essential to African countries if they wish to modernise their infrastructures, survive in economic terms and compete internationally, and if they wish to be in electronic communication with each other and the developed countries for such purposes as trade. Indeed, this view was taken by the Organisation for African Unity, meeting at Addis Ababa in 1981, although its members were wary of increasing dependence on industrial countries. In all sectors, including agriculture, industry, commerce, health, education, defence, local government, transport, energy and water, the technology offers opportunities which are being seized in the Third World, according to a report from an Ad Hoc Panel set up by the US National Research Council (Ruskin, 1986). Foreign aid programmes may require it, and certainly recommend it. Conversely, countries which neglect it widen the technological gap between industrial countries and themselves.

Information technology is in some respects costly to purchase and operate. It creates strong dependency on vendor countries, at least in the short term, and, as Arab participants at a 1985 conference in Damascus noted, developing countries, being consumers of technology rather than producers of it, are exposed to the dangers of cultural invasion (UNESCO, 1985). In African countries where there is under-employment, the technology is not obviously required to automate labour-intensive operations. Even the vaunted speed of computers can sometimes be lost: initially, at least, computerisation of Zambian banks introduced greater delay in serving customers than the old manual system

(Spiro, 1988).

Developing countries do have certain economic advantages over industrial ones in adopting new technology: they have low overhead costs and a young and energetic workforce ready to learn if specialised training can be provided. The International Monetary Fund and the World Bank are said to perceive exploitation of wage differentials between industrial and developing countries as an important way to reduce debts of the latter.

Functions for computers in Africa

Governments of African countries can no longer escape considering computers, but their policy on computers, because it is controversial and expensive to implement, must be backed by an understanding of potential functions for computers in integrating systems, improving problem-solving and analysis, improving management, developing natural resources, and maintaining international communications and national competitiveness.

In African countries, implementation of the World Bank's controversial and reforming Structural Adjustment Programme, criticised by the Economic Commission for Africa and the Organisation for African Unity, has required computers. For example, the Bank included computerisation of the public sector among conditions laid down for aid to Uganda, and retained Price Waterhouse Consultants to study introduction of computers into the country's general development planning (Ojulu, 1988b). But the Bank is not the only advocate of computerisation. For instance, Professor F.H. Allotey, of Ghana's University of Science and Technology in Kumasi, is quoted as saying in Tanzania:

> We paid the price for not taking part in the industrial revolution of the the late 18th century because we did not have the opportunity to see what was taking place in Europe. Now we see that information technology has become an indispensable tool. We can no longer sit down and watch passively (Rwegayura, 1988a).

He was speaking to Tanzania's top decision-makers at a seminar which led to a national task force being set up to study computerisation of national systems. These systems in 1989 suffered from a serious lack of information on which to base decisions. Tanzania severely restricted imports of computers up to 1987, when the government realised that computerisation was essential.

African policy-makers trying to solve local problems involving small amounts of data do not necessarily require computers, but computers are now essential for regional or national problem-solving. Ruskin (1986) quotes an example of computerised hospital management in Lesotho. Zambia's Reserve Bank recently installed a computer to analyse and keep track of the national debt. Kenya produces its national budget on schedule by using microcomputers (Furst and Covert, 1988). The Save the Children Fund and Oxfam in the Sudan use computers to analyse the nutritional status of children and ensure that food aid goes to the right places (Jones, 1988). Each year, the Ministry of Education in Malawi uses computers to mark 1.8 million examination papers

5

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from primary school leavers in 12 days (Kalemba, 1988). These are but a few examples.

African countries lack experienced managers, therefore assisting managers is an important potential function for computers. Successful enterprises contribute to employment and to general prosperity, but such benefits can only be secured through long-term transfer of the technology and its integration into the fabric of each country. Unfortunately, most managers in African countries have never touched a computer and have very little idea of how one can be used in management. Though Ruskin (1986) quotes examples of computers applied to municipal management, and Bayou (1987) and Okogbaa (1987) offer numerous suggestions for financial managers of busines. s in African countries, considerable training is needed before compu.ers can perform this function widely.

Whether in agriculture or forestry, hydroelectricity or mining, computers are now essential for the conservation and development of natural resources. For example, mining companies in Zimbabwe depend on computers for geological data evaluation and modelling (Rushmere, 1988b). National statistical bureaus cannot function without computers. The output of these bureaus is essential to planned development of natural resources.

African countries cannot afford to be isolated from worldwide communication systems, now computer-based. In Kenya, for example, British and Italian computerised digital rural networks, linking small settlements to the national and international systems, were installed in the late 1980s with foreign aid. Financial institutions are demanding further computerisation: as part of the international financial community they cannot operate successfully without computers. As Amon Nsekela, chairman and managing director of Tanzania's state-owned and only commercial bank, the National Bank of Commerce, is quoted as saying: 'Many overseas banks have upgraded their systems to an extent that makes their counterparts in the developing world look antiquated' (Rwegayura, 1988b). Apart from banks, other enterprises operating internationally now use computers: airlines and container shipping lines are examples.

