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A SELF-PACED PROGRAMMED UNDERGRADUATE COURSE IN THE EXPERIMENTAL ANALYSIS OF BEHAVIOR[1]

KENNETH E. LLOYD AND NORMA J. KNUTZEN

WASHINGTON STATE UNIVERSITY

A method of programming a variety of assignments in a course was described. The instructions to students, the course assignments, and the grading system were presented in detail. The rate at which students performed the activities was examined. Different students began working at different times during the semester, but once a student began to complete assignments he continued to work at a rate comparable to all other students. No students stopped working after once beginning to work. The majority of the students liked the course despite being overworked. Several changes in the method were suggested based on the data from this course.

Although the use of programmed teaching materials has been widespread (Lumsdaine, 1964; Gagné, 1965), attempts to program course activities beyond the use of the programmed textbook have not been extensive (*e.g.*, Trow, 1965, pp. 5-6; Kersh, 1965). Birnbrauer, Wolf, Kidder, and Tague (1965) established an entirely programmed classroom for retarded children, and Ulrich and Kent (1966) outlined a plan for programming all the activities involved in obtaining a master's degree. The present paper is most closely related to the writings of Ferster and Perrott (1968), Geis (1965), Keller (1965, 1968), Kent (1965), and Malott (1968) who reported methods of teaching programmed university classes in the experimental analysis of behavior. The purpose of the present paper is to describe one method of programming a complete undergraduate course and to present data from students enrolled in a course taught by this method.

The purpose of organizing the course in the manner to be described was to arrange an environment for the student in which he would be performing many of the activities that psychologists perform. What he must do was specified at the beginning of the semester. Each activity was part of a sequence of activities which added up to a terminal performance that was equivalent to a given grade. The student could decide when he would perform the activities and how many activities he would complete. The course is described in detail and the resulting performance of the students is presented.

METHOD

The course covered the principles of operant conditioning and their application. Thirty-five students were enrolled. Three were freshmen, 14 were sophomores, 11 were juniors, six were seniors, and one was a special graduate student. The class met two mornings each week.

At the first class meeting, students were given a set of instructions and a list of course activities. The instructions were as follows:

> "The experimental analysis of behavior, as an area of specialization within psychology, lends itself readily to applications of the principles of behavior to the everyday activities of man. One purpose of Psychology 291 will be to illustrate some of these principles by the way in which the course itself is organized. Traditional teaching methods involving lectures, quizzes, *etc.*, often violate much of what we know about how learning takes place. Thus, in order to plan a course in terms of some of the basic principles of behavior it is necessary to employ a different method of instruction. The teaching methods that will be used in Psychology 291 will be different from those to which you have become accustomed.

[1]Reprints may be obtained from Kenneth E. Lloyd, Dept. of Psychology, Washington State University, Pullman, Washington 99163.

"The responses which you are expected to make for a given grade will be presented to you in outline form and will be discussed in class. Each activity in the course will be assigned a point value. If you perform this activity you will receive up to the maximum number of points assigned to the activity depending, of course, upon your performance. For some activities there will be a required number of points that you must obtain. If you fail to obtain this required number of points on your first try then you will be permitted to try again after you have made additional preparation. For example, you will read the book *Walden II* and then answer some questions about it. You can get a maximum of 24 points from your answers to these questions but you are required to get 12 points or you must re-do the questionnaire until you do so.

"Your grade for the course will be determined by the number of points that you earn during the semester. For example, 310 points are required for a grade of D, 410 points for a C, and so on. Any student receiving less than 310 points during the semester will receive a grade of Incomplete if he has been responding at a reasonable rate during the semester (the 'reasonableness' of his rate being determined by the instructor, assistant, and proctors). Any student who has earned less than 600 points by the end of the semester may elect to receive an Incomplete. Such a student could then return in the Fall Semester of 1967 to continue working on the course and to improve his grade. Similarly, any student may elect to leave the course at any time after he has earned enough points to receive a grade that will satisfy him. For example, if you are happy with a grade of C and if you have earned 410 points by, say, Thanksgiving, then you may stop working and you will receive a grade of C at the end of the semester. You must,

Table 1

Point values for each activity for each grade and the number of choices of each activity in the course evaluation.

