Programmed instruction: an experiment with a programmed text: self-pacing versus group pacing

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Programmed Instruction

An experiment with a programmed text: self-pacing versus group pacing.

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Previous research in the field of programmed instruction suggests that with groups of homogeneous ability moderate pacing is no less efficient than a self-paced rate of working. To investigate the effects of pacing on hetrogeneous ability groups 180 first year Secondary Modern School children from three schools (I.Q. range 75 - 125 Raven's Progressive Matrices) were randomly assigned to self-paced, moderate paced and fast paced groups to work a programme in physical geography.

Raw gain scores on post-test and retention test, analysed by means of a two-way analysis of variance in which the contribution of schools differences to the variance was eliminated, showed the overall difference in variance among methods to be significant ($P < 0.05$) on immediate post-test. The significance of differences between individual methods, estimated in a series of t tests, confirmed the prediction that self-pacing and moderate pacing would not differ significantly, and that both these methods would be better than fast pacing ($P < 0.02$ in each case). On analysis of retention test scores

after an interval of four weeks, these differences among methods were not maintained. Re-analysis on a reduced sample in a three-way analysis did not reveal any tendency for high or low ability, defined in terms of I.Q. scores above or below the median, to have direct influence on scores on post-test or retention test, nor to interact significantly with other factors in the analysis.

These results suggest that in programmed instruction externally imposed pacing may provide a means of overcoming differences in ability within groups. There is also from these results, some reason to question the assumption that self-paced rate of working is necessarily the ideal. The need for further investigation into long-term retention would seem to be indicated.

PROGRAMMED INSTRUCTION

An experiment with a programmed text: self-pacing versus group pacing.

by

Barbara F. Hope

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C H A P T E R I

INTRODUCTION

It could be argued that at the heart of most discussions of an educational nature there lies a tension between the importance attached to facts and values. As Peters (1966) (1) has pointed out, education is concerned very much with initiation, but also with respect for persons. Ideally, both aspects are presumably in harmony, but, it is reasonably clear that proponents of particular theories or methods in education tend to be emphasising one or the other. In society generally the same kind of dichotomy is revealed in the continuing dialogue concerning the benefits which accrue from our industrial civilisation and the dangers which are seen to militate against a quality of human living. Whatever the truth might be concerning earlier eras, since the Industrial Revolution there has undoubtedly been a situation in which both the material advantages accrueing, and the possibility of dehumanising attributes, have been starkly revealed. Thus while some are mentally orientated in such a way, that they stress the advantages of division of labour and mechanisation, others, no less sincerely, tend to be primarily concerned with the dangers which they see as a threat to the quality of life. Perhaps, nowhere is this difference in outlook more in evidence than in discussions concerning teaching, and it tends to be, perhaps, focussed particularly clearly in the area of programmed instruction.

The entire controversy surrounding programmed instruction appears to be fraught with the emotional overtones and sometimes quite deep prejudices, deriving from the association of words such as 'machine' and 'automation' with the possibility of the debasement of human value. Some teachers feel that both the intrapersonal qualities and inter-personal relationships, which lie at the heart of the activity of teaching, are under threat. While clearly recognising the potential validity of such fears, Blyth (1960) (2) cogently argues that, "Fortunately the mechanisation of the media of communication has not mechanised the minds of those who have something to communicate.", and adds that, "no more will the mechanisation of the method of presenting instructional materials mechanise the materials to be presented". He concludes that, ultimately, the widespread introduction of programmed instruction into schools will depend not on "an emotional reaction to a word", but, on its demonstrated validity as a means towards both the solution of educational problems and the development of more efficient teaching.

The crux here, is probably to be found in what is ultimately meant by efficient teaching, which is under continual review. The concept of programmed instruction has already evolved considerably in a relatively short period of time. The early programme was

narrowly defined as a specific form of text, presented in a book or machine, through printed frames, to which responses were made only by filling in blanks. The situation today is such that Leith, (1968) (3) can insist the programmed learning is a set of techniques "for so preparing and arranging learning tasks that the aims of teaching will be achieved.", and continuing, "There is no reason why programmed instruction should be confined to linear and branching models and solely to verbal materials. The materials may be films, television, practical work, language laboratories, personal teaching, paper programmes, models, or any other techniques, alone, or in combination, so long as they can be revised and improved as a result of preliminary trials."

This is not to imply that the mere use of multi-media will act as an educational deus ex machina, but that the use of such media can be combined with the basic principles of programmed instruction to extend programme goals, methods of programming and discussion on the application of programmes. If Leith is right, the situation becomes one in which programmed instruction can be seen more in perspective.

Much of the early research into programmed instruction and its application was in the fields of industry and the Armed Services, but, as a result of broader interpretations of presentation and

response mode, its extension over a wider educational field no longer lies in the realms of mere theoretical possibility.

Goals are changing. No longer is subject matter confined to mundane topics but what was considered the impossible is being programmed (Klaus 1963) (4). In its early stages it was agreed that programmed instruction would be beneficial wherever extensive practice with rote materials was required. Work on the use of programming for elaborate concepts, aesthetic judgment, creativity or similar skills is in progress. Programmes designed to establish inductive reasoning, creativity, and problem-solving behaviour are being studied intensively at various research centres.

Initially the only approaches to programming were those of Skinner and Crowder but many variations have been developed and are being evaluated. One such variation is Mathetics (Gilbert, 1962) (5), which uses an exercise model with a backward build-up procedure. Because re-inforcement comes from the completion of the task, this is where the sequence begins. In a 'chain' or sequence of actions to be learnt, the first response the student learns should be the last one in the chain, and then the one next to the last, and so on until the entire chain has been taught. For example, in a manual skill, such as tying a shoelace, a child is presented with a bow almost completely tied, but not yet tightened,

and has to tighten it. When he is able to do this he is presented with a more loosely tied knot and again tightens it. The process continues, with his completing a longer segment in the chain until he is able to start with completely untied laces and to tie them. The application of this principle means that a student always knows 'where he is going'; he knows why he is learning the next step. It provides not only motivation for the next step but also considerable opportunity for practice and review.

Another systematic sequencing approach, called spiral programming, covers a variety of subjects at a superficial level, with a review after each topic. The programme sequence then spirals around to a second more advanced level for each of these subjects preceded by a review of the first level. The cycle is continued until the most advanced levels for all subjects have been completed.

Mager (1961) (6) found adult learners allowed to generate their own programme sequence by asking questions of their instructor, developed content sequences which bore little resemblance to conventionally written 'logical' sequences of the same topics. Motivation among the students receiving the treatment was high. The teacher was in effect simulating an information-retrieval system at the students' disposal. System Development Corporation (SDC) is looking into the possibility of adding an information-retrieval

adjunct to its computer-based teaching machine.

An intermediate evolution towards an information-retrieval teaching system is the complex branching programme. Test questions are spaced throughout the programme and if the student makes errors on the questions he is transferred to remedial items. This branching to different material occurs not only on the basis of errors but also in response to the students' taking an excessive period of time. In this case they move to less difficult items that approach the topic in a different manner. Students are also asked to evaluate their own progress and if they indicate they are in difficulty they are branched to lower levels or repeat previous items.

In the field of computer-controlled systems in this country Kay (1968) (7) suggests that investigations "have been conspicuous in ideas but, with one or two exceptions, inconspicuous with computer hardware".

In discussing changing methods in research on programmed instruction Silberman (1963) (8) sees the hypothesis-testing model, even if it does produce significant results, as useless in extending the use of programmed instruction in schools. Teachers need information that will facilitate practical decision making in choice of programme for classroom use and that will also make it possible

to take into account their own preferences and biases. Markle, too, (1967) (9) made a similar point when she called for literature about programmed instructional materials to concentrate on its behavioural analysis, standards and quality control.

Silberman considers that the formal experiment should be increasingly preceded by a phase of exploratory research, where the investigator attempts to identify the variables most important in determining student learning performance. At this stage detailed or elaborate experimental design and procedures for control group comparisions are not important. The later stages of research, where successive revisions carry forward any discovery on the basis of empirical data from repeated trials, enables the conversion to what he terms a "tangible product". In such research he sees the means of bridging the gap between laboratory and classroom.

In the main, research in Britain upon the significant variables in programmed instruction has followed a course similar to that in the United States. Although, Kay (1968) (10) in an admittedly brief review of programmed learning, remarks that some of the developmental work in this country has been characterized by more individuality of approach than is often realised. Much of the early interest in Britain was in the development of the self-correcting system with the promise of gradual improvement upon its initial performance

(Pask 1960) (11). As to the future, the views of Silberman in 1962 are echoed by Kay in 1968 in Britain, when he sees computer controlled studies as providing significant contributions to the understanding of teaching procedures.

It is particularly Sime (1964) (12) who brings one back to the realities of the school situation as it is in the present. He makes the important point that programmed instruction is a method, which, even though not perfect, provides the means of seeing when and where teaching has failed. He suggests that in the more primitive methods of programming, as contrasted to the sophisticated adaptive systems of computer-assisted learning, there is a medium through which, for the first time, "it is possible to exercise a significant degree of control over learning in a 'real life' as opposed to a laboratory setting". He maintains that the findings from such experiments with various teaching techniques make possible the development of better teaching systems.

The issues and problems change. We have passed through, what Green (1967) (13), describes as the "dark ages" of controversy, over such questions as the merits of one rigid system over another, the necessity for overt responding and the desirability of small steps. Despite such developments the widespread introduction of programmed instruction in schools is progressing slowly. It could be, that

implicit in the system, are factors which militate against its acceptance in schools which are still often dominated by a rigid system of time-tabling. Lange (1967) (14) describes the typical school curriculum as being organised into blocks of time in which the time of instruction is held constant while performance varies widely. On the other hand in programmed instruction the opposite holds, with performance held constant and time varying.

One such factor could be in what is frequently asserted to be one of the principal benefits of programmed instruction. That is the opportunity the system affords for the pupil to work at his own pace. When it comes to the question of accepting and integrating programmed instruction into a school syllabus this basic principle of the system can be seen in one sense as its strength but in another as a considerable weakness.

For the student the advantages of proceeding at his own pace seem obvious. In a conventional school organisation, the difficulties of any large class with individuals progressing at what may be widely divergent rates, are also clear. It is a departure from the traditional teacher-paced method. Though Infant and Junior schools have adapted themselves to individual or small group rates of working, the adjustment at other levels could be more difficult, particularly within the framework of a rigid time-table.

From the administrative and organisational point of view the idea of pupils working through a programme at a controlled pace is attractive. Of importance educationally is the view of some psychologists who suggest that students working at their own pace may not, for a variety of reasons, operate at an optimum rate. They may not even know what is the best rate for them.

