IMPROVISATIONS

Teachers who improvise do so when commercial apparatus is not available or not suitable. Even in laboratories with the best equipment, good teachers will improvise; this aspect will be discussed more fully in a later section. Most schools, however, are not adequately equipped, so that their teachers are faced with the choice of improvising or denying their pupils valuable experience. As any science-educator knows, the second option is most commonly chosen, and it is easy to describe the teachers as overworked or lazy. The explanation is probably much more complex (although, of course, most teachers are overworked, or believe they are, and most shools have some lazy teachers). More fundamental explanations probably lie in teachers' attitudes and beliefs about science and about their own competence, and in social circumstances which may be unexpected.

The best-known guide to improvisation is the UNESCO Source Book for Science Teaching; other well-known guides are listed in the Bibliography. The Source Book has been very popular with teachers in the Caribbean although possibly mainly while they are in training. A lower-secondary general science text of the 1960s, written by a teacher-educator in the Caribbean, was based on the premise that teachers would have to make most of their equipment. The principle was welcomed by decision-makers, and the book was widely prescribed. But teachers would not use it.

Most teachers' college courses require students to improvise some apparatus, but it is reported that they want 'the real thing' when they go out into schools. While the Jamaica primary curriculum development, for example, stresses the use of local materials, teachers want what they used in college, for example metre rules instead of knotted string or uncalibrated rules. The Guyana TVC Report (p.5) and information from the Eastern Caribbean support this experience. It has been suggested that teachers' colleges, simply by being equipped with commercial apparatus, are misleading student teachers about priorities in the teaching and learning of science. A sixth-form teacher justified his position with the statement: 'Because that is what scientists are using' (18). Teacher-educators in the Caribbean have not been very successful in giving teachers confidence in their own creativity and critical ability.

Khoo (1976) draws attention to the development of decision-making skills in the RECSAM courses of training in the development of primary science and mathematics apparatus, and the RECSAM systematic approach may be one which we in the Caribbean would do well to emulate. Meanwhile, an energetic Guyanese teacher, in his reference to 'style', may have put his finger on what teachers are looking for in their science materials. It seems clear that locally produced learning resources (apparatus and printed guides) should be well finished and pleasing to handle. Perhaps users have more confidence in resources which have a professional appearance.

Improvisation in the less affluent countries may encounter unexpected difficulties. Dish-washing detergent bottles lend themselves to the construction of wash-bottles, filter funnels, beakers, force pumps and other useful laboratory items. But one forgets sometimes that countries short of foreign exchange may not have dish-washing detergent. When large-scale improvisation begins, creating a demand for 'throw-away' items such as thread spools used in clothing manufacture, local people in need of money themselves suddently put a price on these items. In the Caribbean we are only now discovering what has been known in India and Bangladesh for a long time.

Any good science teacher is something of a scavenger, and probably the first purchase for a science room should be a simple set of tools. The Ministry of Education in Jamaica has produced a four-page list, Suggestions for Equipment and Materials for Grades 7, 8 and 9 Science (4). Beginning with a list of tools, it includes other hardware materials, other household materials, stationery supplies, electrical supplies, supermarket/pharmacy/market supplies, chemicals not so readily available, and other supplies. The ways in which these materials could be useful are outlined, and any teacher is likely to find new ideas in it. Some years ago some teachers in Dominica produced a booklet on improvisation from locally available materials, but it was not widely known even at that time and has not been seen by this author (3). Locally available materials also constitute the bulk of equipment and materials recommended for the Caribbean integrated science curriculum published as New World Science (Reay and Turner, 1975 and 1976). Even given adequate finance and foreign exchange, experienced teachers, and better processing of orders than is described in the Bahamas Report, a year or more may elapse between the preparation of the order and the receipt of the equipment (19), and the local shops can be more useful to science teachers than most of them realise (20).

From Jamaica comes another resource designed to help improvisation. Supported by the Organisation of American States, the Co-ordinator of the Project for All-Age Schools has produced an Improvisations in Science Handbook for teahcers of Grades 1-9 (5, 21). The handbook, whose contents are listed in Appendix 2, freely acknowledges ideas from a fairly varied bibliography, while being selective for local curricula and resources. A written description is often not enough for teachers, especially primary teachers. In Jamaica there are six primary science centres in teachers' colleges and schools containing some equipment supplied by OAS. While teachers can borrow this, it does not exist in quantity, and teachers are encouraged to make their own copies (22).

A Survey of Secondary Teachers

In order to find out what secondary teachers possessed, needed and had made, a survey was carried out with considerable help from the Jamaica Science Education Centre and the Guyana Ministry of Education (23, 24). With Trinidad and Tobago included, the three largest countries of the Commonwealth Caribbean, containing 80% of the population of the region as defined, were sampled. (An attempt was made to include Barbados, the Eastern Caribbean and Belize, but communication problems arose.) It is unfair to ask teachers to take time to count the number of pieces of each item of apparatus in their schools and, in any case, the number of items available to a given teacher tells the researcher nothing about whether the teacher would use them or not, and in what way. In this survey, teachers were asked to indicate:

A if some of the equipment (or adequate equivalent) was available in quantities which enabled them to prepare all their students more or less adequately in the time available to them.