Grade	*Activity*	*Points Each*	*Maximum Points*	*Required Points*	*Increase Points*	*Decrease Points*	*Minus Rating*	*Liked Best*	*Liked Least*
	Class Attendance	1	30	8	6	0	0	0	1
	Class Participation	4	32	16	3	1	3	2	5
	Text Review Items	1	205	205	2	1	0	2	2
	Walden Two	4	24	12	18	0	0	5	1
	Reading Sheets	10	240	35	5	1	4	3	11
D				310					
	Movie Reviews	6	36	12 for	11	1	3	1	2
	Tape Reviews	6	30	either	11	0	6	0	4
	Taped Discussion	8	26	6	14	0	8	2	10
	C Laboratory	18	18	12	7	0	1	13	0
	Reading Sheets	10	360	40	-	-	-	-	-
C				410					
	Staff Discussion	12	24	8	2	2	3	4	3
	Field Trip	10	10	260 by week 8	11	0	1	12	0
	B Laboratory	18	18	12	9	0	4	1	0
	Circuitry	15	15	5	0	4	3	0	1
	Submit Questions	2	12	for	4	1	3	0	0
	Attend Colloquia	1	10	any	12	0	3	0	0
	Reading Sheets	10	360	45	-	-	-	-	-
B				510					
	Field Trip	10	10	5 for	-	-	-	-	-
	Observe Research	10	10	either	-	-	-	-	-
	Major Project	80	80	40	-	-	-	-	-
A				600 total (500 by Week 12)					

however, inform the instructor of your plans at the time you earn the number of points you desire. You may continue to attend the class meetings if you so desire. You will also be required to attend the last meeting of the class on January 25th.

"Students whose points fall between two letter grades at the end of the semester might receive either the lower or the higher grade or an Incomplete depending upon many factors. This decision will be made by the teaching staff. We want to urge you to avoid this situation. In other words, plan your work ahead so that you finish the semester with the number of points required for the grade you want.

"The required activities, the maximum points for these activities, and the minimum required points for these activities, for each grade are given on the accompanying sheets. The details for each activity will be explained in class."

The course activities are listed in Table 1. The activities were discussed during the first class meeting. For some activities this was sufficient. For others, additional sets of instructions were necessary. Each activity was assigned a point value based on an estimate of the amount of effort involved. The Maximum Points column in Table 1 indicates the upper limit of possible points to be obtained by repeating an activity. The Required Points column indicates the lower limit of points that had to be obtained for that activity. The purpose of setting maximum points was to prevent students from repeating one activity many times. The inclusion of required points insured that students would perform a variety of activities and also set a minimum level of acceptable performance. Each activity listed in Table 1 is discussed below under its appropriate grade.

Activities for a D Grade

The first activity was Class Attendance. If a student was present he received one point. There were 30 class meetings and he was required to attend eight of them. The second activity, Class Participation, required explanation. Before each class meeting a list of student names was chosen in a counterbalanced manner from the class roster. The instructor called on these students for discussion or to answer questions during class. Their answers were rated on a five-point scale from zero (no response) to four (clearly correct and to the point) by the instructor and the assistant. After class these ratings were compared and a point score recorded for the student. Students who did not accumulate 16 points in this manner were required to schedule one or more private discussions with the instructor or assistant. The content of the classroom questions followed the topics covered in the text for the course, *Analysis of Behavior* (Holland and Skinner, 1961).

This text contains four sets of review items consisting of 205 responses. Students were required to answer all of the items in one set correctly before trying the next set. The instructor, the assistant, and two undergraduate proctors each scheduled two or three office hours per week. Students came to the offices during these scheduled times and were given a mimeographed copy of the review items to fill out. If the student missed any of these items he was required to return later to correct those he missed.

