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ABSTRACT

A programed course in general histology was completely developed by dental schools in the United States and Brazil. A group of international experts specified the course objectives, wrote and taped scripts for a series of 28 lectures of 50 minutes each, developed slides to accompany the lectures, prepared microphotographs and scripts to explain and illustrate laboratory microscope exercises, and devised daily quizzes. Evaluation of the program after its use showed that successful scripts could be cooperatively developed and easily translated to other languages and that the preparation cost was minimal. Daily quizzes contributed to increased achievement, and quiz scores correlated positively with final exam performances; quiz results also helped to identify weak students early in the term and to highlight areas where remedial attention was needed. Students in general performed well; the lower ability students achieved more than they had in conventional instructional programs. Thus it appears that programed instruction can improve educational efficiency by providing better instruction to more students at lower costs and in less time, and it is recommended that hemispheric cooperation be developed for the production of additional programed instruction and long-range communications. (LB)

ABSTRACT

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ABSTRACT

Programmed learning offers a solution to the critical shortage of faculties and facilities in providing better education to more people at less cost. This paper reports on the cooperative development of a programmed course in General Histology, involving several schools in Brazil and in the United States. The program involves a machine presentation of the lecture and of part of the laboratory exercises. Daily quizzes are used to help locate weaknesses in the program. Objective and subjective acceptance of the program has been excellent. Use of the program in a large scale study involving 800 students at the Federal University of Pernambuco in Brazil proved more satisfactory than conventional teaching. The importance of these findings is briefly discussed. Hemispheric cooperation in further development of programming and long range communications is proposed.

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All around us, there is an increasing demand to educate more people to a higher level of complexity at less cost. Within the next decade, it is estimated that the university systems will have to double their enrollments to meet population demands. It is not possible to increase facilities and faculties to meet this anticipated demand in the short time that still remains, unless a radical departure is made from the conventional preceptor type of teaching which features the teacher, the lecture room, the blackboard and a piece of chalk.

The use of programmed learning permits a course to be prepared prior to its scheduled time for presentation. The material in the program can be analyzed for adequacy of content and details of presentation. On the basis of the feedback from interrogation sequences, weak points in a program can be appropriately modified for subsequent presentations. Once a program is prepared, it can be continually upgraded. Instead of a blackboard, with hasty sketches as is characteristic of present lecture presentations, carefully prepared slides can be used to save time and to explain better. Finally, a program can be carefully prepared by one individual, or group of individuals, and then used by several cooperating institutions.

In 1966, the University of Puerto Rico received a grant from the United States Public Health Service for an educational research program which would involve the development and testing of a series of programmed learning sequences in General Histology. The first step taken was to secure a group of internationally known consultants from the disciplines requiring a prerequisite knowledge of histology. The consultants group included an educational psychologist, a general histologist, a general and an oral pathologist and an electron microscopist. A member of the National Board of Dental Examiners also acted as a special consultant to aid in improving the interrogation exercises. The mission of the consultants group was to insure that all program objectives were in consonance with the latest scientific and educational advancements.

The program development was divided into three phases. The first included the usual material taught in lecture presentations; the second included the material presented in the histology laboratory; while the third phase included a daily quiz that provided the feedback on strong and weak points of the various programs.

It was not possible with limited manpower to develop all three phases simultaneously. Instead, the first year was devoted to developing the outlines for the programs, as well as constructing the questions that were to be used in the daily quizzes. These daily quizzes consisted of five questions. Each question had four subunits which could either be a true or false type, or a one word write-in question. The first two of these five questions always related to the most recent lecture, whereas the last three included material as far back as the first lecture.

Thus, student learning was continually reinforced by interrogation procedures during the course. For the 28 lectures in General Histology, each student was exposed to 500 specific points considered important. To encourage better study habits, the marks received in these quizzes were made a part of the students record. Also, to insure repeated review, the students were informed that any of the daily quiz questions might appear in the quarterly examinations.

During the second year, one completely programmed lecture on muscle was presented. This involved a fifty minute audio visual presentation, with approximately 120 synchronized slides. At the end of each module of information presented during the program, there was a multiple choice question presented on a projected slide. In this way, all students were required to respond to approximately twenty questions during the program. Since this program represented the first contact the student had with the material being presented, the student responses to these questions were not made a matter of record; instead, they were only intended to indicate to the the student his strengths and weaknesses. However, the students were advised that some of the same questions would appear in later examinations for which they would be responsible.

Since the initial testing of the program on muscle, scripts for fifteen lectures have been completed, and of these, five have the synchronized visuals. It is estimated that by June 1972, the scripts for the 28 lectures will be completed.

The laboratory programming has consisted of developing a series of microphotograph and accompanying scripts which explain and illustrate the objectives established for the microscopic exercises.

With this brief explanation of the program format, some of the findings from research data and observation can be reported:

First, it has now been demonstrated that a group of educators, voluntarily working together on a cooperative basis can develop scripts to be used in lectures presented by audio visual means. Language has not been a problem. For instance, several of the scripts were accomplished by histologists in different Brazilian schools, and after translation to English, have been used with equal success by participating institutions in the Northern Hemisphere. Vice versa, several programs were prepared by English speaking histologists, and translated into Portuguese for use in Brazil.