African enterprises face the problem of maintaining their economic competitiveness through continuous modernisation. In Mali, one of the poorest African countries, the Chamber of Commerce and Industry uses microcomputers to carry out monthly financial planning and analysis for all its regional delegations as well as its headquarters. Economic databases on prices and the activities of Malian entreprenuers assist foreign trade. In Nigeria, a survey by the Guardian Financial Weekly showed that about 80 per cent of the banks polled had been forced to install computers to maintain competitiveness and to carry out security-related tasks such as verifying signatures (Jason, 1988b). Ruskin (1986) offers agriculture examples from Kenya and Nigeria.

Structures for introducing computers into African countries

Once the need for computerisation is acknowledged, structures must be established, hardware and software obtained, and people trained. Some African countries have established formal structures to promote, coordinate and assist

the adoption of computers. At one level, these are policy-making and regulatory bodies. At a different level, governments set up structures to implement and advise. Non-governmental computer societies are commonly established: for instance, the Computer Society of Zimbabwe is vigorous, with plenty of international contacts.

There is little standardisation of hardware and software, however, and agencies frequently acquire computers direct from donors, without consulting the national committee. Like many African countries, Zimbabwe suffers from too great a diversity of suppliers, partly because foreign aid donors wish to see their own manufactures favoured, but also because of barter deals such as the one with Bulgaria, to which tobacco was exported in return for hardware and peripherals (Computers in Africa, January-February 1988). Without standardisation, after-sales service is likely to be weaker and stocks of spares cannot be easily maintained. With standardisation come lesser risks of being tied to particular manufacturers and suppliers.

Despite the sincere desire of governments to adopt computers in the national interest, many barriers remain, such as heavy duties on imported hardware and software. Only a few countries have a choice between importing, assembling or manufacturing computers. Assembly and manufacture require high quality control as well as low labour costs. Even if a African country succeeds in overcoming the shortage of appropriately qualified personnel needed to assemble or manufacture computers, it may well be unable to solve, even with foreign assistance, the problem of lack of foreign exchange for importing sufficient computer components. The strategy of bringing in foreign investment through joint ventures with companies such as IBM and Wang has not succeeded in overcoming this barrier. For example, Zimbabwe's foreign exchange allocations for computers go mainly to hardware for the public sector (Thorneycroft, 1988a).

In an African country where there are shortages of qualified personnel and components, efficient distribution of these scarce resources is very important. Regrettably, lack of good local agents or distributors is common, constituting another barrier. Among the reasons for weak dealer networks are uncoordinated purchases of many different and incompatible brands of computer, and inadequate incentives to commercial enterprises to enter the field and remain in it. When foreign manufacturers succeed in dumping on a African country large numbers of machines, as donations or at discounted prices, these same manufacturers and their local agents show little interest in after-sales service. If the machines also happen to be obsolete, or become obsolete within a year or two, after-sales service may disappear completely.

By contrast, pri   f hardw. re in African countries are sometimes raised by middlemen to whatever they think the market will bear: Cumming and Quickfall (1987) report an instance in Africa of a mark-up of 1000 per cent on the European price. Mechin (1988) criticises such inflated prices, yet gives 1989 estimates (unsubstantiated) of 14 000 microcomputers in Cameroon, 20 900 in the Ivory Coast, 350 000 in Nigeria, 45 000 in Kenya and 30 000 in Zimbabwe. African countries keen to help each other are sometimes prevented from doing so. Rushmere (1988a) asserts that other African countries are unlikely to obtain sales and service from Zimbabwe because these countries are tied to aid from

developed countries. They have no money, and certainly no hard currency, to spare to buy from Zimbabwe. Despite such trading problems, African countries such as Botswana, Kenya and Zimbabwe have decided to assemble computers on a small scale, using imported components.

Training people

The greatest barrier of all, however, is the shortage of trained personnel, often due to the passive role played by governments. Few African countries are able to train all the technicians, programmers and systems analysts they require to operate computer-based systems, even supposing that the hardware has been provided. Computers may be installed with the help of foreign aid, but they are under-used because of lack of staff. In some cases, they are abused because staff capable of using them commit fraud, being inadequately supervised by others who do not understand computers.

Even a country that tries to train programmers, systems analysts, computer operators and electronics technicians for its own needs may see them disappear to other countries in search of better-paid jobs. For instance, Ojulu (1988a) suggests that 60 per cent of the qualified Sudanese staff leave to work in rich Arab states. On the other hand, as Thorneycroft (1988b) reports, some African countries can and do train staff from elsewhere, as in the case of Zimbabwe, which trains for Ethiopia, Malawi, Mozambique, Zambia and other countries in its region. Not only computer personnel need training. Managers must be trained too, so that they understand how computers can be used properly in running businesses or government departments.

Should such training be undergirded, as in industrial countries, by 'computer education' of large numbers of children? Should the next generation of workers in African countries include a significant cadre who used them at school or university? Schools and universities may have an important role to play in transfer and integration of computer technology.

RATIONALES FOR PUTTING COMPUTERS INTO EDUCATION

Why do African countries want to put computers into their schools and universities? One reason offered is that students should be aware and unafraid of how computers work, because computers are pervading industrial societies and are likely to be important in African countries too. Since schools and universities prepare students for life, they should prepare them to deal with computers, which ought to be de-mystified. This can be called the Social Rationale, because it deals with students' place in society. It leads Ministries of Education to provide classes or extra-mural clubs where students learn the principles on which computers work, including some elementary programming, but gain only a little hands-on experience. Usually they face no examination.