There were six questions to answer while reading *Walden II* (Skinner, 1948). These questions (*e.g.*, what happens to the notion of a democracy when the principles of behavior are applied to the organization of a society? What controls over human behavior exist in *Walden II* which do not exist in the United States today?) were derived from those frequently asked by students in previous courses. If a student did not receive at least 12 points for his answers he was required to rewrite as many as necessary.

Students were required to select articles from several sources (*e.g.*, Ulrich, Stachnik, and Mabry, 1966; Verhave, 1966) and to answer questions on a prepared form called a Reading Sheet. The questions were: what was the purpose of the study or article? (two points); what response (dependent variable) was measured or suggested by the writer? What independent variable was manipulated or discussed by the author? (two points). What principle of behavior was demonstrated or discussed? That is, how is the article related to one of the topics in the course? (three points). Do you think the article was a good demonstration or account of the principle of

behavior being discussed? (three points). Thirty-five points for this activity (*i.e.*, approximately four sheets) were required for a grade of D, 40 points for a C, and 45 points for a B.

The sum (not shown in Table 1) of the Required Points for the activities for a D grade was 276. However, to obtain a final grade of D a student must have accumulated a total of 310 points. He could have obtained the missing 34 points either by obtaining full point credit on the activities or by repeating some activities. This relationship between Required Points and total points needed for a given grade was the same for the other grades.

Activities for a C Grade

Obtaining a grade of C meant writing reviews of movies or tape recordings; recording a discussion by two or three students about a course topic; adapting, magazine training, and shaping a rat to bar press; and submitting additional Reading Sheets. The movies were shown at announced times at the University Audio Visual Center. A film review was graded by assigning 0 to 4 points to the summary and 0 to 2 points to the comments. The reviews of tape recordings (of speeches by psychologists) were graded on the same basis. The tape recorded discussions were held in the psychology laboratories, the Audio Visual Center, or in the student's living quarters. Students identified themselves by name before speaking. Performance was rated on a 0 to 4 point scale, as was classroom participation. These ratings were then doubled to convert them to a 0 to 8 point scale. The laboratory work with the rat was performed under the supervision of one of the undergraduate proctors. A classroom demonstration was held before the student engaged in this activity. Each student submitted a cumulative record of his animal's terminal performance. His written report followed the American Psychological Association journal format.

Activities for a B Grade

The first activity for a grade of B required two or three students to arrange an interview with a psychologist or graduate student not connected with the course. They discussed an agreed topic (*e.g.*, What does reinforcement have to do with hypnosis? Should more courses be taught by this method?). The cooperating staff member rated each of them on a 0 to 4 point scale which was then converted to a 0 to 12 point scale.

Only students who were turning in work at a rate comparable to obtaining a B grade (*i.e.*, those who had obtained 260 points by Week 8) were invited to attend a field trip to a nearby state hospital where a token economy psychiatric ward was in operation (Lloyd and Garlington, 1968). A written report of the trip earned the student from 0 to 10 points.

The remaining activities for a B included an extension of the laboratory work (extinction, reconditioning, and ratio performance of lever pressing), additional journal readings plus a choice of attending a demonstration of electrical-mechanical circuitry, submitting questions for class discussion, or attending departmental colloquia.

Activities for an A Grade

To qualify for an A, students had to accumulate 500 points by Week 12. The intent of this rule was to reserve the last four weeks of the semester for completion of the major A project, which could consist of conducting an experiment (usually additional work with the rat), of writing a term paper, or of presenting a talk to the class either as a short lecture or as a symposium with other students. An additional requirement for an A was to write a report of a field trip of the students' own design (*e.g.*, visit a state institution over Christmas vacation), or to observe a research project of one of the psychology faculty, read an article related to the research, and submit a written report.

