LEAD PAPERS

LOW-COST SCIENCE EQUIPMENT: STRATEGIES FOR PRODUCTION

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Introduction

The subject of low-cost science equipment has occupied the minds of a large number of teachers and administrators alike ever since science education found its way into the African school system. The matter has been researched and discussed in conferences, symposia, and books. Interest in this problem derives in the first instance from the fact that money is generally in short supply. But, even where nature's resources allowed for an abundance of convertible wealth, other issues have rated higher than science education in the list of national priorities.

People who are interested in finding a solution to this problem generally start by analysing the reasons why the present state of affairs in most developing countries is unsatisfactory. They then proceed to study ways and means of redeeming the situation. With some luck one may find a text in which one of such ways and means is actually prescribed as a "cure". More often than not, the discussion is inconclusive.

In preparing this paper, I have had the benefit of ideas contained in numerous published texts. I should like to mention in particular, the booklet by Warren and Lowe, The Production of School Science Equipment, and the Report of the Commonwealth Regional Seminar/Workshop on Low-Cost Science Teaching Equipment held in Nassau, Bahamas in 1976. These two Commonwealth Secretariat publications taken together contain what I believe is the correct strategy for the successful production of inexpensive science equipment. However, if one takes the African context into account, I believe the ideas in these books will fail to yield the desired results for the simple reason that the proper motivation for producing low-cost scientific equipment has not yet been correctly stated. In these studies, there is a tacit assumption that the science which Europe is pursuing now is the science which Africa should also be doing but "unfortunately" cannot yet do because it is underdeveloped. I think this is wrong. This is the kind of thinking that produces the negative psychological stresses so inimical to progress. Every nation must work on issues relevant to its state of development and strive to improve the quality of its people's life.

What I propose to do in this lead paper is to discuss as part and parcel of the strategy for the production of science equipment, the philosophy which must guide the production of such equipment for efficient teaching in schools. Equipment so produced is low-cost, but this is only a happy coincidence. I shall illustrate my discussion with a brief reference to an actual case, namely the effort at present being made by the Department of Physics, University of Ibadan, Nigeria. I shall suggest that the strategy for the successful production of school science equipment

entails two considerations, the first long-term, and the second short-term. The long-term consideration involves a psychological reorientation of the basis for science education in Africa. The short-term consideration concerns the need to maintain an effective scientific and technological interface with the rest of the world.

Developed Versus Developing Countries

I have always wondered why the world is divided into the developed and the developing. The main problem we in the so-called developing world face is the psychological one that derives from this division. The history of human "cultural evolution" - I shall not use the word "civilization" - shows that no sooner has man solved one pressing problem than another one rears its head. There is no human society that can claim to have solved more than an insignificant fraction of what it considers its problems. The only difference between one culture and another is in the definition of what constitutes their respective problems.

When I was at school, we first did addition and subtraction by counting with objects called counters. We did not handle large numbers in this way, but it did not matter at all since we had no immediate use for such numbers. Then we graduated to higher forms and began to use logarithm tables. And we were quite happy with these. Many of us did not know of the existence of slide rules. But that did not matter. At the level at which we were operating, the existence of more powerful tools was irrelevant. We did not feel inferior to anyone. We were simply at our own level of development. Then later in life, we discovered mini-computers, and larger-than-life IBM and CDC machines, and we used these with as much glee as we used counters at school. Some day there will be more powerful ways of doing arithmetic. This, however, does not interfere with our satisfaction with what we now have. And that is as it should be.

Now you may ask: what has all this got to do with the production of low-cost science equipment? The answer is everything! For in Africa there appears to be the idea that because Europe has learnt a few scientific tricks before us, we must all do what we can to catch up with them. We see ourselves not as people living normally evolving lives like the rest of humanity, but as people lagging behind some others, and perpetually faced with the problem of catching up. This is a negative attitude which ought to be halted. It is true that because of the demands of international trade, no nation can afford to be isolated. Even so, every nation has to discover its level of development and operate happily at that level with the full realization that it will steadily advance in the fullness of time. The reason why low-cost science equipment is imperative in an African environment is that it is nearest to the level of the people's development. It can be fashioned by the people themselves, and so has in the long run a superior pedagogical value to sophisticated equipment. And one is not here saying that "the grapes are sour". Far from it! One is saying that the proper way to learn to do arithmetic is to use counters before one uses logarithm tables. If this philosophy is accepted, the manufacturer of counters will be assured of a decent living even if logarithm tables were to flood the market. Developing countries must see themselves as being at a different stage of development, and approach school science at the level nearest to their state, without feeling that they must make levelling contact with the contemporary state of other cultures. Our experience with the reasonably effective operation of local automobile mechanics with no science education, shows that such levelling-up is not dictated by the necessities of foreign trade involving technological hardware.

