

76053

Research Issues in Science, Technology and  
Education in East, Central and Southern  
Africa

Sunita Kapila  
December, 1983.

This paper presents an overview of recent and current research reflecting the interface between science, technology and education in east, central and southern Africa. There are three levels to the discussion. The first pertains to the human resources aspects of creating indigenous technological capacity and analyses utilisation of scientific and technical expertise. The second raises issues over the role of small-scale as well as informal sector industry, its training and employment potential as well as its production advantages which result in cheaper consumer goods. The third is concerned with the basis for technical skill and knowledge acquisition capacity as laid in the formal system of schools and training institutes and centres around discussion on relevant curricula and the structure of the system.

The themes that emerge from these levels are interlinked and multi-sectoral. Perhaps the most fundamental of all is the questioning of the nature of the industrialization process that African countries have adopted since independence: questions are being asked on what technology transfer through multinationals has meant for the development of local capability and the basic demands of the majority. The role of appropriate technology has received much acclaim but limited operationalization. Correspondingly, significant work on how technology appropriate to the majority can be developed indigenously is also limited. The area through which this concern is beginning to gain prominence is that of school curricula relevant to broad-based development (practical skills versus the academic emphasis, and science versus the arts debates), the related problem of youth unemployment and the largely neglected area of informal and small-scale industry and its technology and training options.

#### Indigenous Technological Capacity and the Utilisation of Expertise and Labour

Indigenous Technological Capacity is essentially an exercise in skill formation at the various rungs of technological processes from decision making capacity to machinery maintenance functions. The dynamics of this skill generation spring not only from the educational and training sources but also from patterns of technology transfer, market mechanism, government policies as well as socio-cultural traditions. While

over the last ten years, there has been considerable thinking on how the multinational and expatriate expertise presence in Africa controls the degree of technology transfer that takes place, there has been little analysis of the transfer in terms of the training component. Although the contracts between foreign investors and local partners usually stipulate a phasing out of the foreign experts as the local counterparts get trained, in reality the synchronisation tends to jar and stall. Monitoring of the training becomes difficult in a situation where the very rationale for the training in the first place is the inadequacy of the requisite local expertise. Nevertheless, researchers with initiative are eager to probe the question of the utilization of local manpower in joint ventures. There are studies being prepared around government parastatals in Tanzania, Zimbabwe and Ethiopia. The varied nature of the parastatals from food processing and manufacturing industries to power stations should lead to a fascinating array of findings.

Amongst the research questions being posed are what constitutes the learning components of successful techno-managerial capability, what factors militate against the use of local expertise, and how a framework for the development of technological and technical expertise within the employing institutions can be devised. The latter relates to the efficient utilization of limited resources for training. The trend in eastern African countries has been to institutionalize training outside the workplace. Hence the demand for certification as passports into industrial employment and the increasing pressure on all training institutes which can facilitate these certificates. What is being proposed is a close look at the potential of the workplace as a training resource. Related questions pertain to the match between the training behind the certificate and the actual skill deployment in the job situation.

A study under the Manpower Research Unit of the University of Zambia is investigating precisely this issue of the academic qualifications demanded by employers and the actual vocational requirements of the job. Part of the rationale for the study is the observation that in some occupations, present job descriptions demand higher academic qualifications than previously. Have the tasks become more complex or is

the demand a response to the higher standard of educational achievement in society? Or, are the entry requirements a way of restricting the number of people eligible and maintaining a higher wage rate? The background to the study is the rapid expansion of secondary and higher education since independence and the national emphasis on assessing the need for various levels of skilled manpower. The study when complete will be able to delineate more clearly the connections between the certification ladder and levels of skill demanded from the formal education system. It would also help clarify what pressures influence the employer in laying down job descriptions. The theoretical underpinnings of the research are concerned with the role of the school in development. Is the economic function of the school to minister to the demands of the economy or is formal education increasingly becoming a cause of greater economic inequality? The two theoretical perspectives are termed by the researcher as 'the human capital perspective' (based on the faith that educational expansion would make for economic growth and equality) and 'the selection perspective' which sees schools as allocators of social roles and reproducers of inequality. Although the research is not restricted to technical jobs, its findings would have implications for a whole range of skill demanding occupations.