The purpose of assigning these various activities was to induce students to behave in ways that resembled many of the behaviors of psychologists. These behaviors included reading the psychological literature, writing about psychological topics, performing laboratory tasks, and talking with other students and with psychologists about psychology. Many of the D, C, and B activities were intended to be components or approximations of the A activities. For example, completing the Standard Reading Sheets provided the student with a background for a term paper. The C and B laboratory projects set the stage for an experimental manipulation of the students' own design. Answering questions in class, talking with other students and with another psy-

chologist were preparatory to lecturing in front of the class.

In addition to completing the various activities, the students, at the end of Week 3, 8, and 13, anonymously estimated the final grade they were seeking. At the end of the semester they completed a course evaluation questionnaire (Table 2) to which they signed their name.

After a student finished an activity the number of points earned was recorded on a grade sheet that indicated the two-week interval during which he submitted the completed work. There were eight two-week intervals during the semester. Points were summed for each interval and these sums were cumulated to obtain the rate at which students completed the activities. Frequency distributions of cumulative points for all the students were presented to the students at two-week intervals.

The students' written papers were graded by the instructor, the teaching assistant, or one of the two undergraduate proctors. All four members of the teaching staff graded all of the papers turned in during the first two weeks to establish common grading criteria. The undergraduate proctors received two semester hours of credit in a reading for their work. Their working time was devoted to talking with students, operating the laboratory, grading papers, and reading articles.

RESULTS

The top portion of Fig. 1 contains four histograms showing the number of students in each grade category at the end of Week 2, 6, 12, and 16. Histograms from Week 4, 8, 10, and 14 resembled those of adjacent weeks. The grade categories were determined by noting how many points a student should have accumulated after, say, two weeks if he were working steadily (linearly) toward any of the four grades. The histograms for Weeks 2, 6, and 12 reveal that over half (19) of the students had done little or no work by the end of the twelfth week.

The twelfth week marked the cut-off date for those students eligible to work for an A. Only two students met the original criterion of 500 points. This criterion was lowered to permit the six students who had performed at a rate above a B to work for an A. Five of these six elected to do so and they all met the original final criterion of 600 points.

The cross-hatched areas above the F, D, and C grades at 16 weeks indicate the number of students who had accumulated sufficient points for that grade category, but who also requested an Incomplete. One year after the end of the semester, the two C-incompletes had completed the requirements for a B. One of the D-incompletes finished the work for a C, the other did not and received a D. Of the five F-incompletes, one moved to an A, one to a B, two to a D, and one remained an F.

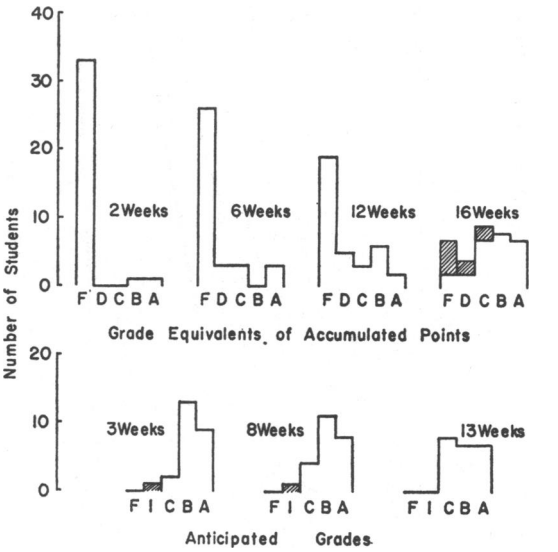

Fig. 1. Frequency distributions of obtained grade equivalents and anticipated grades at different points in the semester.

The three histograms in the lower portion of Fig. 1 indicate the grades the students said they were working toward at three points during the semester. The "I" indicated a choice of Incomplete. Their actual and anticipated grades were inversely related early in the semester, but by Week 13 they were in close agreement.