Galanter (1959) (15) refers to the problem and suggests that time pressure would seem a "valuable addition" in the design of a machine. He suggests this would appear reasonable as "an important element in many verbal skills is a certain speed of performance". He sees the ideal, not as a completely machine-paced approach, but as an adaptive system whereby an optimum time of working, computed by the machine from the student's time of working, could be incorporated into its operations.

Glaser (1963) (16) has made the point quite strongly that programmed instruction provides an opportunity for not allowing students to work at their own speed. He sees 'pacing' as a means of insuring that students both learn at a fast rate and learn to work at a fast rate whenever desirable. Leith (1964) (17) suggests that some pupils at least, may produce better work if they must actively keep up with a forced pace of responding. Kay (1968) (18) feels that it is practically impossible for a student to be able to determine a

learning time that is the most advantageous for him. Hartley (1968) (19) suggests that because of internal and external pressures it is unlikely that a student working on his own will work in the most reliable or efficient way.

The question of an externally imposed rate of pace on working as an alternative to a self-paced rate takes one naturally into the field of the group presentation of material. Again, from the administrative point of view, group presentation is an attractive proposition, if only for economic reasons. Of far more importance are the educational indications that paired or group learning in a variety of situations is superior to individual learning. (Hartley, 1968) (19) from a survey of experiments conducted previously, concludes that programmed instruction provides no exception to this, and states that learning in pairs or groups may have definite advantages.

While considerable further research is undoubtedly necessary before one can feel committed on this point, it is nevertheless clear that there are indications that group working at an externally imposed rate has definite advantages. If this is so, the apparent dichotomy between educational needs and organisational requirements mentioned earlier, may well be susceptible to reconciliation.

Evidence of the effects of externally imposed pacing in the

field of programmed instruction is at present limited. Nevertheless the results of studies conducted so far would suggest, that if groups are homogeneous in ability and previous knowledge, a controlled pace of responding will not lower achievement. Frye (1958) (20) used a linear programme to teach mathematics in a College of Education. He assigned individuals to groups according to similarities for characteristics such as ability and experience. The group instruction material was presented on slides in a group-paced manner, at a rate established by the slowest learner. The results indicated that students of homogeneous ability work as well whether they are externally paced or self-paced. Feldhusen and Birt (1962) (21) administered a short programmed task to students on the subject of teaching machines and linear programming. One of several conditions considered was control of rate of working. They found no difference in results between this controlled group and the self-paced group. Fry (1960) (22) gave controlled pace instruction, using large scale flash-cards to teach Spanish words and phrases. There was apparently no difference between self-paced learners and the flash-card group on a criterion test.

The dangers of assessing such investigations as indicative of the efficacy or not of externally imposed pacing are crystallised by Hartley (1968) (23), when he points out that in most such

investigations the group presentation of material is implicit. The group situation creates social effects which in themselves are important. In the context of such studies, as quoted above, group interactions and group pressures may mask the effects of pacing. The effects of group presentation and pacing may be interdependent. He also points out that much of the material used for group presentation was initially prepared for individual working.

In these circumstances the question of method of presentation becomes a major problem. Several methods have been adopted, including filmstrip, filmstrip and tape, overhead transparencies, television, an Auto-Tutor Mark II, and a linear programme, adapted so that all could contribute. Where such methods are used and the groups are unpaced, all students respond before the material advances to the next frame. This means that the pace of working is the rate of the slowest student on any particular frame. This is a problem, not merely of wasted time, but of the group pressures and interractions that may result. Such pressures and interractions could affect the slower student by creating greater anxiety and the faster workers by a loss of motivation and the onset of boredom. In such instances it would appear that homogeneous groups would progress more efficiently.

Another difficulty in assessing the results of studies lies

in the fact that some experiments have considered controlled pace only incidentally, while their primary concern was with other variables. Such a series were the California studies with the Monitor-Teletest Communications System, reported by Corrigan (1964) (24). Their prime concern was with the efficacy of a feed-back system. They found group-pacing to be effective; but results were improved when group-pacing was coupled with the student feed-back implicit in the Teletest System.

Despite the difficulties inherent in assessing the results of such studies it is important to consider the investigations so far carried out. For convenience these experiments, concerned with the effects of pacing, can be divided into two groups. Firstly there are those that have employed the group presentation of material. This has usually meant that students have worked in groups, reading from a central display of material. The second group are those where self-pacing has been compared with externally paced individual programmed instruction. Hartley (1968) (25) makes the point that this distinction is difficult to sustain, as in the studies he reports there was no interraction between the students in the group situation.

In ten studies concerned with the group presentation of material nine reported no significant difference between paced groups and

self-paced working on test results. In the tenth experiment, Gropper and Kress (1965) (26) found that their slow pacing rate was the most efficient. Eighth Grade Secondary children worked a programme on electricity that was presented on slides. They were divided into slow, medium and fast groups. The fast rate of imposed pacing was equal to the self-paced rate of working. They do not indicate how the 'slow' and 'medium' rates of working were determined, nor do they give the numbers involved.

Nine other studies reported no significant difference between paced groups and self-paced working. Of these, Fry (1960) (22) as discussed previously, taught Spanish vocabulary to secondary children using flash cards, but the display time is not reported. Lewis (1965) (27) used film strip and sound for presenting 'The Analysis of Behaviour' to University students. The forced pacing was "experimenter controlled", but the means of determining the rate are not given. In the other investigations the forced pace of working was in some way determined from the students' rate of working.

Feldhusen and Birt (1962) (21) told the college students, who worked a programme on teaching machines and linear programming, to move on to the next frame at a mean rate for that frame, which had been previously determined. Heimer (1963) (28) used filmstrip for

presentation of material and Greenhill, Lottes and Pagano (1963) (29) used television to teach algebra to University students. In both cases the mean time taken by previous students on a frame, formed the basis of working time. Lottes, Palmer and Oakes (1963) (30) also taught students algebra but using filmstrip to present slides at 80%, 90%, 100% or 110% of a base time that had been determined previously. Three experimenters used slide projectors for the presentation of material where the pace for each frame was computed from the time taken by sixty per cent of subjects to respond, plus a fraction (20% - 60%) of this time. Lewis (1965) (27) used this method in teaching logarithms to secondary children. Moore (1967) (31) used the same in teaching quadrilaterals to primary children and, at the other end of the scale, in teaching physiological psychology to University students.

The material taught varied, the age of the subjects ranged from primary to university level, methods of presentation and pacing were diverse, but in only one case out of ten reported, was there any indication of a significant difference between self-paced and group-paced working, on the basis of test results.

There are even fewer studies that compare self-paced working with externally paced instruction where students work individually. Four, out of five reported, indicate no significant difference on

test results for the two conditions. The exception was the report by Gallegos (1966) (32). One hundred and ten University students were split into high and low ability and randomly assigned to fast, slow and self-paced groups to learn Spanish writing. The machine advanced at a fast rate determined by the mean time per frame for high ability students. The slow rate at which the machine advanced was the mean time for low ability subjects. Under these conditions it was found that (1) self-pacing was better than fast pacing for low ability subjects, (2) self-pacing was best for high ability subjects, (3) slow pacing was best for low ability subjects. A comment must be made that in considering low ability university students one is using the term 'low ability' out of its usual context and if the same criteria were applied in a secondary school situation 'high' and 'low' ability would produce very different levels of ability. This highlights a problem of such experiments. The inferences that may be drawn are valid for small specialised populations and it is not merely dangerous to try to generalise from them, it is impossible to do so.

Silverman and Alter (1961) (33) also investigated with university students. The subject matter was basic electricity. Optimum rates of working for two paced groups were determined by preliminary testing. They found no significant difference between

the groups on test results. Dodd (1965) (34) working with apprentices paced them at a speed based on the average of fast workers in the self-paced condition. The programme was concerned with types of milling cutter. No significant differences between groups were shown.

Hartley (1968) (35) gives details of two experiments with primary children. One with a programme teaching word recognition and the other sentence structure. In each case the machine advanced at the mean rate of previous subjects. In neither case were significant differences reported.

The results discussed suggest that moderate pacing is certainly no less effective than self-pacing. In terms of time, pacing is certainly favoured, depending on how the rate is determined. The time taken is usually the mean time (or below) that taken by individuals. At present there is relatively little evidence on which to base opinions but what there is suggests that there is no real support for the position that asserts that self-paced working is the ideal. Rather, what evidence is available appears to favour some form of externally imposed pacing on rate of working.

In the light of these findings, strengthened by the opinions of some psychologists, the present investigation aims to enquire into the effects of moderate pacing and faster pacing. In an attempt to isolate the effects of pacing from interrelated group

pressures, and because the programme concerned was prepared for individual presentation, the three groups worked individually through the programme; there was no group presentation of material.

The children concerned in the experiment were of mixed ability and assigned to treatment groups randomly, as the programme had been written for a mixed ability group. This may be at variance with the suggestion that for homogeneous groups pacing is effective. On the other hand Stolorow (1961) (36) takes the position that there are two important trends that need to be verified and developed further by research. "The first is that aptitude differences tend to lose their predictive value when more efficient methods of teaching are used. Consistent with this finding is the observation from a variety of sources that individual differences tend to be reduced with programmed instruction. The tendency is for lower ability individuals to achieve more and thereby to become more like higher ability groups in their performance on a programmed learning course".

While of necessity this experiment is concerned with a relatively small sample and is in the nature of an exploratory investigation, its findings could certainly open up areas for other and further studies. If there are no significant differences in results between self-paced and externally paced conditions of

working a principle of programmed instruction, regarded by many as fundamental, is brought into question. If pacing is effective, group-paced working of a programme of instruction at an optimum rate of pacing may provide a means, in certain circumstances, of minimizing differences of ability within a group. This would have implications for the development of team teaching as the system is being developed at present in some schools.

The work of earlier experimenters discussed previously, would seem to indicate that with mixed ability groups a moderate rate of externally imposed pacing could be as effective as self-pacing in terms of results; but that a fast rate of externally imposed pacing would not be as effective as self-pacing or moderate pacing under the same circumstances.

CHAPTER II

THE EXPERIMENT

Method

To examine the differences in the results of children working individually at their own pace, children working individually at a moderate externally imposed forced pace of working and children working individually at a greater externally imposed forced pace, six sections of a linear programme on physical geography, teaching some of the concepts of weather, particularly winds and rainfall (Webb 1966) (37) (See Appendix I) was administered to one hundred and eighty eleven and twelve year old children in three neighbouring secondary schools in a small Lancashire borough.

Three equal groups learned from a linear programme and all were instructed to write their answers on a separate answer sheet.

One group, Group A, worked individually at their own pace. The second group, Group B, worked at a moderate forced pace. The third group, Group C, worked at a greater forced pace.