In Kenya, an attempt at breaking the colonially-inherited system of categorisation of technical skills and its corresponding training systems is being made by the ILO sponsored Kenya Integrated Training Scheme (KITS). The scheme is presented to the trainees who are industrial employees in the form of Modules of Employable Skills (MES). The MES system favours the development of narrow skills at the operational level as against the traditional form of on-the-job training which favoured broad skilled craftsmanship. Kenya is the first country to try out ILO's MES system on a national scale and sees it as an attempt to localize training, away from the dependence on City and Guilds models developed in England. The KITS/MES draws largely from the Swedish industrial training traditions. In its objective of systematizing training, MES demands of the trainee step-by-step analysis of his/her occupational tasks, expressed in standard workbooks. The collective wisdom of this analysis is then shifted to produce 'learning elements', the building blocks of the training in different trades. The entire exercise is profusely paper intensive and one of the first

questions one might ask of this system of training is who will be able to meet the stationery bill once ILO withdraws! According to Britha Mikkelsen, ILO estimated the cost in 1981 per learning element to be between US dollars 1,600 to 1,800 and each trade may well be broken with 200 learning elements<sup>2</sup>. Given the economic climate where companies want to minimize training costs, a cost benefit analysis of KITS/MES would prove useful.

Among Mikkelsen's other comments on the scheme is her criticism that the modular approach inhibits a broad based training which could give a worker the useful entrepreneurial option in the limited formal sector economies of Africa. Proponents of MES do however emphasize that the closer match between skill development and task requirement can make considerable difference to industrial productivity. They claim that production capacity is underutilised because precision in operations suffers from inadequate understanding of the potential of the machines the operators are working on. The appropriateness, however, of the MES system to an economy such as Kenya's is worth questioning. How is the discontinuity with the traditional system of apprenticeship perceived by the employers, the trainees and the local industrial trainers, the Directorate of Industrial Training who will eventually administer the scheme? Do the advantages of self-directed, self-paced learning of more limited focus outweigh the diversity in skills that the City and Guilds type apprentice artisan can presumably call upon? Although in theory the KITS/MES could increase industry's control over labour by restricting training to the job situations in the industry, whether this control in fact materialises could be examined in case studies of industries undergoing the KITS/MES experience. Lessons would be appreciated by other countries in the region who base most of their industrial training on the colonially inherited British systems.

An interesting by product of the MES experience in Kenya has been some exploratory research by some members of the MES team on the visual ability of primary school leavers. Since majority of the trainees under the KITS/MES scheme are primary school leavers and the MES pedagogy is text/visual based, the team attempted to anticipate the quality of the trainees' visual ability through a sample survey of primary schools in Kenya's rural and urban areas. The survey targeted

children on a variety of photographs, drawings with three dimensional effects and different forms of technical drawings such as sectional drawings and elevations. Results show that the rural child's comprehension of spatial elements is usually lower than that of the urban resident's. The research report attributes visual illiteracy to limited exposure to art forms and visual media. It recommends increasing facilities for and placing greater emphasis on art education in schools. Drawings as a means of communication are seen by the MES team as particularly important in countries where the average level of education is low and detailed texts in training courses would be hard to follow. But for the visual mode to be fully effective, it has to be acknowledged that understanding technical drawing is like learning a new language and provision has to be made for its teaching.

While the MES scheme poses questions about operator level training of narrow skills in industry, researchers in the region are also studying issues arising out of the utilisation patterns of technical and scientific capacity in the industrial sector. A means of classification of the various skills being used is the manpower survey, but its shortcomings as a census tool were quite clearly brought out at a recent meeting in Kenya.<sup>4</sup> One such shortcoming is the ambiguous interpretation the present set of categories for skill classification. For example, the distinction between technical and artisan may be based on different criteria in different firms and what would be classified as a technician's work in one place may be considered an artisan's in another. Thus who gets classified as 'technician' could depend on a variety of unforeseen factors. The equation of technician with the possession of certificates is also not an appropriate definition in countries where most of the industrial training is done on-the-job and remains uncertified. These sorts of analyses that point to the inadequacies of present forms of counting scientists, technicians and artisans for example are of significance in the context of policy decisions on countries' manpower needs and the allocation of resources to training institutions.