Figure 2 contains individual cumulative point curves for typical students from each grade category. The data were plotted at two-week intervals. The curves are labeled with a number and a letter. The number is the student's rank in the class after 16 weeks. The letter is the grade he received. The mean cumulative point curve for the 35 students is plotted with open circles on the scale at the right of Fig. 2. This mean curve remained

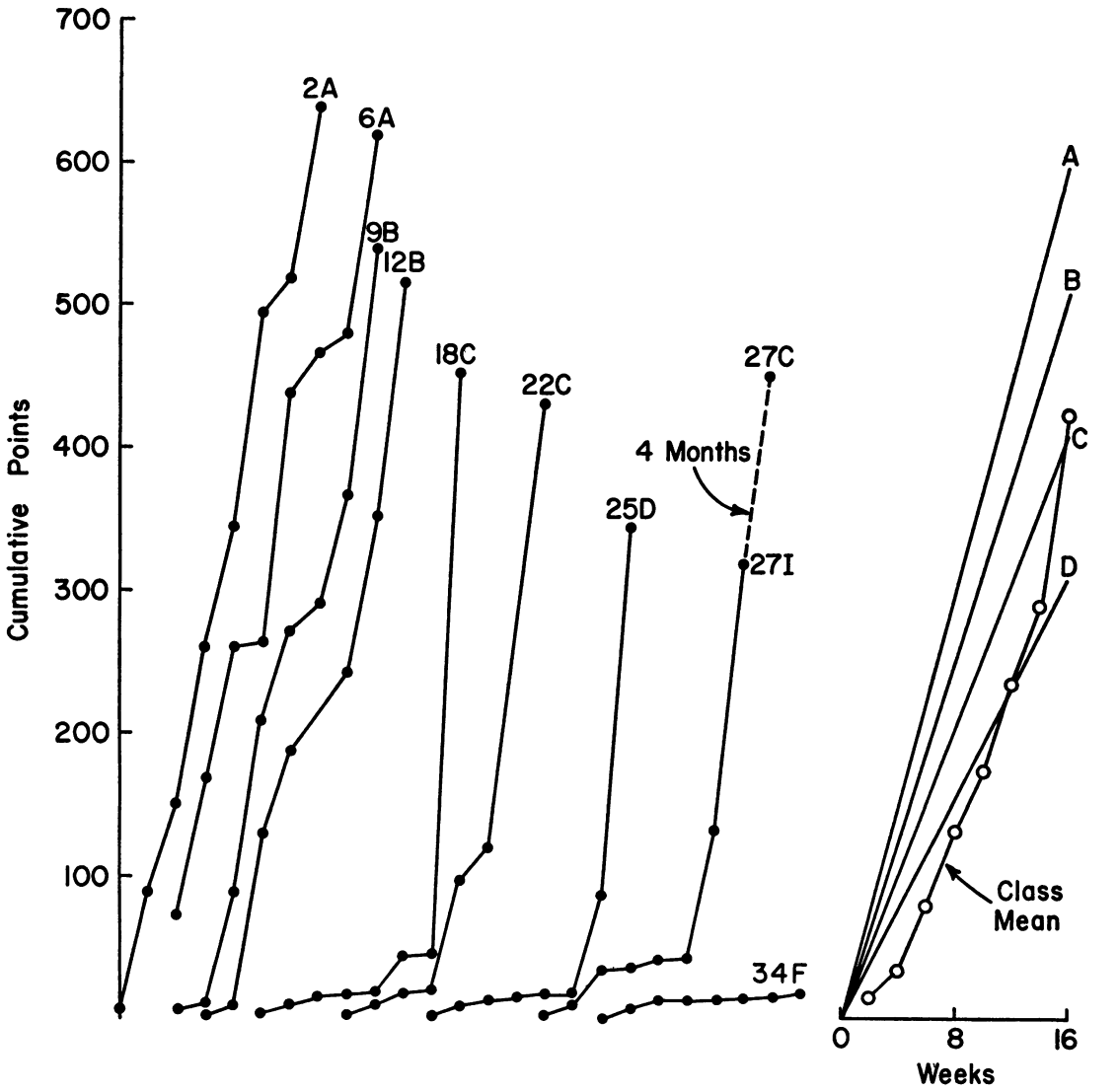

Fig. 2. Cumulative point curves at two-week intervals for typical students from each grade category. The scale on the right indicates linear response rates for the different grades. The class mean cumulative point curve is plotted with open circles.

