THE POTENTIAL FOR LOCAL MANUFACTURE OF SCHOOL SCIENCE EQUIPMENT AND RELATED PROBLEMS

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The last ten years have seen dramatic changes in education in most Commonwealth countries. "Universal Education" has become a political catch-phrase, and the number of schools and colleges has increased enormously in a brave attempt to match this ideal. Africa has been quick to adapt to recent changes in science curricula. In common with world trends, syllabus development has been accompanied by a search for more effective means of teaching, with stress being placed on the learning of practical skills and on promoting a general understanding of the methods and processes of science. Changes such as these impose on the education system considerable demands for science equipment that can be met successfully through production at the local level.

In attempting to survey a field of this scale in relatively few words, there exists a danger of being trite. Because of this, the approach adopted here has been to rely extensively on material and experience gained in Kenya as a basis for discussion. While the diversity of countries and cultures represented at this workshop makes generalization difficult, it should nevertheless be possible to identify a number of situations and problems we have in common.

A further point must be made here. Until comparatively recently, cheap apparatus has been synonymous with improvisation. In this paper where our main concern is local manufacture (i.e. large scale production at the local level), improvisation is seen as something confined to the individual teacher; it is part of his training and approach. Moreover there is always room for improvisation, no matter how well-equipped a school science laboratory may be.

Present Source of Equipment

The present supply situation in Kenya is probably typical of most Commonwealth developing countries. The 1,250 or so secondary schools purchase the bulk of their equipment direct from commercial suppliers operating mainly in Nairobi, the capital city. These firms import directly from overseas, with the bulk of their supplies coming from Western Europe, the United Kingdom and the United States of America. Of late, however, there has been a welcome departure from this pattern in that cheaper materials - from India, Pakistan and Japan, in particular - are becoming increasingly available. Very little effort has been made to harness the support of local manufacturing industries, and although it is possible to buy locally made test-tube racks for example, prices are not competitive and the standard of production is very low.

A certain amount of improvisation, particularly by physics teachers, has added considerably to the range of apparatus available in a few schools. Regrettably, good ideas are rarely passed on, and seem to be the prerogative of those schools and departments with experienced expatriate staff. Also, in the last few years the Nairobi-based School Equipment Production Unit (SEPU) has been making successful attempts to meet increasing demands for equipment for both rich and poor schools.

Difficulties and Problems with Equipping Schools with Suitable Equipment

Very little has been attempted in the way of formal evaluation of science equipment in Kenyan schools, but the writer believes such evaluation is not necessary in order to review some of the difficulties and problems that are discussed below.

(a) Economic: Foreign exchange problems, import restriction and devaluation are important economic circumstances that cause difficulty or delay in getting equipment. Apart from those items that can be obtained fairly readily from the very limited basic stock maintained by most suppliers, it takes from three to eighteen months for orders from abroad to arrive in a school. With rising inflation, the longer the delay, the higher the prices schools have to pay.

(b) Professional: With an irregular supply of apparatus, it would make sound practical sense to co-ordinate all purchases of science equipment through the activities of a central purchasing authority. Specifications could be examined, and the most suitable items purchased in bulk. Unfortunately there are many drawbacks to such a system. Apart from political considerations, it is obvious that for a central authority to be successful and effective, it would have to be well staffed with teachers experienced in local conditions. Many developing countries in the Commonwealth cannot afford the cost of setting up such a body. Thus in Kenya and other countries known to the writer, buying of equipment is the responsibility of individual science teachers or, more often, of purse-holding headmasters who lack specialist science training.

Once the apparatus is in the school, additional difficulties arise. Frequent staff transfers often mean that the teacher who originally ordered the item has left. No one else seems to know what to do and the result is either an item being left to gather dust on a shelf, or abuse and breakage. Such events as using an AC power supply unit for electrolysis, and burning out sensitive meters and damaging the objective lenses of microscopes, may seem petty in this context but they are very real and important problems in any consideration of local production of low-cost equipment.