A second reason is that students should learn to operate computers, at least at a basic level. Teaching them programming gives students some confidence in their ability to control computers, and possibly lays the foundation for a career in computer science. Teaching students how to use applications programs gives them skills that may be useful to them as students and when they move

into jobs. At school or university, runs the reasoning, boys and girls should take courses in 'computer literacy' or even 'computer science', quite often aimed at preparing them for an examination. This is the Vocational Rationale: computer education should be related to future jobs.

A third reason advanced is that students will learn physics, history or any other subject better through computer-assisted learning. This is the Pedagogical Rationale, calling for improved teaching and learning, and may well be the one that commands greatest support among educators. Computers should be classroom aids.

A fourth reason is that schools and universities and the education they offer can be changed for the better by the introduction of computers. Teaching, administrative and managerial efficiency may be improved. Computers require students to do less memorizing of facts and more information-handling and problem-solving. Computers encourage students to learn by collaborating rather than competing with other students. Teachers using them adopt 'more relevant' curricula and bring educational opportunities to a larger number of students. Administrators improve the way they manage schools and universities. Computers are seen as catalysts, enabling desired change in education to occur. This is the Catalytic Rationale.

National policy on putting computers into schools and universities depends to a large extent on the dominant rationale. The Social Rationale does not lead to the same policy as the Vocational one. For example, if a government wants to teach computer awareness in secondary schools, it may introduce rather low-cost microcomputers into a large number of schools. It will expect every school to have several teachers who, between them, can teach all students for 2-3 hours a week in, say, the second year. But if a government strongly influenced by the Vocational Rationale wants to introduce computer literacy or computer science, possibly as an examination subject near the end of secondary schooling, medium-priced microcomputers will be needed, teachers will have to be much better trained, and probably only selected classes will be able to take the course. The government will probably limit provision to a minority of secondary schools, on the grounds of shortage of resources and only a small national requirement for school graduates with computer science. Governments influenced by the Pedagogical and Catalytic Rationales must face a far larger bill for hardware, software and training. Developing and marketing suitable educational software is so costly that few countries attempt it. Many are importing software, but are unhappy with what they get, for educational and cultural reasons. Those doing without it are giving up hope of getting any.

Quite a few African countries <u>are</u> deciding to put computers in their schools and universities. They place greatest emphasis on the Vocational Rationale, and much less on the Social, Pedagogical and Catalytic. Ministries of Education without a policy on computers in schools and universities are waking up to the fact that they need one, based on a clear rationale. The computers come anyway, through donations or purchased out of non-government funds. This sort of pressure can be very damaging. Without a policy computers arrive in uncoordinated fashion. Teachers are not trained. Software is scarce. Hardware is incompatible. Spares, repairs and maintenance barely exist. Expensive

private schools and the universities survive best, with foreign contacts, quickly widening the gap between their students and the rest.

Ministries of Education with a policy, backed by a rationale or rationales, may still be unable to give computers high priority. But at least they are able to take important decisions, within the policy. For example, should they allow their schools and universities to accept donations of hardware, particularly of obsolete hardware? Should they require schools to have at least one properly trained teacher before obtaining a computer? Should they set up a centre for support services and possibly to develop educational software? What degree of dependence on other countries can they tolerate?

EXPERIENCE OF AFRICAN COUNTRIES

It is well worthwhile to look at the experience of schools in several African countries. The experience of universities has been described by other speakers in this Workshop. Obtaining full and up-to-date details is not easy, but the following accounts, arranged alphabetically and based on a research project funded by the Harold Macmillant Trust, provide plenty of examples for discussion. Each begins with a short description of the country and its educational system, after which there is a longer account of how computers came into the schools, what they being used for and what reactions they have provoked.

Botswana

Botswana, a country of 582 000 square kilometres (about the size of Thailand) with a small population of one million living in its eastern quarter, has a sound economic base in its mines. Its educational system was grossly neglected during British colonial rule, which ended in 1966, the year after the first secondary school opened. Now nearly 200 000 children attend primary and secondary schools. Unusually, classes contain more girls than boys, because boys are traditionally the herders of cattle. The pattern is 7:2:3 (Lockhart, 1988).

The use of microcomputers is increasing in business and government. As yet Botswana cannot fully staff its schools with its own nationals and still relies heavily on expatriates. In 1987, the Ministry of Education responded to pressure from schools and teachers, and set up a computer committee to consider much-needed policy (Cumming and Quickfall, 1987). Vocational needs seemed likely to be given top priority. Only senior secondary schools are connected to the electricity supply, but with Ministry approval they were started to obtain a variety of microcomputers for administrative use, for running courses in computer awareness and for computer clubs.

Kenya

Kenya spends a higher proportion of its national income on education than almost any other African country, and has relatively high percentages of its children attending primary and secondary school. Classes are large, 40 being common at the secondary level. English is the main medium of instruction. There are nearly 3000 secondary schools, of which almost 200 are private

(Makau, 1987a). Since 1985, the school system has been restructured to provide eight years of primary education followed by four in secondary school, leading to a four-year degree for those entering university. Public examinations are important, providing certificates to successful candidates at the end of primary school, and on leaving secondary school. In 1989, the last Advanced Level examinations were taken in Kenya: following the restructuring, entrance to university will be on the basis of results in the Kenyan Certificate of Education examination, taken after four years of secondary education. Universities will have to select some 5000 entrants out of 100 000 applicants (Eshiwani, 1988).