Manpower surveys have also triggered off thinking about their limitations in dimensions other than the above. In Zimbabwe, there is currently much discussion about the recently published National Manpower Survey. One comment is that it gives a "static image" of the

demand structure for skills and the needs for expansion and replacement without analysing the dynamics of skill development. Also it ignores the horizontal movement of skilled manpower from public to the private sector. It is not unusual to come across scientific 'experts' who after 5 or 6 years in the public sector<sup>5</sup> resign to move into the private sector sometimes as production managers. An interesting research study could be mounted on the retention rate of science and technology expertise in the public sector. One reason for the low retention could be the large gap between the salaries of the professionals and the administrators in the public sector. Industry on the other hand, appreciates professional expertise at all levels. But after some years, the high salaries offered at the top administrative posts in the public sector attract back into the public sector the experienced professional. Since after independence, the public sector became much more lucrative and attracted specialists into becoming bureaucrats, the private sector has now responded by upgrading its salary structure to supercede the public sector's for most levels. There is, therefore, an on-going tussle between the two sectors for expertise and the sort of salary structures that have emerged could be considered "unrealistic" in the wider economic context. Their ramifications on prices, etc., are also something that should be documented.

Another matter of concern is that of growing graduate unemployment in some countries of the region. In both Kenya and Zambia, for instance, almost two decades of independence and democratisation of education have reduced the once vigorous capacity of the civil service to absorb majority of the university graduates. Now while Zambia is trying to correct the liberal arts and social sciences bias of its university education towards the natural sciences in response to manpower planners' pointers, Kenyan politicians are emphatic that students give up ambitions to white collar jobs and prepare to use their hands! What these trends portend for the school system and the once-upon-a-time belief in development through an expanding modern sector (wishful thinking in the age of economic recession) raises several concerns for science, technology and education research in the region, some of which are outlined in the next two sections. An area that could benefit from further research is the fate of the unemployed highly (university level) educated African - is his/her tuition to entrenchment of the

business, migrating, going for further training and switching skills or resorting to vice? To get insights into the aspirations and job patterns of graduates of tertiary level institutions, technical or otherwise, - would provide commentary on how well the training system is attuned to the social reality - an imperative theme of research in the present regional rhetoric over increasing the investment in scientific and technical training.

In sum, it can be said that the region's research themes in the area of the development of indigenous technological capacity are centred essentially around the modern industrial sector. Concern focusses on the training of personnel from the level of management and engineering expertise to that of machine operation. The issues of manpower development are those of transfer of knowledge about imported technology, the acquisition of techno-managerial capability, alternatives in types of on-the-job training at various skill levels, the appropriateness of inherited categories of skill classification and job descriptions in the post independence contexts, the dynamics of the utilisation of scientific and technical expertise in the private and public sectors and increasingly, the problem of graduate unemployment.

#### Training and Employment in the Informal Sector

Unemployment in the eastern, central and southern African countries corresponds to all levels of education so that there is a pool of unemployed primary and secondary school leavers as well as university graduates in some countries. An option in self-employment is offered to those willing to undergo the rigours of entrepreneurship in the small-scale manufacturing and retail enterprises of the informal sector of the larger urban areas. Official response to the growth of this sector tends to be an attempt to control it through offers of support in terms of shelter and services and a framework of licences, taxation and standards. But the formalization route has the danger of stifling the locational advantages and operational flexibility of informal enterprises, reducing their usually fragile profits. Useful questions are being asked in several countries on the nature of the informal sector, its linkages with the formal sector and the quality of skills and goods produced there.

The informal sector in eastern Africa, as in India, is defined by ease of entry, small scale of operation, unregulated markets and labour intensive operations. Two studies being currently proposed in the region focus on training for technical skills in the informal sector in Nairobi (Kenya), Kampala and Jinja (Uganda). The Kenyan study is a case study of the informal sector training program of the Undugu Society of Kenya which encourages unemployed youth from the poorest homes to learn a trade from a local artisan.<sup>6</sup> While the informal apprenticeship system is widely practised in Nairobi and other African cities, there is usually no academic or 'theory' component in the training. The Undugu program supplements the practical training with formal classes where the theory of the various trades (especially carpentry and metalwork which have the majority of the Undugu apprentices) is taught by lecturers from a village polytechnic. This makes the program particularly attractive to the young school-leaver still chasing the elusive certificates that will raise his labour's value in the formal sector. The apprentices can use these classes to prepare for Government trade certificate examinations. The Undugu research aims at assessing the contribution of formal schooling to learning proficiency in the informal sector and inquires into the relative importance of the various elements of knowledge in the different trades and generally aims at obtaining more insight into the training process. The overall concern behind the program is to improve existing systems of informal training especially with a view to minimising the easy exploitation of apprentice labour. The Ugandan study is similarly researching the indigenous apprenticeship system and informal on-the-job training practices as well as the kinds of technology used in this sector.<sup>7</sup>