(c) Uniformity: Because of this buying in very limited quantities by individual teachers, there is a lack of uniformity not only in the science apparatus in different schools, but also among subject departments within a single school. The resulting hotch-potch renders the purchasing of spare parts and routine maintenance difficult and expensive.

(d) Educational: Junior students in secondary schools are usually weak in manipulative skills. Their home background is generally such that it would be unreasonable to expect otherwise. Unfortunately, because of a general lack of confidence on the part of science teachers, very little is done to correct this: the amount of practical work contained in typical science lessons is minimal and so a weakness extends right through the secondary school course. This situation results in a high rate of breakage. So, in equipping schools with suitable equipment, robustness and durability are characteristics that must be taken into consideration.

One of the important principles put forward by the recent Commonwealth Conference on "Materials for Learning and Teaching" held in New Zealand was that learning materials intended for school use should evolve from the requirements of the curriculum rather than from available hardware or software. The present workshop provides us with an excellent opportunity to stress this idea. If apparatus is being designed and manufactured locally, we should make sure that it fits in with the educational requirements of a particular situation. It is all too easy to build a piece of apparatus without first taking a long hard look at educational objectives.

Summarizing the above problems one would say that in attempting local manufacture of equipment, the following points must be borne in mind:

(a) What we produce must be cheaper than that available through a commercial supplier; this entails a careful consideration of <u>all</u> the costs involved in producing a given item.

(b) Items must be robust and sturdy, but at the same time appearance must not be overlooked.

(c) Instructions must be produced which are fully comprehensive: they must include instructions on how teachers should use the item to make their lessons and schemes of work achieve intended objectives.

(d) Uniformity is important so that replacement and repair are facilitated.

(e) We must never lose sight of educational objectives. It is very easy in the workshop to get carried away with the idea that just because a thing <u>can</u> be done it <u>must</u> be done.

These principles, although they seem very obvious when written down in this way, have been learnt through experience. SEPU has a considerable number of pieces of apparatus which have "gone wrong" because one or other of these principles has been ignored.

<u>Existing Local Resources - Types of Science Equipment that can be Produced Locally and Cheaply</u>

Having outlined the problems of supplying school equipment, we are in a better position to look at possible solutions. But rather than philosophize over what <u>could</u> be done, it might be more profitable to examine closely what <u>has</u> been <u>done</u> in one particular case. The remainder of this paper deals with the current work of the School Equipment Production Unit in Nairobi.

SEPU has been in existence for nearly ten years. Its present form, however, is the result of a process of gradual evolution. Mistakes have been made in the past, and the present structure of SEPU reflects them. The unit is now organized as a private company backed by Swedish aid money and personnel. Over the next five years this aid will be progressively reduced so that by 1980 it is hoped that Kenya will be left with a fully viable and self-supporting unit.

At present the development of items of equipment is in the hands of expa iate staff, while the actual production is carried out by locally employed, unskilled workers. A Swedish design technician produces hand-operated tools for the production of most pieces of apparatus. In this way, SEPU is able to combine labour intensive methods with simple production techniques to produce low-cost apparatus at labour costs of about K.Sh. 12 (US $1.4) per hour.

Currently three types of kit (for physics, chemistry and biology) are being produced by SEPU, and monthly sales have now reached the K.Sh. 60,000 level (approx. US $7,5000). In each case, SEPU's approach has been to produce a nucleus of apparatus that can be used to carry out an adequate range of experimental work up to the East African Certificate of Education level. Each kit includes instruction manuals for students and teachers.

Despite the limited methods of production, SEPU has met with considerable success. Items like hand lenses and variable resistors which SEPU used to import for distribution are now being produced locally with the aid of machinery no more complicated than a lathe. All the same it must be pointed out that SEPU continues to make use of bulk purchases of glassware and thermometers from foreign suppliers for inclusion in its kits.