Modernisation is among the national goals for education. Both the President and the Minister of Education say they want the schools to prepare children to use modern technology (Makau, 1987b). Although Kenya's economy is agricultural, there is also a thriving business community in Nairobi and Mombasa, and a government system, both of which require technological support including computers. As in many developing countries, the educational system is meritocratic and strongly oriented towards preparing students for public examinations. Indeed, teachers are obliged to focus on the syllabus set for each subject by the examining body, thus neglecting any teaching beyond it. Computer studies and computer science do not yet appear in the list of recognised secondary school subjects.

The Ministry of Education, Science and Technology decided in 1982 to allow small experiments in computer education, both to gain experience and to produce computer-literate students (Wray, 1989a). Benson (1988) notes that the government levies very heavy customs duty on computer imports (even those for government use), which must be paid for in foreign currency, but computers for these small experiments were declared exempt under an agreement between the Ministry and the Treasury.

Makau and Wray (1987) report that the Ministry's curriculum panel for post-secondary Diploma Studies in Computer Science recorded its view that computer science should not be a school examination subject -- at least in the short term. Up to 1989 there had been no discussion at Ministry level about software standards for Kenya. In other words, policy on computers in schools is yet to be fully formulated in Kenya, although there are strong indications of Ministry interest and encouragement.

In 1988, Kenyan schools had about 230 microcomputers, of which about 140 were in privately-funded schools. Benson (1988) notes that there were none in government primary or primary-secondary schools, and very few in private primary schools. Machines such as the Apple IIe, Spectrum and BBC-B were the dominant types. Many of these computers came into the schools as part of external aid, paid for by donor agencies which also provided software and some staff training. There is concern that such aid will not continue, leaving the schools with expensive computers they cannot (or do not yet wish to) afford to run.

The Computers in Education Project of the Aga Khan Education Service (CEPAK) deserves special note. According to Makau and Wray (1987), CEPAK was preceded by a small pilot scheme, funded by the Aga Khan Foundation and

described in detail by Wray (1986). Its originator considered that learning abou computers and how to program in BASIC were incidental to future needs of students. Computers should be introduced rather to improve instruction, revitalise teachers and give children experience of using them. Following Ministry approval in late 1982, the pilot began in April 1983 in the Aga Khan Academy, a private coeducational secondary school in Nairobi.

The pilot, based on the Pedagogical and Catalytic Rationales, had ambitious targets: for example, it was expected that teachers across the curriculum would be trained and become self-sustaining in their use of computers by the end of the two-year start-up (Makau and Wray, 1987). This period proved too short: teachers needed more time to become secure in their use of the machines, to sample programs, and to consider how and whether they could integrate these into their normal teaching. They also needed time to think through (and accept or reject) changes in their approach to teaching, suggested by the software and by project staff. It soon became clear that students needed a course, too, on how the world of information might impinge on their lives. And using computers to assist administrators with finance and student records could not be ignored for long.

The pilot project was very thoroughly evaluated by researchers from the University of Nairobi (Gakuru and Kariuki, 1986) and reported on by Papagiannis (1985). The majority of teachers were using microcomputers (Wray, 1984) and were willing to discuss ways of improving their teaching. Students were studying more in groups, some at computers, others carrying out other tasks, and were discussing their work more. A few had become 'computer experts', being able to operate the computers better than their teachers. The principal had decided to create a proper resource centre out of two normal classrooms, and had appointed a coordinator from among the senior staff. The project director had established peer relations with teachers, rather than adopting a superior stance, but he had not had equal success with all in persuading them to adopt the technology. Humanities teachers lagged behind. Programs developed tended to be of the drill-and-practice kind.

Out of the pilot, by then called CEPAK Phase I, the main CEPAK project emerged, aiming to:

- improve the quality of teaching by in-service teacher education using microcomputers as a catalyst;
- use microcomputers as a teaching resource in appropriate school subjects;
- provide pupils with a basic knowledge of information technology to help them in their studies and make them aware of their technological environment;
- improve the quality of school administration through the use of appropriate technology, and
- ensure that the schools become self-supporting in educational information technology through the appointment of appropriately trained staff (Makau and Wray, 1987).

CEPAK Phase II started in 1986 with the Aga Khan Academy and five more secondary schools, government and private, and not all from the top flight, in

Nairobi, Mombasa and Nakuru. Of the five, two are for girls only. Two other assisted government schools were added in 1988; they had to buy the computers out of their own budgets, whereas for the first six schools CEPAK received a very substantial donation from Apple Computer of 33 Apple IIe machines with peripherals and software. The Aga Khan Foundation committed $290 000 to the first year of CEPAK Phase II, to pay for central supervisory, advisory and evaluation staff, m. `itenance and facilities including software, books, magazines and jour. ils about computer education (Aga Khan Foundation (UK) Newsletter, December 1986), and sustained its contributions at least until 1989, when Phase III started.