Subjects

It was hoped originally that all five secondary schools in the town would participate in the experiment. However, because of administrative difficulties this proved impossible and the first year intake of three schools was included. Two hundred and sixty nine children took part in the project. As the project took seven weeks to complete it was inevitable that there would be

drop-outs and the numbers completing the experiment in its entirety would be reduced. In consequence it was decided to base the analysis on three equal groups of twenty from each school, chosen randomly from those who completed the pre-test, programme, post-test and retention tests. This proved wise as drop-outs occurred, not only through absence from school but because of late arrivals at one school where the work was carried out first thing in the mornings. Time-tabling difficulties because of internal school examinations also meant that a number of children were unable to complete the experiment.

The children, ninety four boys and eighty six girls, came from three neighbouring schools: a mixed County Secondary school, a single sex Roman Catholic boys' school and a single sex Roman Catholic girls' school. They were mainly from working class backgrounds drawn from local housing estates and the neighbouring rural areas. They were all in the first year and aged on average eleven years nine months. They ranged in intelligence from 75 to 128 IQ, $\bar{x}$ 101.6, (Raven's Progressive Matrices). The mean and standard deviation of ages of children in each group are shown in Table I.

Table I

Mean and Standard Deviation of Ages of Children in Treatment Groups

	Group A	Group B	Group C
$\bar{x}$	11.10	11.8	11.9
n	60	60	60
s.d.	3.88	4.35	4.67

Number, (of children in each group) mean and standard deviation of scores Raven's Progressive Matrices are shown in Table II.

Table II

Number, Mean and Standard Deviation of Scores Raven's Progressive Matrices for Treatment Groups

	Group A	Group B	Group C
$\bar{x}$	100.95	101.38	102.86
n	60	60	60
s.d.	11.48	11.83	11.49

The subjects had no background of instruction in the concepts and terminology of the programme. They had had no previous experience of working with programmed material.

They were allocated randomly to treatment groups by means of a random number table.

Group A worked individually at their own pace, Group B worked

at a forced pace determined by the mean time taken by Group A. Group C worked at a forced pace determined by the mean time taken by the fastest half of Group A.

Rate of Presentation

Kay (1968) (38) reports that Sime in his fully automatic programmed classroom system developed a flexible means of determining the assessment of time per frame allowed for responding. The response time on each frame for a sample of students was assessed and then by extrapolation fixed the total exposure time for that frame. The example he gives is for fifty per cent of students taking x seconds to respond to the frame and the time set for that frame being 2x. In practice the system is more sophisticated as a sample of between twenty and sixty per cent is found to be more reliable, and, as it is not argued that responses are normally distributed in time, it is possible to add to or subtract from the total frame time according to the kind of material and the students making up the group.

In the present circumstances with a hetrogeneous population, IQ range 75 - 125 (Raven's Progressive Matrices) the more sophisticated system of determining rate of presentation appeared to have no advantage over the simpler method of using the mean time taken by Group A as a basis for fixing the forced pace at which Group B would work; and taking the mean time taken by the fastest

half of Group A as the forced pace rate for Group C, who were to work at a greater forced pace. All the groups were randomly allocated to treatment groups.

The time taken by each child in Group A, where the children worked individually at their own pace, was recorded. The mean time taken by this group to complete each section of the programme was calculated. The mean time per frame for each section was calculated and multiplied by the number of frames per page.

These mean times were taken as the forced pace of working for Group B.

In the same way, the mean time taken by the fastest half of Group A, working individually at their own pace and calculated section by section of the programme, was taken as the forced pace of working for Group C.

Table III shows the mean times taken to complete each section of the programme by Group A working at their own individual pace.

Table III

Mean times taken by self-paced Group A to complete sections of the programme - Forced pace of working Group B

Section	1	2	3	4	5	6
No. of frames	66	42	33	30	33	29
$\bar{x}$	29'13"	21'57"	14'32"	11'37"	12'53"	6'16"
n	60	60	60	60	60	60

Table IV shows the mean times per page taken by Group A to complete sections of the programme and Table V shows the mean times per frame taken to complete sections of the programme.

Table IV

Mean times per page to complete sections of the programme - Group A. Forced pace of working Group B.

Section	1	2	3	4	5	6
$\bar{x}$	2'38"	3'8"	2'39"	2'19"	2.20.5"	1'38.58"
n	60	60	60	60	60	60

Table V

Mean times per frame to complete sections of the programme - Group A. Forced pace of working Group B.

Section	1	2	3	4	5	6
$\bar{x}$	26.41"	31.36"	26.43"	23.23"	23.42"	16.43"
n	60	60	60	60	60	60

The pace of working for Group C was determined from the mean time taken by the fastest half of Group A. Mean times taken to complete sections of the programme by this half of Group A are shown in Table VI.

Table VI

Mean times taken to complete sections of the programme - fast half Group A. Forced pace of working Group C.

Section	1	2	3	4	5	6
No. of frames	66	42	33	30	33	29
$\bar{x}$	25'35"	18'36"	11'59"	8'16.66"	9'35.8"	5'27.5"
n	30	30	30	30	30	30

These times formed the forced pace of working for Group C.

The mean times taken per page by the fast half of Group A are shown in Table VII and the mean times per frame for this group are shown in Table VIII.

Table VII

Mean times per page to complete sections of programme - fast half Group A. Forced pace of working - Group C.

Section	1	2	3	4	5	6
$\bar{x}$	2'19.50"	2'39"	2'11"	1'39"	1'55"	1'8.74"
n	30	30	30	30	30	30

Table VIII

Mean times per frame to complete sections of programme - fast half Group A. Forced pace of working - Group C.

Section	1	2	3	4	5	6
$\bar{x}$	23.25"	26.57"	21.78"	16.55"	19.19"	11.29"
n	30	30	30	30	30	30

The Programme

The programme (Webb 1966) (37) was a linear programme constructed according to the conventional Skinner small-step model. It was constructed with seven sections. Six sections only were used in this investigation because of the limitations imposed in the time available in the schools to complete the experiment. Sections used made a total sequence of two hundred and twenty three linear frames.

The vertical format was favoured by the author of the programme for ease of assembly and the accommodation of diagrams.

The problem of cheating is often raised in connection with this format particularly where the answer to the previous frame is easily available. But as Holt (1962) (39) pointed out, evidence from his own and other studies revealed the negligible effects of cheating. Branson too, (1964) (40) confirms that there is no evidence to suggest that cheating is detrimental to learning. Leith (1964) (41) also concludes that cheating is not a disadvantage from the study of the effects of "forced cheating" i.e. where the answer is given before the response is made, where in most cases the conclusion is that cheating does not detract from learning.

In the present experiment if a child were to "cheat" by reading

the answer before making the required overt written response he would in effect be making both a covert and an overt response. He would be making a covert (reading) response before making the overt (written) response. As the investigation was not concerned with error rate on frames the question of "cheating" in an accepted sense could not really occur.

To estimate error rates on responses within the programme is an unnecessary exercise when the test results of the knowledge acquired are the concern of the investigation. For as Lumsdaine, (1964) (42) points out even responses to criterion frames within the programme, which are by definition unprompted, are not really so because of the undetermined "echoic" carry over effects within the programme context. In this experiment therefore no calculation of error rate was made.

The programme was presented in six stapled booklets and the children wrote their responses on separate answer sheets.

The programme, on physical geography, taught some of the concepts of weather in Great Britain, in particular winds and rainfall. It contained a number of diagrams. The sections used in the experiment were (1) Water as a liquid and a gas, (2) Clouds are Rain, (3) How Clouds form, (4) How raindrops form, (5) Orographic Rain and (6) Convectional Rain.

The programme had been written for first and second year Secondary Modern children. It had been extensively tested with small groups and full classes and on the basis of these field tests had been re-written with minor adjustments before use in a larger experiment with seven first year forms at a large comprehensive school in the Midlands. The topic fitted into the syllabus of the schools concerned in the present investigation and was acceptable to them as the time allocated to the experiment was time from "Environmental Studies".

The children had had no previous background of instruction in the concepts of the programme.

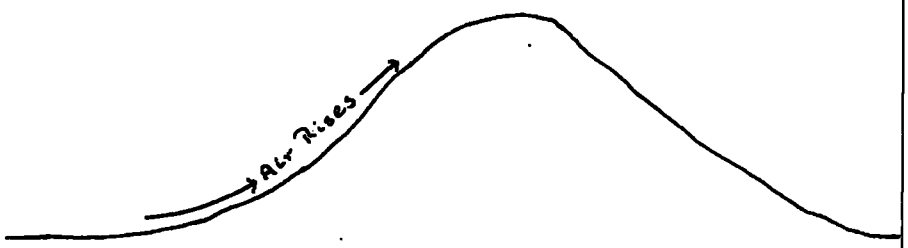
It has been suggested, Larkin and Leith, (1963) (43) Leith and Hope, (1965) (44) that a linear format where children make an overt response (writing or speaking their answers) is more successful than a linear format, where children make a covert response (reading or thinking their answers) with children of this ability range. Cummings and Goldstein (1962) (45) found that overt responding gave higher scores with a programme on the 'Diagnosis of Myocardial Infarction' involving verbal and non-verbal items and Van Wagenen and Travers (1963) (46) found that having children give oral responses in a foreign language vocabulary task, is reliably better than covert responding. This is in line with results on an experiment on teaching spelling

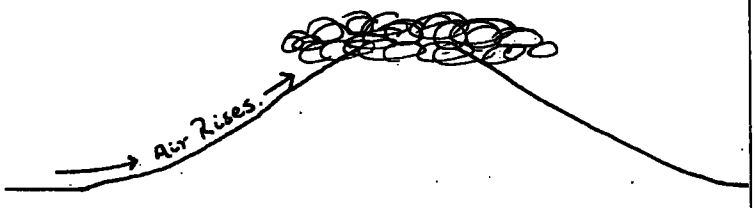
to young retarded pupils, Gordon (1963) (47).

On the basis of these findings it seems likely that tasks involving materials which cannot readily be assimilated to already existing cognitive structures require overt practice. In this instance, as the subjects had no previous background of instruction in the concepts and terminology of the programme, it seemed that this type of linear programme and this method of overt written response were the most appropriate.

Sample frames from the programme are given in Figure 1.

Figure 1

22	When air is made to rise over hills or mountains clouds form. Copy this diagram and put in a cloud. 
rise	

23	This is how your diagram should look.  In the box is the title of the diagram. Diagram showing how _____ clouds form. Write this title underneath your drawing and fill in the missing word.
24 stratus	Air rises in a very different way to form cumulus clouds. Sparks flying from the top of a bonfire and floating upwards and steam rising are two examples of the rule that warm air _____

A sample section of an answer sheet is shown in Figure 2.

Figure 2.