The success of the SEPU science kits should be measured in the light of the difficulties that have already been mentioned. Firstly, local production and bulk purchase reduce costs considerably and, more important, the apparatus going into the schools is suited for its purpose. Secondly, instruction manuals provide the step-by-step help which inexperienced teachers require. Thirdly, each kit is designed for group work rather than for teacher demonstration, and it is hoped that the setting up of the apparatus will lead to an improvement in manual skills. Lastly, these three kits very definitely fit in with current syllabus requirements.

Besides centring the work of the production unit on the science kit, SEPU has been involved in the production of other items. Slide sets on local applications of science, and standard items like dynamics trolleys, ticker timers, meter 'ridges have all been produced in the workshops.

Contribution of Teachers, Technicians and the Community in the Production, Distribution and Evaluation of School Science Equipment

The successful development of an item of science equipment or of a kit depends upon many variables, and the contributions of educational personnel vary from project to project. The flow chart shown in figure 1 is a summary of the development of the SEPU biology kit for which the author of this paper was the consultant.

A diagram of this sort can be misleading in that it presents development as a series of discrete stages: objectives are defined, materials developed, field trials follow, and so forth. In reality there is considerable overlap, and it is quite usual to find that certain items are on field trial while others are in the developmental stage.

In order to make the greatest educational impact, a major project like this must increase the involvement, confidence and skills of average teachers. They must be encouraged to view the project personally; for only then will it meet with real success. This involvement is illustrated in the flow chart. Every box in the figure with the exception of that dealing with actual production of materials, contains the word "teachers". Teachers formed the core of the committee that decided the original objectives; the consultant was a member of that committee and was seconded from the Ministry of Education to SEPU for the purpose of developing the biology kit. The field trials, the development of the accompanying teacher training programme, the evaluation, and all aspects of production required the involvement of the teaching profession.

The question of relevance to the local situation should be high on any list of educational objectives, and it is here that the role of the community is important. It is a rich source of useful material and, with the aid of personal contact, its potential can and should be exploited to the full at the developmental stage.

The other critical component of the development team is the technician. His is often a sobering influence. He talks in terms of money, time and feasibility, and is responsible for translating teachers' flights of fancy into concrete practical terms. The diagram suggests that he is concerned in relatively few stages of the development, but he should, in fact, show an interest in all stages including such areas as sales and teacher training.

Setting up Experimental Units for the Production of Science Equipment at various Levels

Whatever the size and nature of a unit for producing science equipment, two things come immediately to mind - time and money. Anyone experienced in the production of scientific materials will appreciate that the total time involved is considerable. For example, the Nuffield Foundation's "Resources for Learning Project" showed that 22 man-hours were necessary to produce a single hour of student material!

No developmental project is free from political influence, and in many developing countries political pressures can be high. Results are required, often urgently. Time is obviously at a premium. An examination of the apportionment of time in the development of the SEPU biology kit as shown in figure 2 reveals that only about 60% of the available time is spent on development itself. The remaining 40% is necessary to carry out field trials, evaluation and teacher training. Clearly, if pressures are high enough, this is where the cutting will take place, despite the enormous value of these aspects to production.

The diagram representing the allocation of money makes no attempt to discuss the total amount involved. Two basic considerations have been omitted entirely: salaries of staff (other than those of unskilled workers), and the initial cost of establishing the unit.

In addition to time and money, the siting of a unit is a factor that needs to be considered. Various possibilities are reviewed below:

(a) Schools: Students and teachers in Kenya are under considerable stress brought about by syllabus requirements and the spectre of examination. Bearing in mind what has been said about time, it will be apparent that only small-scale production and improvisation are feasible at this level. It is unrealistic to expect anything else.

(b) Technical Colleges: In terms of facilities, technical colleges offer rather more than schools, but the same pressures apply. SEPU was originally planned as a part of the Kenya Science Teachers' College. While it was appreciated that much could be gained from close association of the two, it soon became apparent that staff and workshops had to separate.