For the project, adequate theftproof buildings were needed to house hardware, and to store software. Surge protectors and fans were required in some areas to reduce the risk of computer system damage. Suitable furniture was often specially manufactured, locally and cheaply. Each Phase II school is now equipped with five Apple IIe microcomputers, lent by CEPAK for classroom use, including one for administration, except that the latest schools to join have Apple IIgs machines.

All teachers in CEPAK schools were introduced to computer education by the central staff, and there has been a continuing series of 'hands-on' workshops, conducted by knowledgeable teachers for their colleagues locally. For example, 1988 workshops focussed on using CAL programs in class and applications such as Appleworks' word-processor, database and spreadsheet for teaching and administration. In 1989 there were proposals for a modular diploma in information technology for teachers, to be assessed and validated by the University of Nairobi.

CEPAK has in Nairobi a library of books about computers and computing, and a software library containing selected programs and their documentation. The library includes database, graphics, utility and word-processing software, games, and CAL programs in art, biology, chemistry, economics, English, French, geography, history, Islamic religious education, mathematics, physics, typing, plus several that can be used across the curriculum. It also has a selection of computer language software and Super Pilot, an authoring system. CEPAK schools do not prepare students for any computer studies examination.

By 1987, it was reported that at the Aga Khan Academy the five microcomputers were in use 90 per cent of the time during the eight-hour day, with 3-5 students on each computer, providing 22 000 student-hours of 'hands-on' time each year, at an average cost of about 20 US cents a student-hour for hardware, software and associated materials (Wray, 1987).

An evaluation team, funded by the Aga Khan Foundation, the Rockefeller Foundation and the Canadian government aid agency, followed progress carefully in Phase II, producing detailed quarterly reports and recommendations (for example, Makau, 1987c), and progress of the project was a subject for discussion at international conferences (see Wray, 1986, 1987, 1989b). For Phase III, the team recommended that efforts should be made to persuade the Ministry and the Kenya Institute of Education of the value of information technology in secondary schools. The team saw that bringing

computers into government schools depends heavily on Ministry decision-makers being aware of the opportunities computers offer for changing secondary education (the Catalytic Rationale).

Elsewhere, Starehe Boys' Centre, a Nairobi secondary school catering particularly for boys from poor families but with a high academic entry standard, began offering computer studies as early as 1979, using facilities in the University and Polytechnic. A few years later, the school received a grant (the equivalent of US$150 000) from the Federal Republic of Germany to equip a laboratory with Apple II and Sinclair Spectrum machines (Gottlieb, 1986), to which others have been added. The school teaches candidates for a local computer studies examination. It only provides a computer awareness course outside school hours. Its rationale is stricly Vocational.

Outside CEPAK and Starehe, about a dozen Kenyan secondary schools, mostly private and preparing students for overseas examinations, teach BASIC, on the grounds that learning the language helps students to think logically as well as learning to program a computer. Pascal is available in almost as many, though it is hard to find out how much it is taught.

Some educators in Kenya hold the view that children should learn about programming, others that they should know how to use computer programs for accounting, graphics, word-processing, etc. There is also a feeling that if children of the developed world can learn to use computers, so must children in Kenya, in order to stay abreast of new developments. Among teachers, these views do not crystallize into a firm Vocational or Pedagogical Rationale, though they may be made aware of both during training. Rather, there is a concern that using computers may deprive students of valuable time for studying the examination curriculum. Only a few teachers, including one or two at Starehe, think that computer science courses are a good way for students to get jobs in the computer field.

Principals and administrators are keen to use computers to assist collection of fees: all Kenyan secondary students pay fees. The CEPAK schools use databases for invoices and fee demands, and maintain accounts on a spreadsheet. They hold class lists, examination entries and results on computers. CEPAK teachers like to word-process items such as tests and examination papers. They are also willing to try CAL programs with their classes, and some have attempted to write lessons using Super Pilot. Some well word-processed school magazines have emerged, too, particularly from the journalists' club at one CEPAK school. In fact, these teachers are ready to increase their productivity through using computers.

On the other hand, teachers in Kenya express views about the disruption they feel computers cause. Some teachers, for example, say that they do not like having to take classes to a special computer room. Others feel that classes get too 'noisy' when working on computers. Teachers, and their principals, also worry about the recurrent costs of using computers: they stop children from printing what has been compiled on the computers, because printing is expensive in terms of ribbons and paper. Damage or even theft of hardware and software is a real danger in some schools, causing principals to insist on

access being limited; teachers may then say they cannot use the computers when they would like to (Makau, 1987b).

Kenyan parents are somewhat sceptical about their children's career prospects in this field, despite students' enthusiasm. Businesses nevertheless 'poach' teachers with computer-related skills, and students with computer skills from schools like Starehe can easily get jobs. In some CEPAK schools, boys seem more confident than girls with computers, and are keener to learn programming.

Lesotho

Lesotho is a small mountainous country of about 1.6 million people, with a 'remittance economy', heavily dependent on wages sent home by its workers in South Africa and on foreign aid. It was a British Protectorate until 1966, and counts in some ways as one of the poorest countries in the world. Its people live mainly in the lowlands, 90 per cent of them in rural areas, practising subsistence agriculture. Most able-bodied men work in South African mines and industries. Official languages are Sesotho and English, and Sesotho is the medium of instruction for the first four years of primary school, after which English is mainly used. English is the only medium in secondary school. Education is given high priority by the government, which provides funds to the churches, who own and operate almost all the schools. Seven years of primary education is followed by five years of secondary (Maimbolwa-Sinyangwe and Leimu, 1988).