In Zambia, studies of the informal sector are being done mainly by the ILO's Southern African Team for Employment Promotion (SATEP). The Team has also carried out similar studies in Botswana, Lesotho and Zimbabwe. In Zambia, a study of informal sector businesses in the two cities of Lusaka and Kitwe investigated the education, training and employment history of the sample respondents and discovered relationship between the respondents' levels of education and the kind of activities they were engaged in.<sup>8</sup> The educational level of those involved in modern activities such as radio and car repair was higher than of those who

were working in the more traditional trades such as carpentry, tin-smithing, tailoring etc. But it is possible that those engaging in the more modern activities are younger and therefore beneficiaries of the post-independence education opportunities. The surveys also show that there is a positive relationship between a respondent's education and his monthly turnover. Another interesting finding relates to the effect of previous formal sector employment and job training on choice of the informal activity.

Therefore a substantial number of those engaged in construction, copper curio manufacturing, watch and radio repair and welding had received previous formal training. The SATEP studies and those proposed for Kenya and Uganda in giving credence to the resource for training and employment in the informal sector, are not necessarily typical of the status of the African informal sector. In the Southern African countries the economic dominance of South Africa and its hold over consumer markets give little leeway for the emergence of thriving informal businesses. In Botswana, a USAID study of informal activities in four communities shows knitting and sewing to be the most popular activities. Other activities pertain to those areas where the formal sector does not offer adequate services - such as watch and car repairs. The small size and limited possibilities of the sector makes it insignificant for training. In Harare, Zimbabwe, the municipal council attempts to contain the informal retail and manufacturing activities on the urban fringes through the supply of facilities such as water and shelter. At the same time it has shanty towns bulldozed supported by official orders for urban squatters to return to the countryside to till the land.

Within the urban areas, the small-scale "industrialist-entrepreneur" is increasingly being acknowledged as a hitherto unrecognized element in the building of local technological capability. The training capacity of the informal sector was being exploited by those seeking skills, long before its potential was formally documented. The challenge before social planners is to respond to the needs of the sector with means of flexible support to suit the unique situations of one different entity within it. Attempts to draw the informal enterprises into a structure of rules and regulations based on assumptions of space and resources that

this sector does not have could create obstacles in a spontaneous and indigenous avenue for skill acquisition and income generation in modernizing and urbanizing economies.

Whether rural development can stem the flow of the job-seekers to the cities is the perennial question asked in the face of urbanisation both here and in Africa. Rural development concerns itself with both agricultural productivity and the process of creating viable non-agricultural employment in the rural areas. While small-scale rural industries are part of the solution envisaged for school-leavers and can stimulate the modernization of agriculture as well, local inquiry into the form of such industry is sparse. What has been done over the years is a considerable degree of thinking on the role of the formal education system and the post-school training institutes in equipping students with attitudes and tools relevant to rural development, a subject that is discussed in the following section.

#### School Science and Appropriate Technical Training

The 1961 Conference of Ministers of Education in Africa proclaimed that "African educational authorities should revise and reform the content of education in the areas of curricula, textbooks and methods, so as to take into account the African environment, child development cultural heritage and the demands of technological progress and economic development, especially industrialization" (UNESCO 1961). Science education was seen as a key to building an orientation towards technological advance. Since the sixties, school science in Africa has undergone significant changes which have made the curriculum more relevant to the local context and more amenable to improvisation in teaching methods.

Recent curricular developments in Kenya and Zimbabwe reflect similar objectives. In Kenya, the science syllabus since 1975 has been more practical than before, emphasising the application of scientific principles through experimentation and discovery as against earlier memorisation of facts. The educational assumptions guiding the change have been the universally acknowledged ones: that children to the age of about 14 learn best in concrete situations (assumption based on Piaget's theory) and that everyone learns and remembers best what they

discover for themselves by doing. However, the more practical science has not ruled out the option of teaching science through a "chalk and talk" method. Teachers frequently opt for this because they find it easier and obviously less demanding of their initiative as well as safer in that the repetition of texts eliminates all possibility of error on their part.<sup>10</sup> Abstract knowledge is also considered easier to assess. Those who do exploit the creative potential of the new curricula claim that the jump from science to technology can be made without much difficulty by even primary school pupils. At Kamwenja Primary School in a rural area of Kenya, science teaching sparked off, amongst other smaller projects, the construction of a five metre tall windmill using the nearby town's scrap and junk. The windmill was then used by the children to saw wood and pump water. Other instances are cited of children constructing their own wheelbarrows and running transport services with them and making metal stoves.<sup>11</sup>