ANSWER SHEET	RAINFALL IN BRITAIN SECTION THREE	NAME
		GROUP
1	17	30
2	18	
3	19	
4	20	
5	21	31
6	22	32
7		33
8		

Procedure

Before the programme was administered a pre-test of 16 items, which also served as a post-test and a retention test, was given to the children. The test was made up of three items requiring unaided cloud identification, two items of diagram drawing; the remaining items were of the constructed response type (Leith and Webb (1966) (48). During the period of the experiment the children were given the Raven's Progressive Matrices Test, test scores are shown in Appendix II. The same test was given as a post-test immediately the children completed the programme and also four weeks later as a retention test. Although it would have been desirable had this interval been longer it was impossible to extend the period because of school holidays and other problems.

The programmes were administered to the three groups in school classrooms in one hour sessions, with a week between each session. In order to create as much uniformity in treatment as possible the same people administered the programme to Group A in each school, to Group B in each school and to Group C in each school.

Before the children started work on the programme careful explanation was given to each group on the layout of the booklets. Their use was demonstrated with the appropriate answer sheet.

The instructions to Group A stressed that they were to work

at their own pace. Group B were instructed that they would be told when they were to turn over the page. A demonstration of the time allowed for working each page was given before work started on each section. Similar instructions and demonstrations were given to Group C.

The children were given the opportunity to ask questions on anything about which they were unsure.

The self-paced Group, Group A, started work on the programme a week before the other two groups so that the rate of working for Groups B and C could be calculated. This also facilitated the administration of the Raven's Matrices test for I.Q. The time taken by each child in Group A to complete the sections of the programme was recorded. Each child wrote the time of starting on the answer sheet and on completing a section was told the time which was also entered on the answer sheet.

The subjects were asked to write one or two sentences commenting on whether or not they had enjoyed working the programme, on the back of their pos-test answer sheets. A selection of these comments is given in Appendix III.

The post-test and retention test were given under the same conditions as the programmes were worked.

Figure 3. Experimental Design

	Group A	Group B	Group C
School 1	20	20	20
School 2	20	20	20
School 3	20	20	20
Total	60	60	60

Numbers in Cells

Group A - self-paced.

Group B - moderate forced pacing. The mean time taken by Group A.

Group C - greater forced pacing. The mean time taken by the fastest half of Group A.

The raw gain scores on immediate post-test and retention test were analysed by means of a two-way analysis of variance, permitting an estimate to be made of the overall significance of method differences when the contribution of school differences to the variance was eliminated.

CHAPTER III

RESULTS

Results

The raw gain scores on the immediate post-test obtained by the nine experimental groups were analysed by means of a two way analysis of variance. This permitted an estimate to be made of the overall significance of methods differences when the contribution of schools differences to the variance was eliminated. The overall difference in variance among methods was significant ($P < 0.05$) on the immediate post-test. The methods X Schools interaction term was not significant. Mean gain scores for method groups are shown in Table IX. Analysis of variance of gain scores on the immediate post-test is shown in Table X.

Table IX

Mean Gain Scores and Standard Deviation of Method Groups on Immediate Post-Test

	Group A Self-paced	Group B Moderate pace	Group C Fast pace
$\bar{x}$	4.67	4.68	3.30
s.d.	3.21	2.93	2.90
n	60	60	60

Table X

Analysis of Variance of Immediate Post-Test Scores

Source	Sums of Squares	d.f.	Variance	F	Significance
Total	1757.55	179			
Between Groups	154.50	8			
Methods (M)	75.63	2	37.82	3.90	.05
Schools (S)	40.13	2	20.65	2.13	N.S.
M x S	38.74	4	9.69	1.03	N.S.
Within Groups	1602.05	171	9.37		

The significance of differences between the individual methods was estimated in a series of t tests; the results of which are shown in Table XI.

Table XI

Methods	Mean	Mean	Difference	t	Significance
i ii A v B	i 4.67	ii 4.68	0.01	less than 1.00	N.S.
i iii A v C	i 4.67	iii 3.30	1.37	2.45	0.02
ii iii B v C	ii 4.68	iii 3.30	1.38	2.47	0.02

The results showed no significant difference between Group A, the self-paced group, and Group B, the moderately paced group. The

difference between Group A and Group C, the fast paced group was significant, ($P < 0.02$); as was the difference between Group B and Group C, ($P < 0.02$). These results were as predicted: 1) that self-pacing and moderate pacing would produce results on test scores that were not significantly different and, 2) that the results of self-pacing and moderate pacing would differ significantly from the scores on test of the fast paced group.

The raw gain scores on the retention test, given four weeks after the completion of working the programme, by the nine experimental groups, were analysed by means of a two-way analysis of variance. This permitted an estimate to be made of the overall significance of method differences when the contribution of schools differences to the variance was eliminated. There was no significant difference in methods on the retention test. Neither was the methods X Schools interaction term significant. Mean gain scores for method groups on retention test are shown in Table XI. Analysis of variance of gain scores on retention test is shown in Table XII.

Table XI

Mean Gain Scores and Standard Deviation of Method Groups on Retention Test

	Group A Self-paced	Group B Moderate pace	Group C Fast pace
$\bar{x}$	4.13	3.73	3.57
s.d.	2.74	2.63	2.84
n	60	60	60

Table XII

Analysis of Variance of Retention Test Scores

Source	Sums of Squares	d.f.	Variance	F	Significance
Total	1358.95	179			
Between Groups	71.10	8			
Methods (M)	9.70	2	4.85	.36	N.S.
Schools (S)	8.23	2	4.12	.31	N.S.
S x M	53.17	4	13.29	1.76	N.S.
Within Groups	1287.85	171	7.53		

The main concern of the investigation was with groups of mixed ability but it was considered worthwhile to examine the influence of ability on post-test and retention test scores by the inclusion of ability as an additional factor.

The original sample was dichotomised at the median. The number of individuals falling into each cell of the three way classification is as shown in Table XIII.

Table XIII

Numbers in cells of Three Way Classification

		Method A	Method B	Method C
School 1	High ability	6	11	10
	Low ability	14	9	10
School 2	High ability	10	13	10
	Low ability	10	7	10
School 3	High ability	14	11	10
	Low ability	6	9	10

The unequal sub-groups thus defined would make difficult a complete three-way analysis of the data. Scores were therefore cast out at random with the aid of a table of random numbers (Snedecor and Cochran 1967) (51) to reduce all groups to six scores.

Individual scores in cells for the original population and for the reduced sample on post-test and retention test are shown in Appendix II.

The scores on post-test and retention test for the reduced sample were re-analysed in a three-way analysis (Lewis 1968) (52).

Included were high and low ability (Factor A) in addition to the factors included in the initial analyses (Schools - Factor S, Methods - Factor M). The F ratio was calculated for the main effects and first and second interactions.

Analysis does not reveal any tendency for high or low ability, defined in terms of I.Q. scores above or below the median, to have direct influence on scores on post-test or retention test, nor to interact significantly with other factors in the analysis. On retention test the Schools X Methods interaction term for this reduced sample approaches significance at the five per cent level. (F 3.86).

Analysis of variance of the gain scores for the reduced sample on post-test and retention test are shown in Tables XIV and XV.

Table XIV

Analysis of Variance of Gain Scores on Post-test for Reduced Sample

Source	Sums of Squares	d.f.	Variance	F	Significance
Total	1065.07	107			
Between Groups	157.73	17			
Methods (M)	29.23	2	14.62	1.74	N.S.
Schools (S)	19.57	2	9.79	0.97	N.S.
Abilities (A)	16.32	1	16.32	1.80	N.S.
M x S	33.60	4	8.40	0.83	N.S.
M x A	13.74	2	6.87	1.01	N.S.
A x S	18.18	2	9.09	0.90	N.S.
M x A x S	27.09	4	6.77	0.67	N.S.
Within Groups	907.34	90	10.88		

Table XV

Analysis of Variance of Gain Scores on Retention Test for Reduced Sample

Source	Sums of Squares	d.f.	Variance	F	Significance
Total	760.92	107			
Between Groups	209.08	17			
Methods (M)	10.67	2	5.34	0.23	N.S.
Schools (S)	36.17	2	18.85	3.08	N.S.
Abilities (A)	1.12	1	1.12	0.53	N.S.
M x S	94.66	4	23.67	3.86	N.S.
M x A	24.07	2	12.04	1.26	N.S.
A x S	4.24	2	2.12	0.18	N.S.
S x M x A	38.15	4	9.54	1.56	N.S.
Within Groups	551.84	90	6.13		

CHAPTER IV.

CONCLUSIONS AND DISCUSSION

Conclusions and Discussion

The hypothesis that self-pacing and moderate externally imposed pacing would not differ significantly on test results seems tenable on this evidence; as is the prediction that self-pacing and moderate externally imposed pacing would differ significantly from fast externally imposed pacing.

As the experiment was conducted in three different schools, it was in effect a series of three duplicated experiments. It was necessary therefore to be able to eliminate the effect of the three different schools when the overall significance of methods differences was estimated. The technique of analysis of variance is particularly suitable for this purpose. The raw gain scores on the immediate post-test and the retention test obtained by the nine experimental groups were therefore analysed in a two-way analysis of variance. This permitted the contribution of schools differences to the variance to be eliminated and an estimate of the overall significance of methods differences to be made. On immediate post-test results schools differences was not significant, (F 2.13). The Schools x Methods interaction term was not significant, (F 1.03). On retention test schools differences was again not significant (F 0.31); the Schools x Methods interaction term was also not significant (F 1.76).

Previous experiments, which were discussed in the Introduction, have shown that moderate pacing is as efficient as self-pacing with groups of homogeneous ability. On the evidence of this study it would appear to be justifiable to maintain that with groups of mixed ability the same proposition is also tenable.

The ability range of subjects in the moderately paced group, Group B, lay within the range I.Q. 75 - 125, $\bar{x}$ 101.38 (Raven's Progressive Matrices). The overall range of ability for the 180 subjects participating in the experiment, I.Q. 75 - 125, $\bar{x}$ 101.73 (Raven's Progressive Matrices), was the same as that for Group B. The overall mean, 101.73, was slightly higher than that for the sub-group. Mean differences in I.Q. scores among the three groups were slight.

	Group A Self-paced	Group B Moderate pacing	Group C Fast pacing
$\bar{x}$ I.Q.	100.95	101.38	102.86

(Raven's Progressive Matrices)

(Individual I.Q. scores, mean and standard deviation for method groups are shown in Appendix II).

The results on both immediate post-test and retention test for the self-paced Group A, with a range of ability I.Q. 75 - 122, and the moderately paced Group B, with a range of ability I.Q. 75 - 125,

were not significantly different. The difference in mean score on immediate post-test results was negligible, 0.01, with the difference slightly favouring the moderately paced group. (Mean gain scores for the three method groups on immediate post-test are shown in Table IX. Individual scores are shown in Appendix II).