Imported microcomputers are fairly readily obtainable at reasonable prices considering Lesotho's geographical location, but in 1987 there were serious shortages of people trained to use them, partly because trained workers could earn more in nearby countries (Cumming and Quickfall, 1987). Virtually no microcomputers were yet in schools, no teachers had been trained to use them, and the Ministry of Education had yet to formulate policy in this field. One private school started to teach computer studies, but was forced to abandon the course owing to staffing difficulties and resource shortages.

Anzalone (1984) points out that hand-held battery-powered electronic aids have usually been neglected in education in developing countries and reports on an experiment in Lesotho. In 1983, groups of four students in upper classes in five primary schools each used the aids manufactured by Texas Instruments, Speak & Read and Speak & Math, which offer drill-and-practice in English and arithmetic. Speak & Read deals with letter-sound relationships, word patterns, word recognition and vocabulary, in English. The vocabulary being taught can be expanded to about 1500 words by inserting extra modules. A visual display is linked to synthetic speech. The device replies to both correct and incorrect answers, which students select from the visual display, and for most of the routines also keeps score. Speak & Math poses up to 100 000 variations of arithmetical problems, again linking a visual display with synthetic speech. In our study we were unable to obtain further details of this experiment, and we were conscious that probably the picture is changing constantly.
Nigeria

15

The Federation of Nigeria consists of 19 states and covers about 940 000 square kilometres. After more than a century of British colonial rule, Nigeria became independent in 1960. Its population is probably more than 90 million and growing fast, with at least 40 per cent aged 15 years or less. Although about three-quarters of the people are engaged in agriculture, the economy is heavily dependent on oil exports, with manufacturing becoming more important than it used to be. The official languages are Hausa, Igbo, Yoruba and English, although more than 250 other indigenous languages exist. English is the medium of instruction in upper primary and all secondary classrooms. The education pattern is 6:3:3 (Ogundimu, 1988).

Akinyemi (1986) describes one of the first attempts to introduce Nigerian children to computers. In 1984 and 1985, the University of Ilorin, north of Lagos in Kwara State, organised a week-long computer awareness class (called Compu-Camp) for primary school students. Using Commodore, Apple and Hewlett Packard mirocomputers, the children tried Logo and CAL programs. Their reactions were so positive that the community requested more such classes.

By 1986, microcomputers were just beginning to enter Nigerian educational institutions, but very few were in schools, according to Cumming and Quckfall (1987). Officials at the Federal Ministry of Education held a view that the new technology should be non-elitist and available to all at primary school level, with proper training of the teachers, but policy had not yet been developed. The Ministry's Computer Coordinating Committee seldom met and had no computer scientists or users on it. Because of severe foreign exchange restrictions, prices of hardware were extortionate (prices of IBM PCs were marked up by as much as 4000 per cent) and maintenance arrangements poor. Local programmers had prepared software for processing student records and other administrative purposes at two tertiary colleges, but there was no software for schools. No teachers had yet been trained in using microcomputers, although the Director of the National Teachers' Institute, which is responsible for all in-service training, recognised that demand was likely to be high once computers reached the schools.

In 1988, the Federal Government of Nigeria inaugurated a National Committee on Computer Education, charged with planning for computer education and literacy, and with developing suitable curricula for primary, secondary and tertiary institutions (Jason, 1988a). It also announced that it was considering placing computers in government-funded schools. This plan was confirmed in 1989 (Hamza, 1989).

In Lagos, there is a computer club, called Computer Village, operated on Saturdays by a company for the benefit of local children. The company, which normally trains computer personnel, wants to catch computer-minded children quite young, to bridge the technological gap between Nigeria and industrial countries. It has prepared a range of computer literacy packs for nursery, primary and secondary schools (Jason, 1988a).

Zimbabwe

Creation of the independent Republic of Zimbabwe in 1980 brought to an end 90 years of colonial rule, during which the majority of the country's children received little or no education. Four-fifths of Zimbabwe's rapidly increasing population of about 12 million live in rural areas, and agriculture is the dominant economic sector, although manufacturing and mining are also significant.

After independence, the government allocated to education the largest percentage (17.5 per cent in 1984/85) ever of its budget (Mutumbukwa, 1984). It rapidly expanded the country's educational system, trebling the number of children at school from 892 000 in 1979 to 2 860 000 in 1986. Secondary enrolments increased from 73 000 to 546 000 in the same period (Hawkins, 1987) and have continued to climb. Church-sponsored schools, aided by government funds, thrive alongside government ones. English is the official language and medium of instruction. Curricula have been modified, but public examinations still command the attention of students, parents and teachers, particularly in the secondary schools.