below the D level until the twelfth week of the semester, after which it rose to a C level.

These curves indicate two important features of student performance. First, there is a direct relationship between the time at which the student began to turn in appreciable amounts of work and the final grade he received. The A students began working within two weeks, the B students began after four weeks, the C and D students started several weeks later. Student Number 34 never started. Student 27 would have received a D, but he requested an Incomplete and four months later completed the requirements for a C. Second, although different students began working at different times, once they did begin to work they all worked at approximately the same rate. Students 18 and 34 represent extremes in response rates. The remaining students all performed more similarly to Student 18 than to Student 34. When they worked their response rates exceeded the linear rate for an A grade.

The items in the course evaluation questionnaire are in Table 2. Since all students did not perform all activities, the number of responses

varies from item to item. Responses to Item 1 were variable and often were similar to those made to later items. Several comments were repeated by five or more students. Eight students reported there was too much work in the course, seven said that the method "fools (misleads) the student who dallies", six said they "couldn't help but learn", five reported that the D criterion was too high ("In this course you have to work to get a D—in most courses a D is what you get if you don't work!"), and five said that the teaching staff should attempt to shape responding early in the semester. Twenty-three students included a comparison or rating of this course with other courses. Seventeen of these 23 students said the course was excellent or good, six rated it as poor or terrible. In response to Item 2, ten students said they were overworked, eight said they were not and six were undecided. These comments were not related to their anticipated grade.

The response to Items 3, 4, and 5 are summarized in the last five columns in Table 1. Although students responded to Item 3 by listing a point value, only the number of times students said that the point value for an activity should be changed is indicated in Table 1. For example, 18 students listed an increased point value for reading *Walden II*, none suggested a decrease, and none gave it a minus rating, that is, none thought it should be eliminated from the course. Five students listed it as one of the two best-liked activities (Item 4), and one student considered it a least-liked activity (Item 5). The most favored activities were the laboratory work and the field trip. The most disliked of the activities were the readings and the tape-recorded discussions.

Responses to Item 6 largely expressed regret at not having started working sooner. However, 11 students described how they would attempt to reinforce their own responding on ratio or interval schedules for performing activities. Responses to Item 7 requested some form of instructor control. Twenty students requested deadlines, 12 wrote that bonus points given early in the semester would be helpful, one suggested that points be removed as punishment, and five requested no change in procedure. In Item 8, the median choice of the per cent of class time to be devoted to the four alternatives was 50% for questions, 30% for lectures, 30% for discussion groups, and 10% for work periods. The number of stu-

Table 2

Items in the Course Evaluation Questionnaire

Number	*Item*
1	What is your general opinion of Psychology 291?
2	How many points do you expect to accumulate by January 31? Considering the point requirements in this course, what will your grade be? Do you feel you have been overworked for this grade? Comment.
3	For each activity in the course indicate what you think its point value should be in comparison to the point value it was assigned in the course. Also rate each activity plus or minus depending on whether you feel it should be kept in the course or not. (A list of activities followed.)
4	What two activities in this course did you like best?
5	What two activities in this course did you like least?
6	In the space below draw a cumulative curve indicating your approximate rate of accumulating points during the semester. If you could turn the clock back to September 21 and considering what you have learned about rates of responding, how would you change your performance in this course?
7	What do you think is the instructor's responsibility in controlling your rate of behavior? For example, should he leave it to the student as it was done in this course? Should there be deadlines? Should there be bonus points for rapid rates of responding?
8	How do you feel class time should be spent? a. Instructor questions student, that is, the way Psychology 291 was conducted this semester. b. Lectures by instructor. c. Group discussion. d. As a work period in which you would read the text or outside readings. e. If you prefer a combination of ways of spending class time, estimate the percentage of class time you would like spent in a. through d. above.

dents selecting each alternative was 17, 15, 18, and 2, respectively.