An area for research lies in the investigation of reasons for this distinct approach of some science teachers, the contexts that promote it and the effect it has on the students' performance. A Zimbabwean inquiry is investigating just these issues: the University of Zimbabwe's Dept. of Curriculum Development and Science Education is surveying science teachers' perception of their role and that of practicals in science education. The questionnaires have only recently been distributed but the responses will be illuminating. The same department is encouraging a greater communication between school science and information on industrial processes in keeping with the theory with practice dictum that Zimbabwe espouses ~~to~~. It is writing to production managers in the manufacturing industries asking about the stages in the process, inputs etc. and then transferring the information into teacher training courses as well as pamphlets for schools. This results in school visits to industry and students' awareness of the school science and industrial technology linkages. In time, an evaluation of what this exposure of schoolchildren to centres of production has meant in terms of making school science more relevant to development would be valuable. As well, it will be interesting to monitor this program to see if students themselves are stimulated by the contact with industry to take the initiative in technical experimentation in schools.

While schools and examination councils usually do regular evaluations of the quality of school science a question that they do not ask is whether these new thrusts in school science have made any impact on communities surrounding the schools. This is of particular relevance in the rural areas where the new knowledge could presumably be translatable into farming practice etc. In relation to this, one could also ask what difference the language in which science is taught, makes to a child's understanding of it. In most rural areas, children have little opportunity to speak or hear English beyond the school. The language they communicate in most of the time is their local dialect. Can we assume that the conceptual processes in learning school science can be transferred into the local languages by children who might want to communicate what they have learnt at school outside the school? In other words, what is the capacity of various indigenous languages to absorb the meaning structures of scientific information? It is not a new notion to suspect that part of the mystification of science and alienation from it might arise from its very terminology and 'special' equipment. To what extent would this deter a sense of familiarity with it sufficient to encourage experimentation and dissemination?

Another aspect of the 'new science' in schools worth querying is its relationship, or lack of it, with the post-school technical training institutions. In Kenya, there has been in the past few years, concurrent to the school science changes, an upsurge of rural technical training centres such as the village polytechnics and the Harambee Institutes of Technology. There is some speculation that the new practical school science predisposes more school leavers (more than would have been otherwise the case) towards such technical training and towards self-employment. In a country where 60% of the primary school-leavers do not have access to secondary schools, the effect of primary education in giving skills and moulding attitudes to work has not really been sufficiently analysed. Instead sporadic schemes are presented in answer to the massive problem of primary school leavers. One response to the terminal nature of primary education for most children has been a recommendation to increase the number of years in primary education and to diversify the curricula to include pre-vocational training through technical subjects.<sup>12</sup> But unless these subjects were to be examinable for the Certificate of Primary Education, the seriousness with which technical subjects could be taught or learnt

remains questionable. One of the dilemmas that faces diversification in the entire eastern Africa region is the strong social identification with the existing dominant model of academic education. There are several reasons for this. Historically, during colonial times, vocational training was identified in the region with academic failure or at best, the lowest status jobs in civil administration. In the post-independence situations parents aspire to give their children options wider than they have had. For the rural majority, success in academic education is seen as an avenue out of restricted village economy. Also, the education system as it exists, with its closure of options for technical training beyond the tenth year of education, discourages successful diversification.

An ongoing evaluation of a SIDA (Swedish International Development Aid) program of industrial education in 35 Kenyan schools underlines the problems facing vocational training through schools.<sup>14</sup> This program of aid from 1974 to 1981 consisted of enlarging and equipping school workshops, teaching industrial arts subjects and providing for the training of Kenyan industrial education teachers. Under it, 3,500 secondary school students sat for examinations in metal and wood technology and power mechanics. The evaluation team doing a tracer study of these students has come up with interesting interim observations although it has to be kept in mind (the number interviewed so far is fairly small). Firstly, the ex-students have complained about not acquiring trade certificates (the qualification for technical skills recognised by formal sector employers) since the concept of industrial education in schools is not well-known or trusted in the labour market (a similar preoccupation with certificates is found in the informal sector as discussed above). Secondly, since industrial education terminates at Form IV (fourth year of secondary school) it is not opted for by the brighter students who hope to continue to Form VI and if possible, university. Also, there is no transferability of the subject to other educational institutions except for the polytechnics. The students' reflections on being the victims of an isolated experiment are similarly expressed by the industrial education teachers trained under the program. Since their training, Kenya with the aid of CIDA (Canadian International Development Aid) has acquired a Technical Teachers Training College which gives the teachers a diploma and a salary scale higher than that available to the IE teachers,