(c) Village or City: For political reasons there is much to be said for the establishment of production units as rural industries. In practice, certainly in Kenya, the resulting problems would be insuperable, coverning such features as provision of electricity, close proximity to other supply firms, and communication with teachers. (A teacher visiting a city is quite likely to pay a casual visit to the production unit: it is unlikely he will travel out to a rural area to do this.) Whether the production unit is sited in a village or city, it must be organized on an industrial scale. Its success will depend on good management and the application of hard-headed business methods will take into account the need for an extensive programme of evaluation and teacher training.

THE DEVELOPMENT OF THE SEPU BIOLOGY KIT

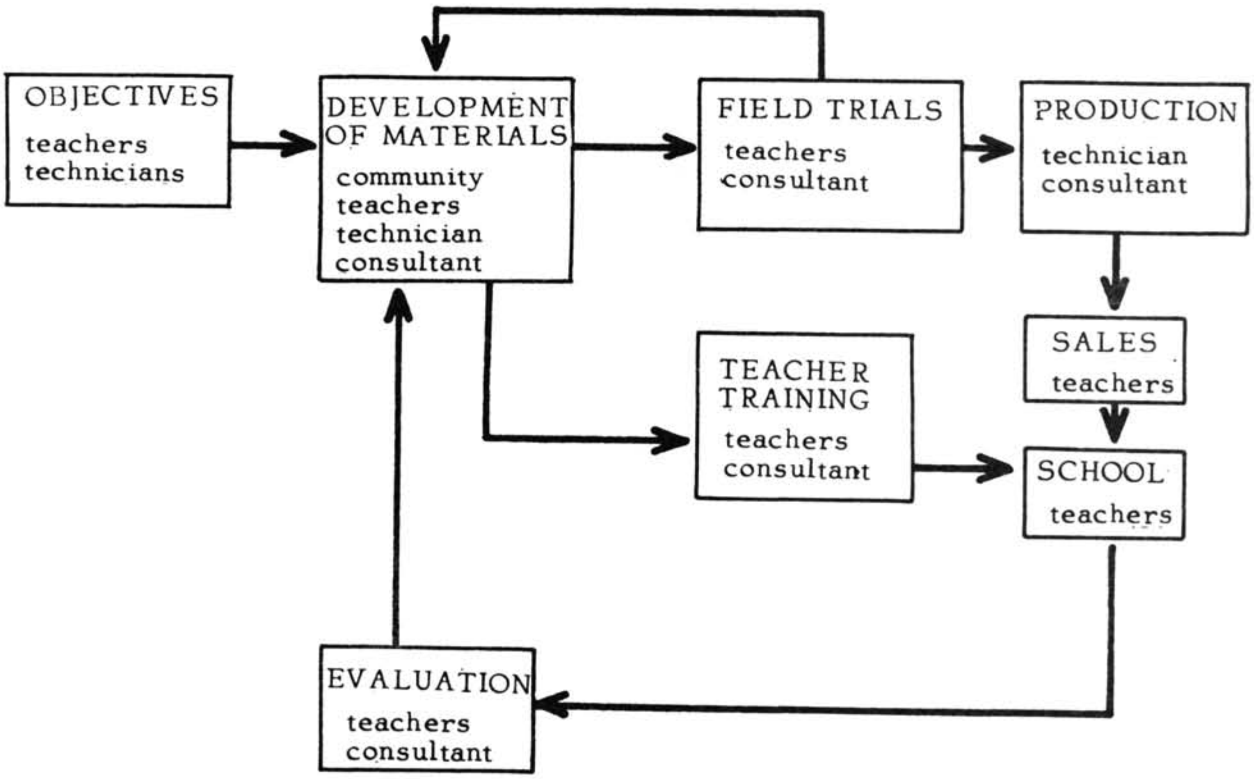

FIGURE 2. THE DEVELOPMENT OF THE SEPU BIOLOGY KIT

APPORTIONMENT OF TIME AND MONEY