The cost of presenting a prepared histology program is minimal. One of the original objectives of the program was to insure that the program delivery system would not require any more equipment than a tape recorder, a slide projector, a pencil and a piece of paper. At the same time, the program was developed with sufficient flexibility to permit later modifications which would make it adaptable to more sophisticated delivery systems, such as closed circuit TV or computer assisted instruction. All initial testing has been accomplished with the most economical type of equipment, since it is not desired to increase the sophistication of the delivery methods until the entire prototype program has been completed and validated.

The students have liked the programmed approach to histology teaching. Since the scripts are prepared to meet course objectives, the students very definitely know the important points for which they are responsible. Also, the program provides a dual sensory input, with the student being able to simultaneously hear and visualize the subject matter. The student is given copies of the script for later study. It should be emphasized at this point that the program with all its advantages, does not replace the course textbook; instead, it supplements it in the same way as the conventional lecture.

During the first year in which daily quizzes were given, the class was randomly divided into two groups. One group took the quizzes, whereas the control group did not. Although the marks made by the students in the experimental quiz group were not made a matter of class record, it was found that in comparing the final marks of both groups at the end of the year, those in the test group were approximately 5 points better than their colleagues in the control group.

In another educational research phase involving use of the daily quiz, it was found that if students were exposed a second time to a question in the same general area, they would do approximately 20 points better as a class average. Thus, individuals and class marks on the daily quizzes were used as a statistical check to determine weak areas. If the miss rate for a question was high, the answer was explained in detail to the class. It should be mentioned that often a high miss rate could be traced to an inadequate explanation in the program, instead of to student weakness. In these cases, appropriate changes were made.

There was a high correlation of the daily quiz marks with those attained by the same students in the major examinations. For instance, the marks of the students in the first daily quiz of the year, were correlated with their final examination marks at the 10% level. The total cumulative scores after the second and third daily quizzes for each student were correlated at the 5% level. After the fourth, fifth and sixth quizzes, the correlation coefficient had increased to 1%; whereas, from the seventh quiz onward, the correlation coefficient was better than 0.1%. This data indicates that it is possible to identify weak students at a very early period in time. Once the total program is developed, it will be possible to prescribe remedial programs to correct indicated weaknesses.

With the continued emphasis on programmed methods, the class marks have become skewed, with more A and B grades awarded than is the case for the total of C, D and F marks. It should be pointed out that this does not represent an easier-to-pass course, since there has not been one student who has taken the National Dental Boards who has flunked in Histology, indicating that the knowledge transmittal and knowledge retention is better than for many other not-so-fortunate students from other dental schools in the United States.

The previous information is a result of many of the early trial-and-error approaches to finding a program format that would best facilitate the achievement of course objectives. In this initial period of testing, only relatively small groups of students, numbering from 40 - 80 were involved. The majority of this testing was concentrated in the School of Dentistry of the University of Puerto Rico, and in the

Federal University of Pernambuco in Brazil. However, in the year 1970-71, a series of events in Brazil forced a critical test of the potential of programming. At that time, as a result of a change in Brazilian law, the University of Pernambuco was confronted with the necessity to teach 800 students instead of the 100 originally expected. Only very limited additional funds were made available to meet this eightfold increase in enrollment. To meet this crisis, the previously prepared histology programs that had been cooperatively tested on a very limited basis, were finalized in time for the incoming class.

It was realized that the use of programmed learning for an entire course would constitute a totally new experience for the faculty and the students. Therefore, it was decided that an educational research effort should be accomplished in order to compare the accomplishments of students taught by machine presented information, in contrast to students receiving the same general information from a teacher. Accordingly, in the first semester of 1970, 36 students were divided into two groups on a random basis, with eighteen to serve as a control group for conventional teaching, and the other as the experimental group for receiving programmed learning.

These students were from the Biochemistry Course. All had passed the university entry tests. In addition, these students had taken a battery of psychologic tests to determine their general verbal, visual and abstract perception levels. From previous experience, it had been found that students with a mark over 75 in this battery of tests, usually

ended up with high marks in their course work; those who had below 40, usually ended up with a marginal or failing performance; whereas, those falling between these two marks, generally were the medium performing students.

Before starting the course, the control and experimental groups were given an explanation of the methods that were to be used. Students who were to receive the conventional teaching, were requested to review the appropriate chapters in their textbooks during the week prior to their classroom lecture. On the other hand, the students in the experimental group were given the scripts for the audio portion of the program, and also requested to study it during the week in advance of the class. On the day of the class, the control group received a classical lecture. The experimental group received an audio vidual presentation given with a tape recorder and synchronized color slides.

In planning the research program, it was agreed that if programming was to be accepted by the academic community, there must be a parallel relationship between the students performance in the psychologic tests, and those attained in the course work. As it turned out, this hypothesis was not exactly correct.