trained to a lower level without choices of promotion through experience. The third shortcoming of this program is that it failed to check the congruence of the training with the labour market - what and where are the employment opportunities? It also paid inadequate attention to how the trained youth could be equipped to set up their own workshops. The latter is made particularly problematic given that the training is acquired on expensive capital intensive SIDA donated machinery and the reality of self-employed has usually to be based on the cheapest, locally available tools. Is it not time aid projects were assessed by their potential for replicability and consideration as to whether the projects were sustainable after agency withdrawal?

These issues of discontinuity between training and employment are also important factors in the success or failure of indigenous movements for education in employable skills. Brief case studies below of the Botswana Brigades and Kenya's village polytechnics illustrate this gap and also draw out the management and financial problems of programs that do seek to be self-sustaining. But most of all, they emphasize the need for supportive social and political environments.

In 1977 nearly 37% (World Bank figures) of the children 6-11 years old in Botswana were enrolled in primary schools. Presently, almost 80% of the children leaving primary school are not able to enter secondary schools. In 1965, an enterprising school teacher Patrick Van Rensburg started the Botswana Brigades in answer to the primary school leaver problem. While building the first secondary school in the town of Serowe using primary school leavers and other volunteers, Van Rensburg initiated the Building Brigade. The Brigade offered an on--the-job apprenticeship type training, in which trainees undertook building for public and semi-public authorities at relatively low costs. The trainees' earnings covered their training costs. Gradually the concept expanded to include Brigades training systems in agriculture, dressmaking, spinning and weaving and carpentry. By 1979, the Botswana Brigades involved 2,500 youth in training and production activities. In 1975 the Government began to subsidise the Brigades by contributing to the instructors' salaries and giving training allowances. But in 1979 aid to the Brigades was suspended and a steady decline and disorganization set in.

The Brigades' initial idealism in terms of making the program self-financing has obviously not been successful. Why? According to Van Rensberg, the internal problems of the Brigades reflected the wider societal context.<sup>15</sup> In the early to mid - 1970s, the discovery of copper and nickel and the expansion of diamond mining made important changes in the Botswana economy: the share of mining in GDP rose from less than 1% in 1966 to 15% in 1974-77. This meant that young people who previously would have joined the Brigades to forge avenues for employment could now go to the mines and be trained on-the-job. Within the Brigades, dissensions were caused by staff demands for higher wages conflicts between Brigade managers and the central Trust and a financial crisis rooted in the shortfall between subsidies and production costs (which included costs of training, education, administration and production outlays) all served to undermine the movement. Finally, inability by some Brigades to obtain Government and local government contracts contributed to their eventual collapse.

Van Rensberg sees the problems that gradually beset the Brigades as inevitable in a society with a dual system of education. The alternative system is susceptible to pressures from the mainstream for formalization along prescribed modes. It is also watched in case it successfully engenders attitudes that could ultimately militate against the status quo. Income-generation in models of education with production such as the Brigades, coupled with an institutional organisation stressing social equity quite easily draws suspicions of "subversive activity" in a capitalist political economy.

In Kenya, the Village polytechnics (VPs) were meant originally to answer both the primary school leavers' dilemma and local community needs for small-scale service and repair industries. The VPs were started in the 1960s by the National Christian Council of Kenya, (NCCCK) a voluntary welfare organisation. When the NCCCK could no longer manage the VPs because of shortage of funds, the Government took over the responsibility. Its contribution to VPs is in the form of grants to cover instructors' salaries and management expenses and tools for training, apparently randomly distributed to the VPs. The majority (almost 96%) of the VP trainees are Standard Seven (last year of primary education) school leavers who hope to obtain from the training an employable skill. Their location in the rural areas where majority

of the schools are located and also therefore the school-leavers, makes them an especially potent instrument for training towards the rural needs and community development. Yet this potential is not being fulfilled. Reasons are numerous: government control which stifles community involvement with VPs although management committees are drawn from the local communities; poor quality of the trainers; lack of equipment which VP graduates can use to help set themselves up in business; little research on the market demand for the skills taught and limited curricula. A review of the VP experience throws up topics for discussion on the official policy towards VPs, their role within the national technical training institutions and on measures that can assist the VPs to become the need-oriented training programme that they had initially professed to be.<sup>16</sup> A question that can be examined usefully is what blocks the VPs becoming contractors to Governments and other public bodies on labour intensive public works and thus in effect, rural job-creators.