Analysis of variance of raw gain scores on the retention test, given four weeks after working the programme, revealed no significant difference in the three methods. The difference between the mean score of Group A and the mean score of Group B (0.04), though not significant, was larger than on immediate post-test, and in this case favoured Group A, the self-paced group. On retention test Group C, the fast-paced group, had a mean score that was not significantly different from that of Group A or Group B. The mean score of Group C differed from Group A by 0.56, and from Group B by only 0.16. (Mean gain scores of all three method groups on retention test are shown in Table XI. Individual scores are shown in Appendix II).

It is interesting to note that the significant differences in methods revealed in the analysis of post-test results are not maintained on the analysis of retention test scores. On the analysis of post-test scores self-pacing and moderate pacing emerge as superior to fast pacing ($P < 0.05$). On retention test, four weeks later, no

significant difference in the three methods is apparent. However, after the lapse of time, the fast-paced group, Group C produce a mean score that is higher by 0.27, than the mean score for the group on post-test results.

Group C	Immediate Post Test	Retention Test
Mean Gain Score	3.30	3.57

It should be noted that the children had been exposed to no further direct instruction on the topic during the intervening period. This does not, of course, eliminate the possibility of discussion on the subject among the children. Such discussion could induce greater familiarity with the material and cause incidental learning to occur. It is also possible that, in the light of the knowledge acquired, they became more acutely aware of weather conditions and variations which could act as reinforcement to their initial learning. It could be that the post-test acted as a "structuring device". As a result of working through the test ideas could have become more structured, with resulting higher scores on the retention test. The most likely explanation, perhaps, is that the test itself teaches. This, of course, was the case with Pressey's well known first teaching machine. He designed a testing device and found that as a result of using it students were learning.

Although the re-analysis of scores on post-test and retention test was performed on considerably reduced sample (108 as against 180 in the original population) it would appear to support the hypothesis that for groups of mixed ability moderate pacing will not be less efficient than self-pacing. High ability and low ability were defined in this instance in terms of scores above and below the median. This meant that high ability was defined within the range I.Q. 122 - 101 (Raven's Progressive Matrices) and low ability within the range I.Q. 100 - 75 (Raven's Progressive Matrices). Individual I.Q. scores for the reduced sample are shown in Appendix II. Analysis does not reveal any tendency for high or low ability, as so defined, to have direct influence on scores on post-test or retention test nor to interact significantly with other factors in the analysis, although on retention test the Methods x Schools interaction term approaches significance at the five per cent level (F 3.86). Analysis of variance for the reduced sample on post-test and retention test scores is shown in Tables XIV and XV.

It has been suggested earlier that if groups of children of mixed ability produce results on test that are not significantly different, whether they work at their own pace or at an externally imposed rate of working, programmed instruction, where the rate of working is controlled, could provide one means of overcoming some of

the problems inherent in teaching groups that are hetrogeneous in ability. The results of the present experiment appear to indicate that this could be so.

The necessity of finding a solution to the problems of teaching mixed ability groups at secondary level assumes greater urgency as the movement towards unstreamed classes gathers momentum. As evidence accrues against the system of streaming by ability, which discriminates in favour of the middle class child and against the working class child, more schools are moving away from the system and introducing non-streamed classes, particularly in the early years of secondary education. In the light of the results of this experiment, where children in mixed ability groups working at a forced pace, show results on immediate post-test that are almost identical with the results of similar children in mixed ability groups, working at their own pace, it would seem justifiable to suggest that programmed instruction, where rate of working is controlled, may provide one solution to the problems of teaching hetrogeneous groups at this level.

By the same token, programmed instruction, at a controlled pace of working, can be seen as a means of resolving the apparent dichotomy, which was discussed earlier, between educational needs

and organisational requirements. Such a system eliminates the "inconvenience" of children's working at widely differing rates without a loss of achievement. The rate of working Section 1 of the programme (66 frames) by the self-paced Group A, ranged from 40' 00" to 18' 45". Moderately paced Group B worked at a rate of 29' 13" for this section. Group C, the fast paced group, worked at the rate of 25' 35" for the same 66 frames. A similar range in times for working all six sections of the programme was recorded by Group A. (Individual times and mean time of working each section for Group A are shown in Appendix II; as are individual times and mean time of working for the faster half of Group A. Times of working each section for Group B and Group C are shown in Tables III and VI). The differences in time of working are considerable, in many instances. Yet on immediate post-test the difference in mean score between Group A and Group B was negligible (0.01). Although on post-test the mean score for both these groups was significantly higher than that of Group C ($P < 0.02$), on retention test there was no significant difference in methods revealed on analysis of variance.

A system of programmed instruction with the added control of working rate, could be used to advantage in the team teaching

situation as it is being developed in a number of schools. A programme of instruction could be used in place of the usual lecture for the presentation of basic material. This would ensure the active participation of all the students concerned, with the greater likelihood of their acquiring the central core of information upon which their ability to pursue a topic further often depends. Control of rate of working, at an optimum rate, would not result in less efficient learning, and administrative arrangements could be facilitated. At the same time this method of presentation could prove more economical in terms of staff time and effort. Such a system could provide a situation for the introduction of programmed instruction into a school. Success with the use of a programme in this way could prove helpful in overcoming some of the reluctance towards programmed instruction displayed by many teachers.

The original plan of this investigation attempted to isolate the effects of an externally imposed rate of working in a group situation. An attempt was made also to prevent any detrimental effects which might accrue from the use of a programme that had been prepared for individual working, for the group presentation of material. Therefore, although the children were randomly assigned to Group A or Group B or Group C, and worked as Group A or B or C throughout the period of the experiment, each child worked

individually through the programme whether they were paced or not. There was no social interaction during working whichever of the three method groups they were assigned to. It seemed reasonable to give priority to the question of pacing over the problems of the group presentation of material. If an externally imposed rate of working proved to be less effective, in terms of test results, than working at a self-determined rate, it appeared that the question of any group presentation of material at such a fixed rate would be irrelevant.

The results obtained seem to indicate that such pacing at a moderate rate is as effective as self-pacing on post-test results; while on retention test scores the significant differences between self-pacing and moderate pacing, as against fast pacing disappear. The question of long-term retention is one that has tended to be neglected when experimenters have been considering pacing. Some investigations have not been concerned at all with retention tests; in others the period between post-test and retention test has been slight. In this instance the period of four weeks between tests was not as long as would have been wished for, but it was the longest time possible in the circumstances. The results of the present investigation would seem to suggest that this is an area where further research could be pursued to advantage. Long term

retention is the real concern of education. Lumsdaine (1963) (49) makes a strong case for the development in the future of a system of assessment for programmed instruction that is based, not merely on some immediate criterion of success, not even on the results of retention tests, as long as two years later, but on whether the knowledge originally gained can be easily "re-learned" whenever it is required.

That a student should work at a self-determined rate has been considered by many as a cardinal principle of programmed instruction. Whether or not this is always the ideal is open to question. Previous experiments, discussed in the Introduction, have shown that with homogeneous ability groups self-pacing is no more efficient than moderate pacing in terms of results on test. In terms of economy of time and greater ease of organisation moderate pacing has the advantage. On the results of this investigation, the hypothesis, that with mixed ability groups moderate pacing and self-pacing would not differ significantly on test results, seems tenable. That there was no significant difference in the three rates of working on retention test scores, would appear to strengthen the argument that a self determined rate of working is not necessarily always the ideal. If control over the pace of working makes it possible to create an

even more efficient system of programmed instruction, it would appear reasonable to suggest that a self-determined rate of working, is not always of the fundamental importance that it was originally thought to be. In fact, in some instances control over working rate can be seen to add to, rather than to detract from, the efficiency of a programme of instruction.

The underlying issue in programmed instruction is the problem of efficient communication. Curr (1964) (50) suggests that in the judicious use of programmed instruction may be the means of solving the fundamental dilemma in education of "improving the communication of ideas at the expense of incidental personal and social development" or of retaining, "the educative community at the cost of inefficiency in communication". The introduction of programmed learning for ease and speed in the communication of basic material can save time in which pupil and teacher can share enjoyable pursuits with greater opportunities for establishing the relationships that lie at the heart of so much "good" teaching. Programmed instruction, he asserts, "may be not only compatible with the continued exercise of craftsmanship by the teacher; it may help to prevent the teacher himself becoming a machine".

References

1. Peters, R.S., Ethics and Education. London, George Allen and Unwin, 1966.

2. Blyth, J.W., Teaching Machines and Human Beings in Lumsdaine, A.A. and Glaser, R., (eds) Teaching Machines and Programmed Learning. Washington N.E.A. 1960. p. 401.

3. Leith, G.O.M., P.L.C. Bulletin 4. National Centre for Programmed Learning, University of Birmingham. 1968. p. 1.

4. Klaus, D.J., Programming the Impossible in Ofiesh, G.D. and Meierhenry, W.C. (eds) Trends in Programmed Instruction. Dept. of Audio-Visual Instruction, Washington N.E.A. 1964 pp. 19 - 23.

5. Gilbert, T.F., Mathetics: The Technology of Education Journal of Mathetics Jan. 1962. pp. 7 - 14.

6. Mager, R.F., On the Sequencing of Instructional Content. Palo Alto, Calif. Varian Associates 1961.

7. Kay, H., Programmed Instruction in Butcher, H.J., (ed) Educational Research in Britain. London University of London Press 1968. pp. 152 - 166. p. 165.

8. Silberman, H., Trends in Programed Instruction - An Improvement in Educational Technology in Filep, R.T., (ed) Prospectives in Programing. New York. Macmillan. 1963. pp. 134 - 150. p. 142.

9. Markle, S.M., Empirical Testing of Programs in Lange, P.C. (ed) Programed Instruction, Sixty Sixth Year Book. NSSE. Chicago NSSE 1967. pp. 104 - 138.

10. Kay, H., op. cit. p. 164.

11. Pask, G., Adaptive Teaching with Adaptive Machines in Lumsdaine, A.A. and Glaser, R., (eds) Teaching Machines and Programmed Learning. Washington. NEA. 1960. pp. 349 - 366.

12. Sime, M.E., The Elements of a Teaching System in, Austwick, K. (ed) Teaching Machines and Programming. London Pergamon. 1964. pp. 113 - 135.

13. Green, E.J., The Process of Instructional Programming in Lange, P.C. (ed) Programed Instruction, The Sixty Sixth Year Book NSSE. Chicago. 1967. pp. 61 - 80.

14. Lange, P.C., Issues and Problems in Lange, P.C., (ed) Sixty Sixth Year Book NSSE. Chicago NSSE. 1968. p. 141.

15. Galanter, E., The Ideal Teacher in Galanter, E. (ed) Automatic Teaching: The State of the Art. New York. John Wiley and Sons Inc. 1959. pp. 1 - 11.

16. Glaser, R., Research and Development Issues in Programed Instruction in Filep, R.T. (ed) Prospectives in Programing. New York. Macmillan. pp. 278 - 308.