Human and material resources were stretched to the maximum in the 1980 and the Ministry of Education's priorities did not include computers for schools. Even if priorities had changed, lack of foreign exchange to pay for imported hardware and software since the 1982 economic crisis would have been (and is) a serious problem for the Ministry as well as individual schools and supply companies (Mechin,1988). It is all the more remarkable, therefore, that a number of secondary schools and a few primary schools have obtained microcomputers and that their staff have shown such great interest in intro ducing them to the students. The students, in turn, are enthusiastically learning to use them, whether to write programs in BASIC or Logo, or for using business applications and educational software.

Ministry policy appears to have been to encourage developments where these were funded from private rather than government sources. No agreed policy guidelines exist yet, though a Computerisation Planning Committee was established in 1985 with a view to putting computers into selected secondary schools. The Ministry itself was computerised by Wang in 1986, using United States aid funds to install a complete financial management system handling an annual budget of over £100 million, for about 5500 schools and over 100 000 teachers. The Zinformatics project, a joint mid-1980s venture by the University of Zimbabwe and the Ministry aimed at creating an awareness of information technology in secondary schools, folded for lack of funds despite its call for software and courseware to be written or adapted 'in Zimbabwe by and for Zimbabweans'. Takawira (1988a and 1988b) more recently called for a national plan, a new coordinating centre and a software library.

Adoption of computers by the schools has come about as a result of at least two kinds of pressure: parents and principals have combined to raise funds to buy the equipment in a bid to increase the schools' prestige and modernity, and teachers have asked for it in order to be up-to-date professionally. There is no strongly and widely held rationale, although parents look anxiously to their children's job prospects. Private schools (in which the Ministry subsidises teachers' salaries) have led the way to adoption, chiefly because their students

come from wealthier families able to make donations to school funds or because these schools were able to persuade companies to donate computers. Government secondary schools, of which there were 1484 in 1989, receive support from three sources: government grants, levies on parents and money raised by the schools themselves. Most schools, especially those in rural areas, have difficulty in raising funds to obtain computers, although some have been given hardware and software by foreign computer companies. Occasionally, computers arrive from unexpected quarters: in 1988, the Palestine Liberation Organisation held a Logo and PASCAL workshop in Harare for students from many schools, some of which received afterwards the computers imported for the occasion. Communications Systems of Zimbabwe, a joint venture by a British company, Plessey, and the government, was set up in 1988 and assembles PC-compatible microcomputers from knocked-down kits imported through a barter deal (Thorneycroft, 1988b).

The Ministry's Curriculum Development Unit appointed an officer in the mid-1980s to foster computers in schools, and for about two years (1985-87) circulated a quarterly newsletter, Microcomputer Users in Zimbabwean Education, containing contributions from teachers. From this newsletter and other sources it is clear that teachers faced difficult hardware choices. Schools obtained different types, with no hardware or software standard being set. Spectrum ZX-81 and BBC-B machines dominated in 25 schools with microcomputers in 1986, but the range has widened since, with Amstrad, Atari, BBC Master, Commodore Amiga, Nixdorf, Wang and other makes coming in as more schools purchased their own or accepted donations. The schools that already had them in 1986 have obtained more advanced models, not necessarily of the same make as before. For example, Plumtree School, near the border with Botswana, installed 10 Commodore 64s where previously it had made do with a Spectrum, a BBC-B and an Apple. In 1986 one of the largest teacher training colleges received IBM and Apple computers as part of a foreign aid package.

In 1989, only a handful of schools were offering computer studies courses at Ordinary or Advanced Level. A few offer their own course in information technology, in either the first or the last year of secondary schooling, focussing on some use of Logo and on teaching word-processing skills. Almost all the computer-using schools run clubs, in which programming in BASIC is the dominant student activity. Because classes end at 1 pm, these clubs thrive in the afternoons.

One of the leading private boarding schools, Peterhouse, started by using Commodore 64s. To serve the Vocational Rationale, in 1987 the school acquired 25 Amstrad 1512s, donated by a London businessman, Sir Mark Weinberg. These PC-compatibles are similar to those used in offices, there is plenty of software for them, and after-sales support is available in Zimbabwe. An Amstrad 1640 with a 20 Mbyte hard disk was added in 1988. These machines ousted a collection of Commodores.

Peterhouse decided against offering Ordinary and Advanced Level computer studies, because the timetable was full already, the University did not fully accept the A-level for entrance purposes, and the syllabuses were more

academic than practical. The school also wanted all interested students to use the computers, not merely the most able. To quote the Rector (Peterhouse, 1988):

> All boys should know the elements of word-processing and the use of spreadsheets. All should be able to make some use of the graphics faclities. In today's world, such experience and knowledge is not a luxury: it is essential. The girls, who have their own smaller computer facility, will also make use of the Sir Mark Weinberg Computer Room for both typing and computer studies.

Peterhouse created its own Information Technology syllabus and now awards its own certificate with the approval of the Ministry and of the Computer Society of Zimbabwe. Students work towards the certificate in their own time, outside class hours. They become familiar with terminology, learn keyboard skills, gain some understanding of problems the technology can address and develop techniques for solving them. Students choose at least two options from among BASIC, Logo, Pascal, COBOL, FORTRAN, databases, word-processing and spreadsheets. In addition, Peterhouse offers an introductory course on computers and computer-handling (including MS-DOS) for all first-year students and a six-week word-processing and databases option in the penultimate year (Blake, 1989).