Both the VP experience and that of the Brigades are attempts to deal with the common problem of school leavers who cannot continue with formal schooling and want to acquire employable skills. The Brigades were for a period of time an example of the successful combination of education with production. Their decline could be attributed in some ways to the unique circumstances of Botswana, but nevertheless points to the problems of alternatives developed outside the mainstream of government initiated and supervised institutions. The VPs on the other hand underline the stagnancy that can set in with central control by officials remote from the problem. Who the appropriate managers would be has to be assessed largely within the particular context of a national situation but the issues facing the managers are likely to have similarities.

Countries of the eastern Africa region are engaged in exciting innovations in science teaching and technical training. There is scope here for networking between those at the helm of such developments in order to disseminate learning and stimulate further work. The nature of the desired network and whether it should be co-ordinated by a centre of some sort, is a question that should be answered by those involved in science and technology education.

Although national contexts define the emphasis and suggest different perspectives, social problems in the delivery of education and training are essentially the same. Restricted resources, large demand, the academic bias of existing pedagogies, job aspirations geared to the modern and usually, the urban sector and lack of co-ordination between initiatives impacting on technical education and youth employment all play significant parts in science and technology education in the region. The distinct national responses to these problems also have common elements. The region's educational research over the last two decades has emphasised increased use of local teaching materials, curricular reference to the specific local environments, greater stress on experimentation in school science and a consequent search for equipment that is less dependent on imports. Governments are encouraging school structures and curricula that recognize the terminal nature of primary education for majority of children.

#### Emerging Research Themes

The above discussion has touched upon a variety of research activities in the region. In this concluding section, two areas of research that are emerging out of changes in the science, technology and education field are discussed. The first is that of small-scale industry and the need for systematic research on the form of technical inputs into the current plethora of such industries across the region, the industries' training and employment practices and the potential for linkages with the large scale industries. The first dilemma in any such research would be that of definition of small scale industries. In most local literature, there is obvious confusion between the informal sector and small scale industries. While both are characterised by a similar scale of operations and usually greater labour intensity than the larger enterprises, the dividing line can be drawn over the number of people employed and licensing status. The latter qualifies an enterprise's position vis a vis taxes, wage, premises and product standards as well as eligibility for enumeration within the formal or informal sector statistics.

The importance of small scale industries has increased in response to

at least two things: first, the expanding urban informal sector and official desire to control and upgrade it and second, the continuing rural - urban drift and the growing unemployment problem. In Ghana, foreign exchange shortage and consequent reduced production of larger enterprises had high lighted the virtues of small scale industries and led to their resurgence;<sup>17</sup> foreign exchange shortage is a phenomenon common to several African countries. Hitherto, responsibility for the development of the smaller industrial enterprises has been allocated to government parastatals functioning largely on foreign aid support. Their structure tends to be in the form of industrial estates, dependent on the parastatal through loans, expert advice and sometimes for machinery purchase. What is proposed here is that alternative structures for small scale industry support be explored - structures that allow decentralised location, (urban and rural) flexible linkages with the formal and informal sectors (without continuous reference to the central officials allocated to supervise them) and access to information and training around the use and development of indigenous (locally available) technologies. Research into engineering applications to this sector, contextual studies on the various types of trades in the industry and their technology and training needs, analyses of how to improve productivity in particular local conditions and strategies for effective links with the education system and other formal sector skill acquisition opportunities are all worth considering. The issue of appropriate technology can also be studied within the framework of such enterprises and their markets (especially with regard to basic needs).