17. Leith, G.O.M., Research on Programmed Learning in Leith, G.O.M. (ed) A Handbook of Programmed Learning. Supplement to Educ. Rev. XII, 2. 1964. pp. 67 - 87.

18. Kay, H., op. cit. p. 157.

19. Hartley, J., Some Factors Affecting Student Performance in Programmed Learning. Programmed Learning and Educational Technology 5. 3. pp. 206 - 218. 1968.

20. Frye, C.H., Group vs Individual Pacing in Programmed Instruction, Teaching Research Oregon State System of Higher Education. Title VII, Project No. 847. National Defense Education Act 1958.

21. Feldhusen, J.F. and Birt, A., A Study of Nine Methods of Presentation of Programmed Learning Material. J. of Education. Res. 55. 9. pp. 461 - 466. 1962.

22. Fry, E.B., A Study of Teaching Machine Response Modes in Lumsdaine, A.A. and Glaser, R. (eds) Teaching Machines and Programmed Learning. Washington. NEA. pp. 469 - 474. 1960.

23. Hartley, J., op. cit. p. 209.

24. Corrigan, R.E., Programmed Instruction as a Systems Approach to Education in Ofiesh, G.D., and Meierhenry, W.C. (eds) Trends in Programmed Instruction. Washington. NEA. 1964. pp. 33 - 45.

25. Hartley, J., op. cit. p. 211.

26. Gropper, G.L., and Kress, G.C., Individualising Instruction through Pacing Procedures. Audio-Visual Communication Review 13. 2. 1965. pp. 165 - 182.

27. Lewis, J.T., A Study of Pacing Rate and Mode of Presentation in Programmed Instruction. Dissertation Abstracts XXV 1. 649. 1965.

28. Heimer, R.T., Comparison of External Pacing and Self-Pacing on Programmed Instruction in Mathematics Using Different Methods of Presentation in Hartley, J. Some Factors Affecting Student Performance in Programmed Learning. Programmed Learning on Educational Technology 5. 3. 1968. pp. 206 - 218.

29. Greenhill, L.P., Lottes, J.J. and Pagano, A. ibid.

30. Lottes, J.J., Palmer, G. and Oakes, H. ibid.

31. Moore, D.L., Group Teaching by Programmed Instruction and Educational Technology. 4. 1. 1964. pp. 37 - 36.

32. Gallegos, A.M., A Study and Comparison of Experimental Pacing and Student Pacing of Programmed Instruction, Dissertation Abstracts. 27. 3. 702 A.

33. Silverman, R.E. and Alter, M., Response Mode, Pacing and Motivational Effects in Teaching Machines in Evans, J.L. Programming in Mathematics and Logic in Glaser, R. (ed) Teaching Machines and Programed Learning II. Washington. NEA. 1965. p. 383.

34. Dodd, B.T., Programmed Learning Against the Clock. New Education. 1. 7. 1965. pp. 37 - 38.

35. Hartley, J., op. cit. p. 212.

36. Stolorow, L.M., Teaching by Machine. Co-operative Research Monograph No.6. Washington. U.S. Dept. of Health, Education and Welfare. 1961.

37. Webb, C.C., An Investigation into the Effects of Adaptive Linear Systems and Review Procedures upon a Programmed Learning Task in Physical Geography. D.C.P. Dissertation Birmingham. 1965.

38. Kay, H., op. cit. p. 158.

39. Holt, H.O., Discussion on an Exploratory Study of the Use of a Self-Instruction Program in Basic Electricity in Hughes, J.L. (ed) Programed Learning. London. Sir Isaac Pitman 1962. p. 56.

40. Branson, R.K., Some Pitfalls in the Classroom Use of Programs in Ofiesh, G.D. and Meierhenry, W.C. (eds) Trends in Programmed Instruction. Washington NEA. 1964. pp. 78 - 79.

41. Leith, G.O.M., op. cit. p. 70.

42. Lumsdaine, A.A., Assessing Instructional Programs in Filep, R.T. (ed) Prospectives in Programing. New York. Macmillan. 1964. pp. 229 - 259.

43. Larkin, T.C. and Leith, G.O.M., A Comparison of Linear and Branching Methods of Programmed Instruction. Programming 1963. Research Unit Education Dept. University of Sheffield. 1963.

44. Leith, G.O.M. and Hope, B. A comparison of Two Modes of Responding to Linear and Branching Programmes. Educ. Rev. XVII 3. 1965. pp. 170 - 175.

45. Cummings, A. and Goldstein, L.S., The Effect of Overt and Covert Responding on Two Kinds of Learning Tasks. Technical Report 620919. Center for Programmed Instruction. 1962.

46. Van Wagenen and Travers, R.M.W., Learning Under Conditions of Direct and Vicarious Reinforcement. J. Educ. Psychol. 54. 6. pp. 356 - 362.

47. Gordon, M., D.C.P. Dissertation. Birmingham 1963.

48. Leith, G.O.M. and Webb, C.C., A Comparison of Four Methods of Programmed Instruction with and without Teacher Intervention. Research Reports No.18. National Centre for Programmed Learning. University of Birmingham 1967.

49. Lumsdaine, A.A., op. cit. p. 259.

50. Curr, W., Education Without Teachers in Leith, G.O.M. (ed) A Handbook of Programmed Learning. Supplement to Educ. Rev. XVI 2. p. 18.

51. Snedecor, G.W. and Cochran, W.G., Statistical Methods 6th Edition, Iowa State, Ames. 1967.

52. Lewis, D.G., Experimental Design in Education. London, V.L.P. 1968. p. 121.

APPENDIX II

APPENDIX II

Individual Ages, Mean and Standard Deviation of Method Group A

11	10
11	7
11	5
12	1
11	7
11	8
11	9
12	2
12	0
12	1
11	10
12	0
11	8
11	6
11	5
11	10
11	5
12	1
11	8
11	10
11	10
11	2
12	1
12	1
11	8
12	1
11	7
12	1
12	0
11	7
11	9
11	6
11	11
11	7
11	7
11	11
11	5
12	1
11	5
11	3
11	7
12	7
12	4
11	10
12	0
12	0
12	7
12	0
11	5
12	5
12	0
11	10
11	5
11	10
12	0
12	5
11	10
12	2
11	8
12	5
Σx	711 0
$\bar{x}$	11 10
n	60

$\bar{x}$. 11.10
sd. 3.88

APPENDIX II

Individual Ages, Mean and Standard Deviation of Method Group B

12	0
11	5
12	4
11	8
11	11
11	11
11	8
11	3
11	10
11	6
11	8
11	3
11	6
11	10
12	0
11	3
11	3
11	10
11	10
11	6
11	8
12	0
11	9
11	6
11	6
11	8
12	2
11	8
11	6
11	3
11	5
12	1
11	6
11	7
11	2
11	7
11	8
11	9
11	7
11	3
12	0
12	5
12	4
12	6
11	11
12	5
11	10
12	0
12	5
12	7
12	0
11	10
11	5
11	3
11	10
11	10
12	0
11	9
12	5
12	3
Σx	706 8
x	11 9.3
n	60

$\bar{x}$. 11.9.3
sd. 4.35

APPENDIX II

Individual Ages, Mean and Standard Deviation of Method Group C

11	4
11	11
11	11
11	10
12	3
11	8
11	6
11	8
11	1
11	9
11	6
12	2
12	1
11	8
12	2
11	5
12	1
11	5
11	6
11	5
11	8
11	5
12	1
11	5
11	9
11	9
11	2
11	6
11	9
11	7
12	0
11	7
11	11
11	7
11	7
11	0
11	8
11	7
11	5
11	9
11	9
12	2
12	8
11	10
12	7
11	10
12	3
12	5
11	11
11	9
11	11
11	10
12	7
12	0
12	4
11	9
11	11
12	5
12	7
12	6
Σx	709 6
$\bar{x}$	11 9
n	60

$\bar{x}$. 11.9
sd. 4.67

APPENDIX II

Individual Scores, Mean and Standard Deviation of Method Group A - Raven's Progressive Matrices

94	115
108	99
99	87
84	100
112	104
87	98
99	98
75	89
98	112
78	109
84	115
104	114
104	115
90	102
94	111
96	115
112	122
98	99
112	86
89	116
102	88
105	118
106	106
115	76
101	119
93	92
88	101
104	93
98	
112	Σx 6057
117	$\bar{x}$ 100.95
100	n 60

$\bar{x}$.100.95

sd. 11.48

APPENDIX II

Individual Scores, Mean and Standard Deviation of Method Group B - Raven's Progressive Matrices

99	91		
103	99		
101	101		
117	116		
116	117		
75	108		
75	99		
110	101		
101	102		
115	91		
82	117		
110	112		
100	100		
98	108		
89	107	$\bar{x}$	101.38
101	91		
86	84	sd.	10.83
101	125		
89	102		
108	99		
91	91		
104	95		
100	106		
99	94		
107	115		
82	110		
115	90		
101	103		
115			
110	Σx	6083	
103	$\bar{x}$	101.38	
106	n	60	

APPENDIX II

Individual Scores, Mean and Standard Deviation of Method Group C - Raven's Progressive Matrices

91	81
105	88
98	97
107	102
95	94
119	107
91	107
116	95
98	119
110	97
89	109
111	115
115	99
89	89
80	107
93	81
112	110
98	94
114	122
122	96
116	95
91	88
111	94
119	104
122	125
104	115
119	106
99	96
100	
97	ΣX 6172
99	$\bar{x}$ 102.86
110	n 60

$\bar{x}$.102.86

sd. 11.49

APPENDIX II

Individual Times and Mean Time of Working the Programme - Self-paced Group A - in Minutes and Seconds

Section 1. 66 Frames

30	10
28	20
25	30
30	00
25	45
30	30
33	00
35	00
22	20
31	00
24	10
32	30
23	50
30	00
24	10
25	50
35	00
24	10
30	25
31	35
42	25
30	20
29	00
29	00
30	42
32	00
25	30
29	00
35	30
30	00
35	00
32	00
28	35
40	00
30	00
35	10
32	14
22	45
35	00
28	00
22	20
28	20
28	35
26	50
24	10
18	45
19	30
20	45
25	45
25	00
28	20
29	00
32	00
31	00
38	00
30	00
27	00
30	42
32	00
28	00

Σ x 1753' 18.00"

n 60

$\bar{x}$ 29' 13.30"

per frame 26.41"

per page 2' 38.00"

Mean time Group A - rate of working Group B.