In evaluating the relationship of the final course marks against the psychologic scores, it was found that students having a high score in the battery of tests, also achieved high scores in either conventional or programmed instruction. This was much as expected. However, in the marginal group with psychologic scores below 40, and in the medium group

between 40-75, there was an unexpected outcome. In both of these lower groups, the students performed as expected with the conventional teaching; however, in both the medium and the marginal groups, the course of marks of those receiving programmed instruction approximated those of the next higher group that was taught by conventional teaching. These findings were at the 5% or better level of significance.

In the second semester of 1970, the experiment was repeated with 72 students from the course in Pharmacy. The same results were apparent. Again, as in Puerto Rico, the results at the University of Pernambuco demonstrated a skewing of the grade curve towards higher marks, indicating that the same programmed material could be translated in two different languages with similar results. In summary, those students with high marks in the psychologic tests can be predicted to be high achievers, no matter whether course material is presented by conventional or by programmed instruction. However, in those cases of those students who are medium, or marginal performers, a higher mark can be expected from use of programmed instruction, than by conventional teaching. Let us now briefly discuss the impact of this information on planning for the greatly increased enrollments that we can expect in the near future.

Efficiency in education might be defined mathematically as the factor that represents an integration of all the variables that contribute to better educating more people at less cost in time and money. An equation fitting this definition would be: Efficiency of education equals the number of students times the quality of students coming out of the system, divided by the cost of education in terms of faculties and supporting facilites times the time necessary to accomplish the education*

* $Ee = \frac{\text{Number of students X Quality of students}}{\text{Cost X Time}}$

In using this formula, it can be seen that in order to expand conventional teaching to include more students, it is necessary to increase the cost of larger faculties and expanded facilities, which cancels out any possibility for an increase of efficiency in education. On the other hand, at the University of Pernambuco, the 800 students were divided into ten classes of 80 each, and all given the same machine presented program by the same faculty personnel. Thus in programmed learning, an increase in student enrollment does not require a proportionate increase in need of a highly trained staff.

In conventional teaching, an increase in quality of subject presentation usually requires additional faculty personnel with a higher level of educational preparation, as well as a lower teacher to student ratio. Conversely, in programmed presentations, a minimally trained faculty member can present the programs prepared by the most qualified authorities.

If the factors of the divisor of the formula can be considered, namely cost and time comitment, the comparison is equally interesting. In conventional teaching, it is impossible to increase the number of students without a proportionate increase in cost. On the other hand, once a program is prepared, it costs very little more to present it to 800 students, than it does to 100. Thus, in a programmed course, the per student cost goes down as the number of students increases.

Finally, in conventional teaching, all students take the same period of time to go through a course. In general, outstanding students require four years to graduate, which is the same time as required for marginal students. If this time committment could be reduced for the more capable, it would result in economies for the student, and for the teaching faculty. In programmed learning, it is possible for the rapid learner to use the programs for self instruction and then provide the opportunity to finish earlier.

In summary, programmed learning can be used with any number of students, with better results than can be attained with conventional teaching. The cost and time factors can be greatly reduced by programming, whereas with conventional methods, the cost and time factors increase proportionately with the number of students. Thus, the efficiency of education with programming increases as the number of students increase; whereas, with conventional teaching, the efficiency of education decreases as the number of students increases. I will repeat this last statement because of its importance. The efficiency of education with programming increases with the greater number of students; in conventional teaching, the efficiency decreases with the greater number of students. This means that universities of the future should be able to expand to meet the great demands for student enrollment, just as the histology course could be equally well taught to 600 students at the University of Pernambuco, instead of to the 100 expected.

Up to this point, the advantages of programming and cooperative development have been discussed. However, much more needs to be accomplished, and possibly YOUR participation can be solicited. For instance, once a program is prepared, it should be upgraded and further edited to introduce new information, or to correct weaknesses indicated in interrogation procedures and student feedback. This need to continually modify programs cannot be accomplished by a small group because of the immensity of the task. Instead, if committees could be formed in each subject area, with members serving on a rotating basis, new knowledge could be continually introduced. In this Hemisphere, such a committee should include representatives from the Spanish, Portuguese and English speaking nations. In this way, the greatest regional representation is possible, thus making the resources of the Hemisphere available to all.

Efforts are now underway to secure the support of an international organization to support an administrative base for such a cooperative effort. Only in this way can the eventual funds, political support and prestige be available to secure the success of such an international educational effort. Such support would include the possibility of carrying programs over satellite TV transmissions; or would include the possibility of using satellite based telephone conferences to expedite committee actions; and, it would include the possibility of linking the universities of all nations with remote educational computers.

In conclusion, the use of programmed learning methods in General Histology have proved effective in both small and large scale experimental programs. However, to make the value of any program permanent, a greater and continued input of new ideas and materials i.to the program is essential. If there are any in this audience who would be interested in the cooperative development of a Hemispheric program, please let me know after this meeting. I would like to have your name, address, university, academic rank and subject area of choice. Or, if desired, you can write to me at the School of Dentistry of the University of Puerto Rico. We who are now here have the capability to help establish a model for international cooperation that will both foster an exchange of information between health educators, as well as have a very major favorable influence upon international friendship. With your help, these two great objectives can be accomplished.