At this early stage of development in Zimbabwean computer education, it is true to say that almost all teachers do not see the relevance of computers to their work, and indeed teach in schools with no computers. Those teachers who are keen to use the machines are somewhat isolated and face some opposition: for example, the University of Zimbabwe still appears to prefer undergraduates who have not used computers at school, and a Professor of Computing is quoted as saying, 'BASIC is a form of intellectual syphillis - it's fun getting going with it, but the long-term effects are invariably fatal' (MUZE Newsletter, No. 6) . In addition to the fairly large distances between towns in Zimbabwe, schools have different hardware, and offer different courses, and their teachers do not have much contact with each other, although 'Spectrum hints' are said to circulate quite freely. The University has mounted a few short in-service workshops to support computer applications in education, but many teachers are self-taught.

Despite such problems, teachers' views expressed in the Newsletter in the early days of microcomputers in Zimbabwe were optimistic. Peterhouse teachers said: 'we seek to ensure that our pupils are aware of the part played by computers in the modern world and that they should not be mystified by or apprehensive of the machines.' Similarly, Arundel teachers had every girl in the school using their 13 BBC-Bs. Kutama's teachers started by teaching Computer Studies at Advanced Level on their 12 ICL (Canada) PC machines, obtained with help from the Canadian Government and the Marist Brothers' Catholic order. St. George's offered a one-term course and started a computer club. Teachers' efforts today are supported by computer hobbyists, such as those in Harare's Greenscreen Club, and in some centres private computer clubs for children afford extra opportunities. On the other hand, there are a few glum stories about computers breaking down and being affected by dust and

humidity. One mission school, Katenhe, started in 1986 with a battery-operated Spectrum, because the school had no electricity. The batteries were recharged at another mission some distance away.

The views of students and parents are strongly influenced by the threat of unemployment, the most serious problem facing Zimbabwe. Hawkins (1987) estimated that 18 per cent of the workforce was unemployed in 1987, and that in the years 1987-91 over a million secondary school-leavers would enter the labour market. Unemployment rates of at least 30 per cent during the 1990s are expected (Scott, 1988). Each year, these school-leavers will equal 25 per cent of the employed formal sector labour force. The total number of jobs available in the Zimbabwean economy did not change noticeably 1975-87, though the pattern of employment has altered, with increased numbers in services, particularly education and public administration (Hawkins, 1987). Fcr most school-leavers, small-scale farming in the informal labour sector is the most likely source of income, but not the one they want. The economic future of Zimbabwe remains dependent on geopolitics, with no obvious signs of rapid growth on the horizon.

In these circumstances, the Vocational Rationale is likely to prevail among students and parents alike. If their children can gain a significant advantage in job-seeking through learning how to use computers for work, parents are powerfully motivated to provide the funds to put computers into the schools, with or without Ministry policy. A notable example is the Dominican Convent School in Harare, at which 12 BBC-Bs were installed in 1985. In 1988 the Zimbabwean agents for Wang donated 25 word processors, enabling the school to set up a word-processing centre, open (for a fee) to students from other schools in the area. The centre was furnished and is run by the school's Parent-Teachers Association. Teachers, paid by the Association, prepare students for the Pitmans word-processing examination. The Minister of Primary and Secondary Education, Comrade Fay Chung, opened the centre.

THE FUTURE

The ideal picture: what should happen next?

Look first at Kenya, which has led the way. The future of computers in schools in Kenya is far from assured, despite continuation of CEPAK into Phase III. Government policy is not yet fully established. Despite strong economic growth in Kenya in recent years, expenditure on education is not likely to expand sufficiently fast to allow for a full government-funded programme to put computers into all secondary schools, or even a majority of them. At best, it seems likely that resources will be allocated to a larger selected group than at present and that the work done so far will be sustained.

Zimbabwe is another developing country with considerable natural and human resources. As information technology enters its economic life, will its Ministry of Education decide that for the 1990s the schools are already doing enough to prepare their students in the field of computers? Or is Zimbabwe likely to follow countries like China and Jordan, which have adopted a deliberate policy of computer education at secondary level? As a country that

has espoused Marxist socialism, Zimbabwe may well be more concerned than capitalist countries about problems of access and equity raised by allowing computers into schools which serve the children of wealthier parents. We quote the Minister for Primary and Secondary Education, Comrade Fay Chung:

> Computer technology is going to change ways of teaching and possibly challenge the manner in which we think about schools (Zimbabwe Herald, May 23 1988).

The likely picture: what will probably happen next?

These two examples do not offer much encouragement to those who would like to see a proper policy announced, backed by a well-developed five-year plan and leading to government-funded provision of a national training and software centre, regional or local support centres, and a full range of hardware and software in suitable classrooms in a large number of schools.

The evidence so far indicates that computers will come into African education in a fairly haphazard manner, except perhaps in universities. Indeed, last April the Paris Congress on Education and Informatics, organised by UNESCO, gave universities top priority in all countries (UNESCO, 1989). It seems as though the African universities have an exceptionally important role to play in introducing large numbers of students to computers. To a great extent, the universities are being expected to do in this field what schools do in many other countries, industrial and developing. The challenge for the 1990s to the African universities is this: Can you enable these students to 'catch up' quickly with their age-mates in other countries. We are here this week to discuss how it can be done.

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