

PROGRAMMED LEARNING IN MATHEMATICS AND BIOLOGY  
IN SECONDARY SCHOOLS IN WEST NIGERIA

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Summary

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This research project, based at the University of Ibadan, was conducted in West Nigeria from 1966 - 1969 in an attempt to assess how far programmed material might be useful in overcoming some of the difficulties that arose from the shortage of suitably qualified teachers in mathematics and science.

Using published programmed materials as trial tests, the researchers developed several other programmes which were evaluated on a large scale. In nearly all evaluations the programmes produced a significant amount of learning; but there were big differences in the amount learnt, and in the starting levels of the learners.

The conclusions were, quality of programmed materials apart, certain variables were important in controlling the successful use of programmed materials as teaching instruments, viz,

1. Second language difficulties
2. Problems of acculturation and vocabulary
3. Pupils' study habits
4. The teacher and method of teaching
5. The pupils' socioeconomic background

The report states that the problems of implementation of programme learning were human, and not merely directed by patterns of education, and that the need was to match the programmed instruction to the teachers and the pupils as they were, not as one would like them to be.

## Report

A recent review of fruitful areas of research and sponsorship in education in developing countries notes the potential of programmed materials in coping with teaching when the supply of suitably qualified teachers are in short supply (World Bank, 1972). There was a stage in the development of programmed learning when the presentation techniques rather than the underlying principles seemed to offer an answer to the problems of teacher shortage.

It was in this vein that after preliminary discussions at the Ottawa Commonwealth Education Conference the British Government sponsored a research project into the use of programmed material in West Nigeria from 1966 to 1969. The project was based at the University of Ibadan, Institute of Education and its aim was to assess how far programmed materials might be useful in overcoming some of the difficulties that arise from the shortage of suitably qualified teachers in mathematics and science. Earlier work had been done by UNESCO workshops in Nigeria and Jordan which had suggested (Schramm 1964) that in this role programmed instruction was more likely to succeed in developing countries because "introducing the new media into a relatively new and rapidly growing system is not accompanied by the same restrictions as introducing them into a well developed system where patterns of education have hardened..."

The Project was at all stages hampered by the fact that it was conducted in Nigeria during the Nigerian Civil War. Though the area used was physically involved in the conflict to a very slight extent there were, nevertheless, constant psychological and administrative pressures which tended to disrupt the organisation of the development and use of the programmed materials. From the beginning it was accepted that it would be impossible for the project to run at its originally planned level, though it was able to maintain a team of four researchers for a large part of the two year period.

### The plan of action

The plan adopted was to develop a number of programmed texts in biology and mathematics for use with 3rd year secondary school pupils and then to evaluate these in a wide range of situations, and attempt to assess how far the programs achieved their objectives. At the same time through concurrent assessments of the attitudes and the background characteristics of pupils there was to be an attempt to determine what variables were important in controlling the success of the programmed materials as teaching instruments. It was decided to concentrate entirely on paper and pencil presentations of programmed materials because this was the cheapest form to produce, it could be used in all schools and it matched the type of programmed material that was already available for use in West Nigeria. In fact, the layout of the programmed texts was very traditional in the strict allocation of space to each frame, but the aim was to produce the materials in a form that could be readily copied and used by an educational establishment in the country. It did not involve the use of unusual or expensive reproduction facilities. Teaching machines were not considered - other than as novelties - because of their expense and maintenance problems and the fact that they would not be able to be used in many schools, certainly not in representative establishments.

During the period when the project programs were being developed an attempt was made to try out a wide range of commercially available programmed texts at secondary school level in order to assess how far pupils were able to learn from them, to see what particular difficulties were associated with their use, both for pupils and teachers, and to gauge the level of teacher interest. Most important, these trial uses were to see whether much could be learned which would be of importance in determining the form and method of use of the project programs.

### The use of published programmed materials

Most of the programs selected for use were available for purchase in shops in West Nigeria and some were already known to teachers. In one case a program had been used for some time in a Technical College.

The trials with these programs were as a result of requests from teachers following a lecture tour by the Project Director. More requests were received than could be met, and only thirty evaluations were successfully completed; but all did provide insights into the problems of using programs within the prevailing West Nigerian secondary grammar school context. No attempt was made to dictate how a teacher should use a program. With the exception of requesting that pupils should be tested before and afterwards the teacher determined the timetable and mode of working - with one or two exceptions where programs were 'doctored' for experimental purposes or when differential comparative modes of use were under investigation. Through 'normal' disruptions to teaching a considerable but not unexpected loss of data were experienced.