The other area that is just beginning to draw research attention is that of the use of computers as teaching and learning aids in schools. It is very probable that all the countries in the region are now using computers in the public sector and the private industrial and commercial concerns. Two, Kenya and Swaziland, have at least three schools each that are using computers. Zimbabwe is planning widespread dissemination into schools of locally assembled micro-computers under a scheme called ZIMFORMATICS. The effect of computers on traditional student learning needs to be anticipated;<sup>18</sup> the question of equity of access to this new technology and the rural - urban imbalance that will inevitably ensue could be addressed; what comprises indigenous technological capacity in

this field needs also to be asked. Those who are supporting computers in schools and the training of schoolchildren in its use argue that it contributes to computer literacy in social environments that already encourage computer utilisation in the adult world. The expatriates play a prominent role in the computer industry; local training in this technology from school upwards could be a vital contribution to indigenisation. Computer-related occupations such as the assembly of the computers (components could be imported) and their servicing would also gradually develop. However implications for versatility in teaching and learning methods, balance between the academic and practical components of curricula, employment, the financing of computer facilities, dependence on the industrialized countries for computer software (what scope for indigenisation on this front?) and trainers are all questions well worth asking. The impact of electronics based machinery in local industries also remains to be assessed.

When one takes the introduction of electronics technology into the region at one end of the spectrum of the science, technology and education discussion and issues of appropriate and simple tools for primary school leaver training as a carpenter at the other end, one gets some sense of the vast dimensions of this subject. Some of the complexity is illustrated by the above references to school science, vocational training and employment issues, the popularity of certificates and their match or mismatch with available jobs, the informal sector initiatives in technical training and response to consumer demand and the broader underlying dynamics of apparent movements away from technological dependence towards indigenous technological capacity and capability. A challenge for the region's researchers is to develop analytical frameworks and methodologies that can accommodate the multidisciplinary required of studies in this field and to present policy-makers with integrated profiles of the various facets of this range of issues.

## References

1. Clarke Roy, research proposal on 'The Relationship between Educational Qualification and Employment: An Empirical Investigation to Compare the Usefulness of Two Different Theoretical Approaches', Manpower Research Unit, Institute of African Studies, University of Zambia, Lusaka, 1983.
2. Mikkelsen, Britha, unpublished draft chapter entitled 'Labour and Industry - Industrial Training and Social Reproduction of Labour', from a forthcoming book, Copenhagen, 1983.
3. Brugman, M.G., 'Report on the Visual Ability of the Kenyan Primary School Leavers', Nairobi, 1983.
4. King K.J. 'Report of a Technical Workshop on Science, Technology and Education Research in East and Central Africa', Nairobi, Aug. 1983.
5. Ndela, Daniel, Dept. of Economics, University of Zimbabwe, in conversation with the author, Harare, Oct. 1983.
6. Ngethe N. and Ndua F.G., a research proposal on 'Education, Training and Welfare in the Informal Sector: An analysis of Metalwork and Carpentry Sub-sectors in Selected Areas of Nairobi', IIDS, University of Nairobi, Nairobi, 1983.
7. Odurkene J.N., research proposal on 'The Indigenous Apprenticeship and Informal On-the-Job Training Practices in Uganda', Centre for Continuing Education, Makerere University, Kampala, 1983.
8. Hans H.C., 'Some Characteristics of Informal Sector Businessmen in Lusaka and Kitwe', SATEP, ILO Office, Lusaka, 1983.
9. The Herald, Harare, 8 Oct, 1983.
10. Informal discussion with science teachers in the Nyeri District of Kenya, Nyeri, Aug. 1983.

11. Berluti, Alex, 'Elementary Technology in Primary Schools', Technical Workshop on Technology, Education, Employment and Development in East and Central Africa, Nairobi Aug. 1983.
12. The Government of Kenya, Report of the National Committee on Educational Objectives and Policies, The Government Printer, Nairobi, 1976.
13. Sheffield J.R., Moris J.R. and Herman J., Agriculture in African Schools. Case Studies of Botswana, Kenya and Tanzania, The African-American Institute, 1976.
14. Norman, Anders, Consultant to SIDA, in a talk 'Swedish Aid to Education: Two Case Studies from Kenya', given at the Education Research Bureau, Kenyatta University College, Nairobi, 29th Nov, 1983.
15. Van Rensberg P. 'Looking forward from Serowe', unpublished draft monograph, 1983.
16. Waithaka D. and Oiro S., 'Realising the Potential of Village Polytechnics: A Study by Action Aid - Kenya', Nairobi, June 1982.
17. Afful K.N., 'The Changing Status, Scope and Technology of Small-Scale Industry in Response to Foreign Exchange Shortage in Ghana', paper presented to Workshop on Technology for Small-Scale Industries, Nairobi, Oct. 1983.
18. Rathgeber E. presentation on New Information Technology and Education, Science, Technology and Education workshop, Nairobi, Jan. 1983.