APPENDIX II

Individual Times and Mean Time of Working the Programme - Self-paced Group A - in Minutes and Seconds

Section 2. 42 Frames

17	45
13	45
21	45
19	00
23	45
27	45
29	15
27	45
19	00
29	00
20	10
30	15
21	00
22	00
29	00
16	00
34	00
18	15
25	05
15	00
16	05
21	00
23	15
21	00
13	45
16	05
20	15
14	45
25	00
20	00
20	15
30	00
20	00
24	00
24	05
26	00
23	00
23	00
24	00
21	00

19	00
22	10
21	00
22	00
21	10
14	00
16	05
20	00
19	15
25	00
20	15
20	15
24	10
25	10
22	10
23	10
23	10
25	00
27	05
21	00

$\frac{\Sigma x}{n}$ x 1316' 53.00" / 60

$\bar{x}$ 21' 57.00"

per frame 31.36"

per page 3' 8.00"

Mean time Group A - rate of working Group B.

APPENDIX II

Individual Times and Mean Time of Working the Programme - Self-paced Group A - in Minutes and Seconds

Section 3. 33 Frames

17	15
13	00
14	45
11	30
12	45
15	45
13	00
12	00
28	15
19	30
19	30
16	15
17	30
16	00
19	00
12	45
19	30
12	45
13	00
13	30
12	45
17	30
16	15
11	15
9	45
8	15
18	20
11	15
12	20
12	45
13	00
23	15
13	45
13	30
17	30
17	00
16	00
15	45
14	00
13	00
12	10
16	15
16	00
15	00
13	30
8	30
12	00
15	00
12	30
13	00
15	30
11	20
12	00
17	00
16	00
14	45
14	00
10	00
16	00
9	15

Σx 872' 25.00"

n 60

$\bar{x}$ 14' 32.41"

per frame 26.43"

per page 2' 39.00"

Mean time Group A - rate of working Group B.

APPENDIX II

Individual Times and Mean Time of Working the Programme - Self-paced Group A - in Minutes and Seconds

Section 4. 30 Frames

8	15
6	45
9	30
9	00
6	30
4	50
11	00
9	15
20	00
20	00
6	30
14	00
11	00
9	30
14	00
6	15
9	30
8	35
5	15
9	00
12	00
12	00
9	00
4	50
14	00
7	30
20	00
15	30
16	15
13	25
9	15
10	05
11	20
15	00
8	15
20	00
17	35
10	00
16	00
12	00
11	30
5	20
7	30
15	00
14	00
8	35
15	30
9	30
12	00
8	35
13	45
11	20
12	30
18	30
19	00
14	30
16	30
10	00
9	15
11	30

Σ x 697' 00"

n 60

$\bar{x}$ 11' 37.00"

per frame 23.23"

per page 2' 19.00"

Mean time Group A - rate of working Group B.

APPENDIX II

Individual Times and Mean Time of Working the Programme - Self-paced Group A - in Minutes and Seconds

Section 5. 33 Frames

11	00
7	00
13	30
15	00
7	00
7	00
14	30
11	30
11	30
12	30
7	00
11	00
10	00
11	30
17	00
9	00
11	00
12	30
8	30
10	05
13	00
13	45
11	30
8	15
18	00
20	00
9	15
15	30
17	00
20	00
10	45
10	20
10	45
20	00
11	00
17	00
19	30
16	00
15	30
10	05
16	15
8	06
8	00
10	02
16	15
17	35
11	20
8	06
12	40
10	02
14	45
13	00
12	45
22	10
17	30
15	30
19	00
15	30
10	05
9	15

Σ x 773' 06.00"

n 60

$\bar{x}$ 12' 53.10"

per frame 23.42"

per page 2' 20.50"

Mean time Group A - rate of working Group B.

APPENDIX II

Individual Times and Mean Time of Working the Programme - Self-paced Group A - in Minutes and Seconds

Section 6. 29 Frames

5	00	5	00
6	35	6	15
5	15	6	00
5	30	6	15
5	00	6	00
6	30	6	45
6	30	6	15
5	00	5	00
9	45	5	15
9	45	5	30
6	30	6	30
5	30	6	45
7	30	6	15
6	20	7	30
5	15	7	00
7	30	7	30
6	45	7	30
6	45	5	00
6	00	5	15
5	30	5	00
6	30		
5	00	Σ x	377' 40.00"
6	30	n	60
6	30		
7	00	$\bar{x}$	6' 16.60"
9	45	per frame	16.43"
7	00	per page	1' 38.58"
7	30		
6	45		
5	45		
5	30		
5	15		
6	30		
6	30		
6	00		
6	45		
6	45		
5	00		
5	00		
5	15		

Mean time Group A - rate of working Group B.

APPENDIX II

Individual Times and Mean Time of Working the Programme - Fast half self-paced Group A - in Minutes and Seconds

Section 1. 66 Frames

28	20
25	30
25	45
22	20
24	10
23	50
24	10
25	50
24	10
29	00
25	30
29	00
28	35
22	45
28	00
22	20
28	20
28	35
26	50
24	10
18	45
19	30
20	45
25	45
25	00
28	20
29	00
27	30
28	50
29	00
Σx	769' 35.00"
$\bar{x}$	25' 35.00"
n	30.

$\bar{x}$	25' 35.00"
per frame	23.25"
per page	2' 19.50"

APPENDIX II

Individual Times and Mean Time of Working the Programme - Fast half self-paced Group A - in Minutes and Seconds

Section 2. 42 Frames

17	45
13	45
21	45
19	00
19	00
20	10
21	10
16	00
18	15
15	00
16	05
21	00
21	00
13	45
16	05
20	15
14	45
20	00
20	15
21	00
19	00
21	00
21	10
14	00
16	05
20	05
19	15
20	00
20	15
21	00

$\bar{x}$ 18' 36.00"
per frame 26.57"
per page 2' 39.00"

Σx 558' 00.00"
$\bar{x}$ 18' 36.00"
n 30

APPENDIX II

Individual Times and Mean Time of Working the Programme - Fast half self-paced Group A - in Minutes and Seconds

Section 3. 33 Frames

13	00
11	30
12	45
13	00
12	00
12	45
12	45
13	00
13	00
12	45
11	15
9	45
8	15
11	15
12	20
12	45
13	00
13	45
13	30
13	00
12	10
13	30
8	30
12	00
12	30
13	00
11	20
12	00
10	00
9	15
Σx	359' 35.00"
$\bar{x}$	11' 59.00"
n	30

$\bar{x}$	11' 59.00"
per frame	21.78"
per page	2' 11.00"

APPENDIX II

Individual Times and Mean Time of Working the Programme - Fast half self-paced Group A - in Minutes and Seconds

Section 4. 30 Frames

8	15
6	45
9	30
9	00
6	30
4	50
11	00
9	15
6	30
11	00
9	30
6	15
9	30
8	35
5	15
9	00
9	00
4	50
7	30
9	15
10	05
8	15
10	00
5	20
7	30
8	35
9	30
8	35
9	15
10	00

$\bar{x}$ 8' 16.66"
per frame 16.55"
per page 1' 39.00"

Σx 248' 20.00"
$\bar{x}$ 8' 16.66"
n 30

APPENDIX II

Individual Times and Mean Time of Working the Programme - Fast half self-paced Group A - in Minutes and Seconds

Section 5. 33 Frames

11	00
7	00
7	00
7	00
11	30
11	30
7	00
11	00
10	00
11	30
9	00
11	00
8	30
10	05
11	30
8	15
9	15
10	45
10	20
10	45
11	00
10	05
8	06
8	00
10	02
11	20
8	06
10	02
10	05
9	15

Σx 287' 56.00"
$\bar{x}$ 9' 35.80"
n 30

$\bar{x}$ 9' 35.80"
per frame 19.19"
per page 1' 55.00"

APPENDIX II

Individual Times and Mean Time of Working the Programme - Fast half self-paced Group A - in Minutes and Seconds

Section 6. 29 Frames

5	00
5	15
5	30
5	00
5	00
5	30
5	15
6	00
5	30
5	00
5	45
5	30
5	15
6	00
5	00
5	00
5	15
5	00
6	15
6	00
6	15
6	00
6	15
5	00
5	15
5	30
5	00
5	15
5	00
6	15
Σx	163' 45.00"
$\bar{x}$	5' 27.50"
n	30

$\bar{x}$	5' 27.50"
per frame	11.29"
per page	1' 8.74"

APPENDIX II

Individual Gain Scores, Mean and Standard Deviation of Post-Test Scores - Method A.

3	6
7	6
6	11
3	7
8	0
2	5
8	3
0	8
8	10
0	9
1	2
3	0
8	0
6	3
6	1
6	3
4	5
9	9
6	1
3	0
5	
3	Σx 280
3	$\bar{x}$ 4.67
7	n 60
1	
3	
5	
1	
5	
10	
7	
0	
6	
4	
5	
14	
7	
4	
1	
3	

$\bar{x}$. 4.67
sd. 3.21

APPENDIX II

Individual Gain Scores, Mean and Standard Deviation of Post-Test Scores - Method B.

2	1
4	4
4	8
4	4
8	5
0	4
0	9
-2	2
2	5
5	6
1	4
5	6
5	5
8	6
1	6
1	7
1	7
8	10
7	6
5	6
3	
3	Σx 281
8	$\bar{x}$ 4.68
4	n 60
5	
7	
1	
2	
5	
2	
11	
5	
2	
2	
3	
9	
12	
9	
7	
1	

$\bar{x}$. 4.68
sd. 2.93

APPENDIX II

Individual Gain Scores, Mean and Standard Deviation of Post-Test Scores - Method C.

3	5
3	3
3	1
-2	6
5	3
3	4
-2	0
4	7
5	0
10	1
2	2
0	2
-3	2
2	3
2	3
4	9
2	4
5	2
1	8
0	6
4	
3	Σx 198
0	$\bar{x}$ 3.30
10	n 60
13	
7	
2	
4	
5	
3	
2	
2	
3	
0	
3	
9	
6	
2	
3	
1	

$\bar{x}$. 3.30
sd. 2.90

APPENDIX II

Individual Gain Scores, Mean and Standard Deviation of Retention Test Scores - Method A.

6	2
5	3
6	9
5	5
8	1
7	4
7	3
0	2
3	8
1	10
3	0
6	1
3	1
5	3
6	2
10	3
9	4
4	7
9	1
6	1
4	
4	Σx 248
3	$\bar{x}$ 4.13
3	n 60
1	
2	
5	
0	
5	
7	
5	
1	
3	
4	
3	
9	
7	
2	
0	
1	

$\bar{x}$. 4.13
sd. 2.74

APPENDIX II

Individual Gain Scores, Mean and Standard Deviation of Retention Test Scores - Method B.

1	0
3	3
5	7
4	1
7	1
0	1
1	3
1	3
1	5
8	6
2	3
4	8
3	3
4	4
4	5
6	3
1	5
2	8
4	7
3	2
3	
2	Σx 224
5	$\bar{x}$ 3.73
3	n 60
3	
8	
0	
0	
3	
2	
9	
5	
1	
2	
1	
10	
10	
7	
7	
1	

$\bar{x}$. 3.73
sd. 2.63

APPENDIX II

Individual Gain Scores, Mean and Standard Deviation of Retention Test Scores - Method C.