The types of schools ranged from small bush grammar schools with only the first two years operating, to stable long-established large grammar schools with many of the Country's leaders among their former pupils. The schools were selected from throughout the West State, several being over 120 miles from Ibadan.

It was particularly noticeable that the pupils' attainments were very dependent upon the administrative arrangements adopted by the teacher and by the amount of verbalising expected by the program. A mathematics program when used with a degree of teacher involvement (checking pupils answers to subtests) was successful in two widely differing school environments. When used in a teacher-substitute role, toying along with two other programs to provide the only mathematics teaching available to pupils in the first three years of one school, the amount of learning was negligible. A chemistry program was very well managed by one trained teacher on an individually paced basis with pupils reporting to the teacher at regular intervals for check tests. An untrained school leaver was able to take over this systematic use as a complement to his normal teaching, though, as with his predecessor, only with frequent assurances that the method was in fact working. Two equally verbal Geography and Physics programs, which presumably needed this degree of systematisation, failed when used without, and pupils resorted to copying rather than attempting to cope with the verbal juggling expected by the programs through their constructed response formats. These two programs were in a school whose administration was frequently disrupted by shortages of staff, and of pupils (who had not paid fees), and was also at one point closed by the Ministry. The programs accentuated pupil differences within the classes and thus made it difficult for teachers to organise on their own an effective method of using the programs which did not substantially change (in the way described

for the chemistry program above) the way in which they normally organised their classroom.

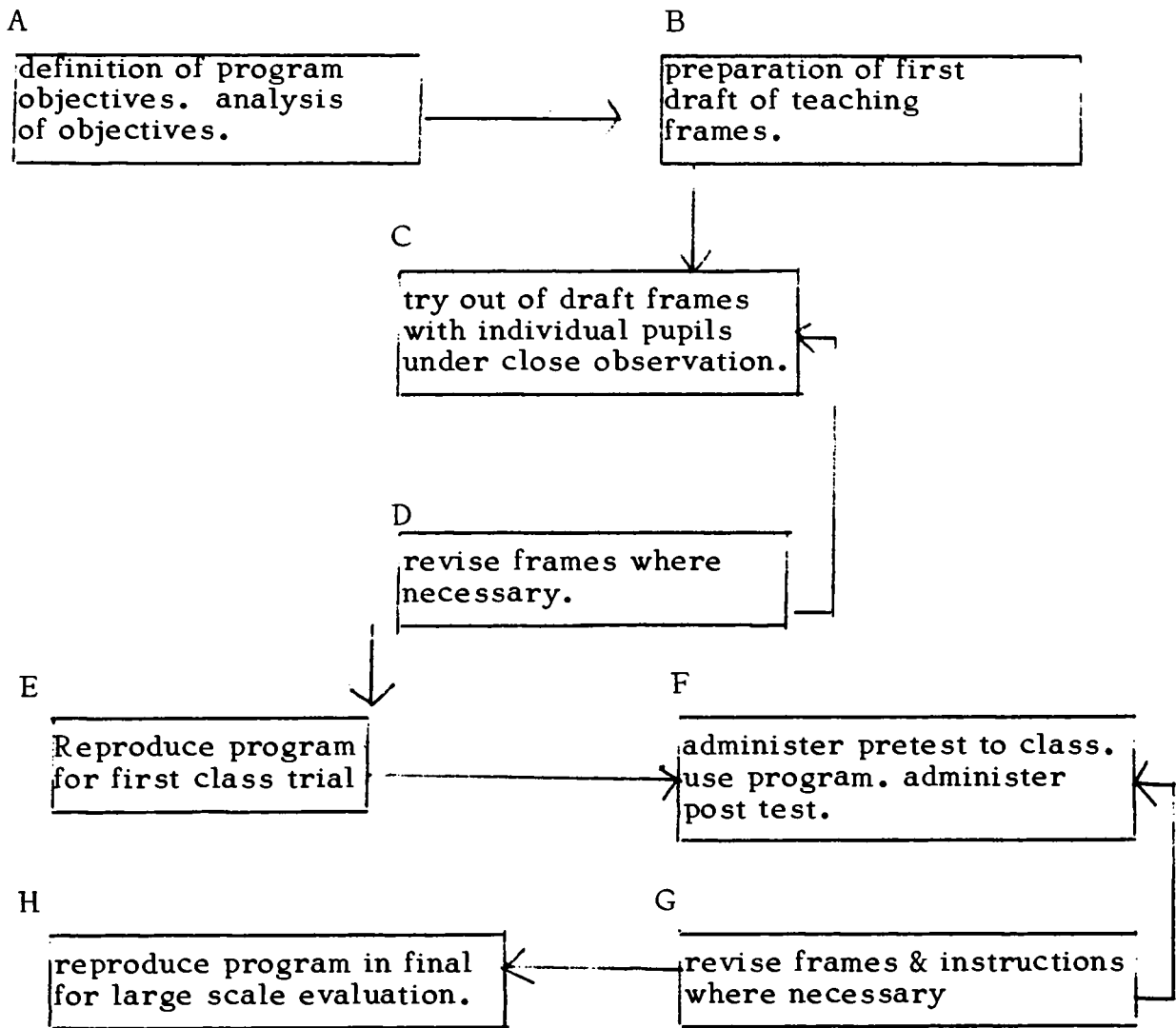
The brief description can only highlight one or two points and make reference to but a few of the evaluations. The overall picture with the commercial programs is one of very mixed attainments. In some schools programs did well, in others quite poorly. Successful performances were achieved where programs were used with a degree of participation by the teachers in the pupils' learning from the program (and thereby changing, intentionally or otherwise, from their normal whole class approach to teaching to a more individualised arrangement). This was done in two ways:

- (1) by integrating practical activities with the paper and pencil learning from the programmed text. In two physics programs experiments were done by pupils at intervals and as was appropriate to the learning sequence. In a geography program pupils modelled contours in clay. In a sequence on seeds pupils were required to make close observations of specimens.
- (2) by requiring pupils to report at intervals for the checking of tests at the end of sections of the programs.

It is undoubtedly true that many of the programs which were tried turned out to be quite unsuitable for the Nigerian pupils. The examples chosen and the language used were often unsuitable - though not necessarily any more unsuitable in this respect than many of the school textbooks in regular use, and the use of some was discontinued because it was obvious that pupils could not obtain any real benefit from continuing with them.

### Design of Project Programs

Five programs were produced and four were used in large scale evaluation. The topics chosen had to match the abilities and interests of the programmers and the availability of schools to try out programs in given topics. The programs used were on Polygons and Parallel Lines in mathematics and Osmosis and Water Relations of Plants in biology. In their preparation all were subject to the same process of try-out and revision with a number of individual pupils and then with one or two class groups. The stages are shown below:



The class trials for the first program were done with a duplicated form of the program but for all the others the programmed frames were put onto overhead projector transparencies and used in an externally paced fashion rather than allowing every pupil to proceed at his or her own rate. The reasons for adopting this approach were: (1) it was cheaper and quicker to produce the transparencies than to duplicate and assemble booklets; (2) the programs required pupils to manipulate shapes or examine specimens, and it was easier to supervise these activities and note difficulties and any need for change when all the pupils were at the same stage; (3) where two class trials were conducted on consecutive days it was relatively simple to alter the frame sequence on the basis of the first trial and thus try out a revised version with the second class.

In the final form the programs were duplicated using an ink duplicator on foolscap paper and were supplied with full details of the objectives and method of use, the materials required and a brief account of the trial results. Answer sheets were supplied for use in the program

evaluations so that the research team obtained feedback on the responses of pupils to individual forms and sections of the programs.

The earlier work with the published programs suggested that the programs should be designed to investigate a number of specific features:

- (1) Because of the obvious concern of pupils about the provision of answers in the programs and the ease of cheating it was decided to produce programs in versions with and without answers, with only some answers, and with answers embedded in frames and not specifically labelled as 'answers'.
- (2) It had been observed that pupils had difficulty with certain forms of constructed, completion-type responses, and in one mathematics program versions were prepared which were (a) mainly multi-choice; (b) mainly constructed response; (c) an 'optimum' mix of multichoice and constructed.
- (3) Not all schools had facilities for pupils to do practical experiments, or were willing to allow practical work below the certificate year, and so the biology programs were provided with simulated paper and pencil practicals based upon photographs and drawings. The intention was to see how far pupils suffered from the use of these compared with actual practical work.