The Strategy

It was mentioned earlier that the strategy may be divided into two parts: one long-term, and the other short-term. But both are related. The long-term strategy is to alter the philosophy behind science education in Africa in a direction that will enable the average scientist to operate happily at his nation's current level of development without feeling bad about not yet being able to do what scientists in other countries are doing. This then means that the process of production of science equipment is part of the development of science in the country. In practice, this means that a few of the country's more developed institutions of higher learning will undertake, as part of their normal pedagogical functions, the production of such equipment as may be used in primary and secondary schools. The production of equipment by a section of the people themselves has the same effect on the rest of the people as a spectacular American space feat normally has on the average American, however modest his own personal intellectual endowments may be. I believe children will learn faster, and with greater confidence, if they can identify with the sources of the tools they use. The strategy here is to have the apparatus production firmly rooted as a matter of principle in an existing institution. This is confirmed by the rich experiences described by Warren and Lowe.

The short-term strategy has to do with the kind of apparatus that should be produced. I think this will be determined by the workshop facilities actually available in the institution. For instance, a number of universities in Commonwealth Africa are institutions that have very good workshop facilities manned entirely by local people, from the Professor and Head of Department to the youngest technician. The limit to what can be fashioned is set only by skilled manpower available and by human imagination. As a short-term strategy, what we have done at the University of Ibadan for instance, is to concentrate on producing standard equipment used in routine text-book type experiments: accurately machined brass balance weights, metre bridges and potentiometers, optical benches, resistance boxes, switches, ray boxes, and so on. We have in the process gained considerable experience and confidence. We have been selling such equipment to schools and to some of the country's new universities. As a result, we must now pay some attention to quality control. This is because our customers are reacting critically. At the same time, we are encouraged to move into innovative sectors, and look at equipment with some electrical and electronic content, and with design possibilities dependent only on our own imagination and stamina. The investment is quite modest since ours is a teaching workshop, and technicians are learning from the process of production.

When the short-term objective of gaining confidence has been achieved, and people realize that it is best to make equipment locally, we can then gradually reshape school curricula through novel experimental packages developed with specific objectives in mind. All this will take a long time. It is therefore essential that at each stage, we see ourselves as living perfectly normal scientific lives at our own level, and not locked in a desperate struggle to catch up with someone else on another continent. This then leads one to conclude that no teacher from a foreign culture, however good his intentions may be, can make any meaningful impact on the situation. The reason is that an expert from a foreign culture tends to live at his own level and would want to pull other people up to this level in the short space of time he generally has at his disposal. This can be a frustrating exercise. His success can only be superficial. Indeed African universities are bristling with the results of such effort - a growing community of academics carefully tutored to do measurement-oriented research in the best traditions

of the West and East, but totally unable to produce even the most basic components of the equipment they use.

I seem to have deviated from the issue of low-cost. This is because I believe this issue is fortuitously in consonance with the view that science equipment for successful teaching in schools should be locally produced by a section of the people themselves. It happens also to be cheaper this way!

Conclusion

Rather than suggest a wide range of ways and means for producing such equipment therefore, I think it is far more beneficial to confine oneself to one method which has been tested here in Ibadan, Nigeria, and seems to be working. To iterate, I would suggest that:

(a) Every African country, however poor, should accept its state of development realistically.

(b) Each country should establish at least one good workshop in an existing institution of higher learning, and as a first step use it to produce standard scientific equipment for schools. The technicians would learn in the process.

(c) When sufficient confidence has been achieved, the workshops should venture into the innovative sector, and try things that can change school science curricula in a predetermined direction.

(d) There should be no need for workshops to use only local material, unless these materials are found to be better than imported ones.

Where the government is unable to provide the funds necessary for this modest activity, foreign foundations should chip in what they can. They should, however, scrupulously avoid sending their own men to do the work. I believe that any country that needs such sustained external input of manpower in order to develop its science is a lost cause, and should be left alone.