B for items (familiar and unfamiliar) which were not available and would not be used if they were made available; this category was especially useful in identifying the problems of teachers in keeping up to date.

C for items which they did not have, would certainly use if they had them, but could manage reasonably well without.

D for items which they possessed in such limited quantities that the preparation of their students was severely handicapped.

E for items which they did not have and whose absence made it impossible to cover crucial areas of the curriculum.

It was hoped that such questions would be non-threatening and would provide a reasonably valid description of the teacher/equipment interrelationship in schools.

Four such checklists were distributed to named secondary teachers. To avoid personal bias in the researcher, the checklists were prepared from lists constructed by others for other purposes. The nature and sources of the checklists, and the number of responses, are shown in Table 1.

Table 1 : Science Equipment Checklists Distributed in Caribbean Survey

Curriculum	Source of Checklist	Response
A Level physics	Verbatim from APPIL Teachers' Handbook Appendices 2 and 3 (25).	19
O Level physics	Complete list prepared by an ASETT committee (26).	29
Upper-secondary integrated science	Verbatim list prepared by some Guyanese educators for CXC integrated science - not comprehensive.	19
Lower-secondary integrated science	List extracted from Philip Harris and Griffin & George special catalogues for WISCIP and WISC and from New World Science; locally available materials excluded.	33

Very few schools and almost no teachers were asked to complete more than one checklist, so that nearly 90 schools and teachers in the three largest Commonwealth Caribbean countries provided information about their resources and needs. A and O Level physics teachers were also asked to indicate the number of GCE candidates entered in 1980. Although two A Level and six O Level teachers overlooked this information, the total reported GCE physics entry was 246 A Level candidates from 17 schools and 1055 O Level candidates from 23 schools. All teachers were asked to indicate any items produced in their own countries. Any items for which there was a great demand would merit serious consideration for local mass production.

The information emerging from both physics checklists was thin. Only one school (27) appeared to have any home-produced equipment. There were indications that teachers did not recognise the equipment items listed. For example, a teacher who describes himself seriously short of ticker timers, while indicating no use for ticker tape, may be interpreting 'ticker timer' as 'stopclock'. If this is so, the information provided about equipment needs and stocks is unreliable and details about each item are not worth reporting. However, the categories of responses are summarised in Appendix 3 (A Level physics) and Appendix 4 (O Level physics). We can examine these in an attempt to learn something about the teachers, for it is no good making equipment that teachers will not use.

The A, D and E responses must be treated with caution. In one of the countries, the checklists were distributed and collected by a Ministry of Education officer, and it appeared that some teachers did not lose the opportunity to indicate to the Ministry that they should have injection of equipment. Indeed, one return was accompanied by a letter which said "....we are sorry to say that we do not have any of the items. We are preparing students .... We will be grateful .... Thanking you in anticipation ...." It did appear, however, that items of the type demanded in quantity for the GCE practical examinations were much more likely to fall into the A/D/E categories (have, or need badly) than were other items with at least as much potential for the teaching of physics.

A school which does not have laboratory apparatus and materials cannot provide practical experience. In many Third World countries, foreign exchange and school budgets are so limited that teachers must either improvise or provide little or no concrete experience. What of countries without such problems? Can we expect teachers' perceived problems and needs (their view of their resources) to be related to the money available? In other words, is money the fundamental problem? Since the checklists for this survey were distributed in countries representing the economic extremes in the region, there was an opportunity to search for a relationship. None was found. A Wald-Wolfowitz runs test of significance on the data in Appendices 3 and 4 failed to show, for any category of response, anything approaching near the 0.05 level of significance, with the exception of the A Level booklist summarised in Appendix 3 (28). At least for physics, it appears that both resources and needs of teachers are related only remotely, if at all, to the amount of money available from governments. It would appear that decisions about the local production of resources should take into account much more than economic considerations, and should pay special attention to teacher education. This might become clearer if we look at the B/C responses to the physics checklists, shown in Appendices 3 and 4, both disturbingly large. There are too many items which teachers are happy enough to do without (C) or, worse, would not use if they had them (B). Of course, the lists are not definitive; but if they contain items which are not really useful for the teaching of physics this would have been recognised by knowledgeable physics teachers whose B/C response would have shown a low standard deviation. This kind of finding failed to emerge from the survey, which showed that teachers are not in agreement about what is needed for the teaching of physics. The best we can do to evaluate the list is to consider the response of Teacher 25 in Appendix 4, without doubt the most experienced and expert physics teacher in the region (27). Of the 215 items suggested for O Level physics, this teacher selected 35 as in category C and only one in category B, the other 179 items being regarded as essential. We thus have some support for the judgement of the ASETT Physics Committee which prepared the list.