### Results of Using Project Materials

In nearly all evaluations the programs produced a significant amount of learning but there were big differences between schools both in amount learned and in starting levels. None of the programs enabled all the pupils to achieve all the objectives but many of the pupils did not have all the necessary prerequisites.

The programs did not consistently increase or decrease within class heterogeneity. There was no obvious levelling-up effect. One program might appear to accentuate class differences and another reduce them. The changes that were brought about were undoubtedly due to factors other than could be attributed to features of the programmed sequences. In some cases there were consistent differences between the performance of boys and of girls.

The experimental investigations of the effect of providing answers to the programs provided significant differences within schools between the versions with answers and without answers but no consistent pattern of differences. There were significant interactions between the provision of answers and the form of responding (multichoice versus constructed), and between the provision of answers and the provision of practical experience; but differences between schools as to the nature of this interaction. Thus, though these program variations and the modes of answering or methods of use were important determiners of pupil achievement, they themselves interacted with school factors such that there were no general conclusions to be drawn.

From attitude questionnaire data it appeared that the programs were favourably received. Differences were observed between pupils which could reflect the relative convenience of the programs. The most notable feature of the attitude data was the concern about the answer provision. Though there was no significant relationship between the provision of answers and achievement there was an obvious one between the provision of answers and 'cheating', and the provision of answers and pupils' concern about the ease of cheating.

It was concluded that in addition to the undoubted effect of the quality of the programmed materials the following five factors had an important influence on their successful use:

- (1) Second language difficulties: The performance of the pupils on the program post tests were correlated with the scores on a test of English sentence structures, and it therefore seemed possible that programs which used completion items were liable to induce the acquisition of mere verbalisms, vocabularily without content. The pupils viewed the Project programs as easier to read than conventional textbooks.
- (2) Problems of acculturation and vocabulary: Second language vocabulary is notoriously narrow and words have a very small range of meanings. Thus many of the 'prompting techniques' that were originally used in programming are ineffective. The correct interpretation of photographs and diagrams could not be assumed. During the development of the Parallel Lines program pupils had difficulty in manipulating templates and in relating a small labelled diagram in the program to a larger version on a worksheet, and both to an even larger image projected on a screen. It may well be that the observed lack of significant differences between the 'practical' and 'nonpractical' uses of the biology programs were a reflection of the pupils' lack of experience in making observations from both real apparatus and diagrams.
- (3) Pupils' study habits: Where pupils are used to equating learning with the rote memorisation of written material and of competing for answers, it is unlikely that the provision of answers to frames will necessarily facilitate learning. Unfamiliar layouts would appear to have an effect on the rate of working, and any future programming in developing countries must consider format. There was no evidence that the use of selfpaced programs reduced the time taken to teach a topic; the reverse would seem likely unless a style of presentation is developed which de-emphasises the need to recall factual content expressed verbally.
- (4) (The teacher population and the methods of teaching: In no school could it be guaranteed that the arrangements made for the use of a program would be allowed to continue uninterrupted. In no school could it be guaranteed that the teacher in charge of a class would occupy the same position one or two months later, and, thus, the most important influence on a pupils' academic achievement was probably not the quality of the instruction. The lack of consistency in class population and organisation increases the disparity between the good and poor pupils which the programs tend to increase still further. Thus, a teacher who was relatively inexperienced or worried about

discipline was likely to be unhappy about the selfpacing and individualising nature of the programmed instruction.

- (5) Pupil socioeconomic background and the stability of the pupil population: There is an obvious close relationship between the attendance, the attainment on the programs and the home background of pupils. The effect of this is likely to be most marked in the more heterogeneous classes which are more usually in the poorer schools where time-tables are most frequently disrupted and where teachers with experience and ability are most scarce.

In conclusion, therefore, the optimism of Schramm and others which typified opinions at the time of the promotion of the Project was found not to be justified, in that the problems of implementation were human and not merely directed by the patterns of education, and, as is reported elsewhere (Roebuck, et al., 1972), the need is to match the programmed instruction to the teachers and pupils as they are not as we would like them to be.

This brief report merely touches upon some of the findings of the research conducted by the team at Ibadan. Expanded comments on aspects of the work are available elsewhere (Roebuck 1968, 1970, 1972), and the author will be pleased to supply further information to interested persons. In writing this description of the work the author is very much aware of the debt owed to his colleagues in Ibadan, S.O. Adewakun, T.A. Balogun and T.N. Omotoso, and to the Overseas Development Administration and the University of Ibadan for the help received during the duration of the Project.

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