7	3	
2	3	
10	0	
1	3	
4	1	
5	4	
-2	6	
3	5	
3	1	
8	5	$\bar{x}$. 3.57
1	4	sd. 2.84
-1	7	
2	0	
6	3	
3	3	
5	9	
1	6	
6	0	
3	2	
7	5	
4		
2	Σx 215	
0	$\bar{x}$ 3.57	
10	n 60	
12		
5		
2		
3		
3		
3		
0		
2		
4		
0		
2		
7		
6		
2		
2		
2		

APPENDIX II

Individual Raw Scores of Method Group A on Pre-Test, Post-Test and Retention Test

PRE	POST	RETENTION
1	4	7
3	10	8
1	7	7
0	3	5
2	10	10
1	3	8
1	9	8
0	0	0
5	13	8
1	1	2
0	1	3
1	4	7
0	8	3
1	7	6
2	8	8
2	8	12
2	6	11
1	10	7
3	9	9
0	3	6
0	5	4
0	3	4
4	7	7
7	14	10
2	3	1
0	3	2
5	10	10
3	4	3
5	10	10
6	16	13

PRE	POST	RETENTION
2	9	7
0	0	1
2	8	5
1	5	5
0	5	3
0	14	9
2	9	9
1	5	3
2	3	2
0	3	1
6	12	8
6	12	9
1	12	10
5	11	10
4	4	5
2	7	6
11	14	14
4	12	6
4	14	12
0	9	10
3	5	3
4	4	5
4	4	5
4	7	7
2	3	4
1	4	4
0	5	4
1	10	8
6	7	7
6	6	7

APPENDIX II

Individual Raw Scores of Method Group B on Pre-Test, Post-Test and Retention Test

PRE	POST	RETENTION
3	5	4
5	9	8
5	9	10
2	6	6
0	8	7
0	0	0
0	0	1
6	4	7
5	7	6
1	6	9
1	2	3
3	8	7
0	5	3
1	9	5
0	1	4
0	1	6
0	1	1
0	8	2
2	9	6
3	8	6
0	3	3
1	4	3
1	9	6
1	5	4
1	6	4
1	8	8
1	2	1
2	4	2
1	6	4
1	3	3

PRE	POST	RETENTION
3	14	12
0	5	5
1	3	2
3	5	5
0	3	1
1	10	10
0	12	10
0	9	7
1	8	7
2	3	2
3	4	3
1	5	4
4	12	11
5	9	6
5	10	6
5	9	6
3	12	6
0	2	3
2	7	7
5	11	11
0	4	5
1	7	9
1	6	4
1	7	5
1	7	6
0	7	3
0	7	5
2	12	10
0	6	7
1	7	3

APPENDIX II

Individual Raw Scores of Method Group C on Pre-Test, Post-Test and Retention Test

PRE	POST	RETENTION
0	3	10
2	5	4
0	3	10
2	0	3
1	6	5
2	5	7
2	0	0
1	5	4
5	10	8
5	15	13
0	2	1
3	3	2
3	2	7
1	3	7
0	2	3
5	9	10
4	6	5
2	7	8
4	5	7
3	3	10
2	6	6
2	5	4
0	0	0
0	10	10
2	15	14
1	8	6
0	2	2
0	4	3
4	9	7
4	7	7

PRE	POST	RETENTION
0	2	0
1	3	3
1	4	5
2	2	2
2	3	4
0	9	7
1	7	7
1	3	3
2	5	4
0	1	2
4	9	7
3	6	6
8	9	8
0	6	3
2	5	3
3	7	7
2	2	8
0	7	5
6	6	7
1	2	6
2	4	6
1	3	8
3	5	3
1	4	4
0	3	3
1	10	10
3	7	9
4	6	4
6	14	8
0	6	5

APPENDIX II

Individual Gain Scores in Cells on Post-Test for the Original Population

METHODS

SCHOOLS	A	B	C
1.	3,7,6,3,8,2,8,0,8,0, 1,3,8,6,6,6,4,9,6,3,	2,4,4,4,8,0,0,-2,2,5, 1,5,5,8,1,1,1,8,7,5,	3,3,3,-2,5,3,-2,4,5,10. 2,0,-3,2,2,4,2,5,1,0.
2.	5,3,3,7,1,3,5,1,5,10, 7,0,6,4,5,14,7,4,1,3,	3,3,8,4,5,7,1,2,5,2, 11,5,2,2,3,9,12,9,7,1,	4,3,0,10,13,7,2,4,5,3. 2,2,3,0,3,9,6,2,3,1.
3.	6,6,11,7,0,5,3,8,10,9, 2,0,0,3,1,3,5,9,1,0.	1,4,8,4,5,4,9,2,5,6, 4,6,5,6,6,7,7,10,6,6,	5,3,1,6,3,4,0,7,0,1. 2,2,2,3,3,9,4,2,8,6.

Individual Gain Scores in Cells on Retention Test for the Original Population

METHODS

SCHOOLS	A	B	C
1.	6,5,6,5,8,7,7,0,3,1, 3,6,3,5,6,10,9,4,9,6,	1,3,5,4,7,0,1,1,1,8, 2,4,3,4,4,6,1,2,4,3,	7,2,10,1,4,5,-2,3,3,8. 1,-1,2,6,3,5,1,6,3,7.
2.	4,4,3,3,1,2,5,0,5,7, 5,1,3,4,3,9,7,2,0,1,	3,2,5,3,3,8,0,0,3,2, 9,5,1,2,1,10,10,7,7,1,	4,2,0,10,12,5,2,3,3,3. 0,2,4,0,2,7,6,2,2,2.
3.	2,3,9,5,1,4,3,2,8,10, 0,1,1,3,2,3,4,7,1,1,	0,3,7,1,1,1,3,3,5,6, 3,8,3,4,5,3,5,8,7,2,	3,3,0,3,1,4,6,5,1,5. 4,7,0,3,3,9,6,0,2,5.

APPENDIX II

Individual Gain Scores in Cells on Post-Test for the Reduced Sample

		METHODS		
		A	B	C
School 1.	High Ability	7, 8, 3, 8, 4, 6,	4, 8, 5, 1, 8, 5,	3, -2, 4. 10, -3, 1.
	Low Ability	6, 2, 0, 0, 6, 6,	2, 0, 0, 1, 1, 7,	3, 3, 5. -2, 2, 5.
School 2.	High Ability	5, 7, 1, 7, 6, 7,	5, 2, 2, 5, 3, 9,	0, 13, 2. 9, 2, 3.
	Low Ability	3, 5, 0, 4, 14, 4,	3, 8, 4, 7, 2, 2.	3, 3, 3. 3, 3, 6.
School 3.	High Ability	6, 6, 11, 7, 0, 1,	1, 4, 9, 6, 10, 6,	5, 1, 0. 0, 9, 2.
	Low Ability	9, 2, 0, 3, 9, 0,	4, 5, 2, 4, 5, 7,	3, 3, 4. 7, 3, 6.

APPENDIX II

Individual Gain Scores in Cells on Retention Test for the Reduced Sample

		METHODS		
		A	B	C
School 1.	High Ability	5, 8, 6, 3, 9, 9,	3, 5, 1, 1, 4, 6,	2, 5, -1. 1, 3, 7.
	Low Ability	6, 6, 7, 5, 10, 4,	1, 0, 3, 4, 1, 4,	7, 10, 3. 6, 5, 6.
School 2.	High Ability	4, 4, 3, 0, 5, 3,	3, 0, 2, 5, 7, 1,	4, 0, 10. 5, 2, 2.
	Low Ability	2, 5, 1, 2, 0, 1,	3, 5, 8, 1, 2, 7,	2, 3, 4. 0, 2, 6.
School 3.	High Ability	3, 9, 4, 3, 2, 4,	0, 7, 3, 6, 5, 8,	0, 3, 6. 1, 0, 2.
	Low Ability	10, 0, 1, 3, 7, 1,	3, 5, 3, 4, 3, 7,	3, 1, 4. 5, 7, 5.

APPENDIX II

Individual I.Q. Scores (Raven's Progressive Matrices) for Method Groups in the Reduced Sample

METHODS

	A		B		C	
	High	Low	High	Low	High	Low
	108	99	101	99	105	91
	112	87	116	75	107	98
	104	75	110	75	116	95
	104	78	101	82	110	91
	112	90	101	86	115	80
	112	96	108	89	114	98
	102	93	107	91	111	91
	115	88	101	100	122	97
	101	100	110	99	110	99
	117	94	106	82	102	81
	115	100	101	91	107	97
	104	98	108	99	107	94
	112	99	102	91	119	97
	109	86	108	100	109	99
	115	88	107	91	107	89
	114	76	106	84	110	81
	116	92	110	91	104	94
	101	93	103	94	115	96
Σx	1973	1632	1906	1619	1990	1668
$\bar{x}$	109.61	90.67	105.89	89.94	110.56	92.67
n	18	18	18	18	18	18

I.Q. scores for the original population are shown in Appendix II page XXVIII.

APPENDIX III

Comments from the Children

The staffs of the schools were most helpful and co-operative. They knew little about programmed instruction and were interested to know more.

The children co-operated willingly and for the most part, appeared to enjoy the novelty of the work. Their comments revealed a wide range of reaction from positive enthusiasm to intense dislike. It was interesting to note the recurrence of similar points of view. There were few children who felt they had not been given sufficient time for working, even in the fast-paced group. Although they were completely unsophisticated in the use of programmes it is particularly interesting to note that a number of comments reflect some of the principles behind the concept of programming; they enjoyed working the programme because it was easy and because the answers were there, and they were able to check as they went along. The general impression was one of enjoyment. There were more favourable than unfavourable comments and the words "fun" and "exciting" appeared a surprising number of times. A selection of these comments follows. They are uncorrected and just as written by the children.

"It is realy good. I enjoyed it."

"Its alright working from books like these and I think its fun to do these. I like it a bit because you get to know more if the answers are there."

"I like doing these tests because they help us to learn a bit more and there fun to do. There easy and they don't take very long."

"I thought that they were quite good because they were exciting and that these books are better than ordinary."

"I like working from these books because you know when you have got the answers wrong and you can find out where you have gone wrong and it is very interesting."

"I Liked doing it. It was Okay. It was easy fun to do. It was Interesting. I would like to do it again though."

"I think this is a very good idea as well as exciting. I do not mind doing it.I am sure I have learnt a very lot from these book and they are simple to do."

"I thought it was alright and you were going just the right speed."

"It's not bad. It's fun."

"I did not like the test. I did not think we was rushed."

"I did not like the test because I know nothing about rain and clouds and all that. It was rotten."

"I only liked copeying down the answers."

"I do not like This test because they are too hard and we expect to larn it all and we can't because you give so much time and than you say turn over."