Where there is no in-school improvisation, a large number of C responses would suggest either a teacher who does not teach the related concepts or one who attempts to teach them by chalk and talk. And a large number of B responses suggests a teacher who does not know about the apparatus and its educational potential. The nature of responses to the physics surveys conform to what is well-enough known anyway in the Caribbean: much of the physics teaching is being done by teachers who are not comfortable with physics; and there are hardly any teacher-educators themselves comfortable enough in physics to help teachers of physics and integrated science. Obviously, one cannot expect much in the way of designs for improvisation from teachers already struggling with physics content and methods. Further, such teachers need help in selecting commercial apparatus and materials; with this in mind, each teacher was sent two copies of the survey checklist with an invitation to keep the second copy as an aid to determing future requirements (29). Accordingly, the checklist itself might be described as a resource.

The physics surveys, then, provided little useful information about the adequacy of equipment stocks but strong indications that physics teacher education is badly needed.

The upper integrated science checklist, being incomplete and specific to a Caribbean course, did not yield information of general interest, and the data from it will not be reported here.

The lower integrated science checklist, however, raised some general issues. While the very large majority of Caribbean secondary schools teach science which is more or less integrated in at least the first two years, there is no single curriculum. To be sure, the majority of schools in the Eastern Caribbean and Guyana use WISC, but half of the schools responding to the survey did not come from these 'WISC countries'. In Trinidad and Tobago, less than half of the responding schools teach WISCIP (the forerunner of WISC) while the rest teach integrated science curricula developed in-school. In Jamaica, none of the schools teach WISC or WISCIP although most teach the Grades 7-9 curriculum developed and recommended by the Ministry of Education. It was not surprising, therefore, that the 33 responses from the three countries showed no curriculum-related or national patterns.

In contrast to the physics survey, teachers gave the impression that they knew what they were talking about, and they appeared to have given much thought to their responses (30). Some locally-made materials did emerge, although not more than two schools indicated this for any particular item. In the Caribbean in the 1970s, teacher development and curriculum development have concentrated on integrated science, and this may account for what appeared to be a greater level of awareness in lower-secondary integrated science teachers.

Responses appear reliable enough to report in more detail than those from the physics surveys.

Accordingly, Appendix 5 lists each item on the checklist in descending order of adequacy for the teachers' practices, with a summary of the way in which teachers responded. (Items readily available in the local shops were not included in the checklist.) Appendix 5 also indicates hows many items have been locally produced, all in-school as it turns out, with notes on some of these.

Bearing in mind that the checklist included the term 'or adequate equivalent', teacher-educators may feel that teachers were not dissatisfied enough about the lack of certain items of equipment. As with the physics surveys, this could indicate a tendency to chalk and talk and/or a lack of knowledge about aspects of the discipline and ways of teaching it. Teacher-educators selecing experiences for in-service courses might find the list useful as an indication of where to start.

If we examine the order of adequacy, we note a tendency for what is generally described as 'standard laboratory apparatus' (equivalent to apparatus for general chemistry courses?) to appear high in the list. Apparatus required for GCE biology and physics practical examinations also tends to be high, in accordance with the physics teachers' responses. Physics equipment for the teaching of ecology, and visual aids tend to be low. Remembering that lower-secondary integrated science demands are relatively attractive to market-conscious manufacturers, and that teacher demand and use is closely related to teacher education, priority areas for attention in local production and teacher education may be identified. Clearly, we cannot expect to provide many of the high-demand items by local production in the near future (e.g. item 168, colour blindness text book, and certain components of item 160, the electromagnetic kit); but there is no reason why excellent versions of item 161, kinetic theory model, cannot be put together locally and why animal skeletons (e.g. 83, 87, 96, 111, 112 and 154) cannot at the same time clear carcases from the roads and provide schools with materials which appear to be in reasonable demand (31).

The physics and integrated science surveys confirmed that mass production and in-school design and production in the Caribbean are virtually non-existent. They may, however, have achieved something more positive by identifying needs to educational decision-makers in the Caribbean and suggesting problems that may be paralleled elsewhere. Clearly, local production of science equipment should be much more concerned with issues of teacher development than with the idea of saving money and foreign currency, even if one adopts the priorities of the financiers rather than those of the educators. No matter how centralised the decision-making processes in a country, the teachers who intervene between the resources and the children must understand what they are up to.

Finally, one wonders whether the adequacy of provision of resources from those who hold the purse strings has any effect on the children. Could it not be that any teacher conscious of the value of direct experience will arrange for the children to have this? Obviously, a teacher, in a well-equipped school will have spend relatively little time in designing learning experiences in science, but can we expect the same teacher in a different kind of school to subject children to experiences in which they will not learn well? It is more likely that good equipment helps the teacher, not the children, reducing the demands on his ingenuity. At least, responses from teachers known to the author indicated that needs and perceptions depended much more on the teacher's insight and competence than on the resources in his school. Decisions about whether or not to undertake local production, and the priorities of local production, ought to begin with the teachers, not the economy, nor the children, nor the examination. This is the Guyana position. In a different Caribbean country, a decision at Cabinet level to undertake local production of science equipment, including equipment for schools, was taken without consulting a single science-educator or scientist (32). This illustrates the simplistic view of those not at the chalk-face, and educators should be alert to the possibility of such uninformed decisions.