DISCUSSION

The purpose of this paper has been to describe a method of programming a university course and to examine the performance of students enrolled in it. Several suggestions for future courses may be made. If some means of inducing more students to begin working sooner were arranged, then more of them should complete more activities. This is a reasonable prediction, since once students began to work they worked at a high and steady rate; once started no students arbitrarily quit working part way through the semester. Introducing various deadline and due dates for completing activities would produce more work earlier. Such deadlines could be maintained throughout the course or it might be possible to impose them early in the semester and then remove them. Hopefully, at some point the content of the course would begin to control part of the student's behavior. Mallot and his associates (1968) programmed an Introductory Psychology course in which daily assignments and due dates served to maintain behavior at a steady rate throughout the course.

The original assignment of point values to the activities was an arbitrary decision. The responses of students to the questionnaire indicated several possible changes in point values. Although most of the indicated changes were in an upward direction there was a differential recommended increase. For example, increasing the point value for reading the text or for the staff-student discussion was recommended only twice, while doing the same for *Walden II* and for the taped discussion was recommended many times. These recommended point changes would increase the likelihood that the point values for one activity would be equated to those for another activity. At present this is only an assumption, even though the data in Fig. 2 are plotted as if equal intervals were established.

Another assumption was that certain activities in the lower grades would be facilitative components for the A activities. An empirical examination of the role played by these component activities should be made. Despite some obvious faults, the course demonstrated how students behaved under the contingencies of the class. The data provide a baseline against which to compare the effects of different conditions that can be introduced into subsequent classes.

The method used here considerably changed many of the customary ways in which both the instructor and the students behaved. For example, instead of passively meeting for two or three class sessions per week, students were actively participating in all phases of the course. They were interacting with the teaching staff and other psychologists throughout the semester. Performing many of the activities required their presence in the psychology laboratory. Encountering students in the halls or various rooms set the occasion for interaction in a way that is less likely to occur before or after a class meeting. Simply meeting them in this way did not guarantee that the conversation would include a psychological topic, but this proximity was a prerequisite for the conversation.

The program permitted the instructor to illustrate for the student some of the principles of behavior being discussed in the course. It was possible to distinguish clearly between a system that employed large reinforcements after a long chain of behaviors and a system employing many small reinforcements for short sequences of behavior. It was possible to indicate how performing one set of responses could facilitate performance on another activity that included as components the first set of responses. Discussions of such questions induced students to re-examine the role of the teacher and student in an educational system and to consider different ways in which educational environments could be constructed.

Finally, this method of programming a course removes many of the ambiguities associated with teaching. The student can read and write with considerable confidence that what he is doing will pay off. He can always discriminate where he stands in relation to the goal he has set for himself. Likewise, the instructor is informed about what the student has been doing because everything the students does can be submitted for evaluation. When the instructor talks with a student about his work, he can be very specific in the suggestions he makes.

One possible step for the future would involve an arrangement in which the behaviors established in one course would serve as com-

ponent behaviors for a succeeding course. The use of prerequisities has long been a part of educational systems, but as envisioned here, prerequisities would be defined in terms of behaviors already established in the students' repertoire. Courses organized in the manner described here demand that the instructor specify clearly the criterion behaviors he hopes to establish in his students. Doing this has long been considered aversive by educators in all fields. Programmed textbooks already represent one step in this direction. Programming entire courses may point the way to further specification of student behaviors that instructors seek to reinforce.

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