EXAMINATION PERFORMANCE IN LECTURE-DISCUSSION AND PERSONALIZED INSTRUCTION COURSES¹

DAVID G. BORN, STEPHEN M. GLEDHILL, AND MICHAEL L. DAVIS

UNIVERSITY OF UTAH

Students enrolled in a Psychology of Learning course were assigned to either a lecture section, one of two similar personalized instruction sections, or a fourth section that rotated across all three teaching procedures. All students took identical midterms and a final examination. After correcting test performance for differences in the cumulative grade point average of students in the four sections, examination performance of students in the personalized sections was found to be superior to that of students in the lecture section. An analysis of class section examination performance by item type revealed that students in the lecture section scored lower on all item types, but the greatest differences occurred on items that required written responses (essay and fill-in items) rather than recognition responses (multiple choice items). A gross analysis of student performance in the class rotated across the instructional procedures suggests that personalized instruction had its greatest impact on students with "average" to "poor" academic records.

Following the outline and subsequent elaboration of Keller's "personalized system of instruction" (Keller, 1966, 1968) several persons (*e.g.*, Ferster, 1968; Gallup, 1969; McMichael and Corey, 1969; Malott and Svinicki, 1969; Pennypacker, 1969; Sheppard and MacDermot, 1970; Born and Herbert, 1971) have implemented courses that are in some way or other variations on Keller's basic theme. Although many important questions remain to be answered about the effects of various procedures within the Keller course format, among the more pressing and important questions are those related to the general effects of these procedures on the quality of student performance in comparison with the quality of performance generated under more traditional lecture-discussion procedures.

Comparisons of examination performance following instruction with traditional lecture procedures and personalized instruction procedures have been reported by both McMichael and Corey (1969) and Sheppard and MacDermot (1970). In both comparisons, the results showed that students educated with personalized procedures performed at a significantly higher level on final examinations than students attending daily lectures over the same material. The present investigation attempted a similar comparison and also attempted to identify additional ways that the resulting student performance differed. A secondary objective was to determine further the impact of these two general procedures on rates of withdrawal from the courses, and how opportunities for additional flexibility in progress through a personalized course affects student performance in that course.

METHOD

Subjects

The 60 students enrolled in a Psychology of Learning course at the University of Utah during Spring Quarter, 1969, participated.

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Procedure

The fact that different instructional procedures would be used in the course was first announced at the initial class meeting. At this time, each student was also told where to report for subsequent classes, but students were not told about the different instructional procedures to be used in the various class sections.

Before the first class meeting, the cumulative grade point average (GPA) was calculated for each of the students assigned to the Learning course through computer pre-registration. These cumulative GPAs were subsequently used as a partial basis for assigning students to the different class sections in an attempt to equate the levels of academic skills in the various sections; *i.e.*, the students were rank ordered on the basis of GPA, and the students in each successive set of four were randomly assigned to one of the four class sections.

Lecture-discussion section. Since the course was scheduled to meet on Monday, Wednesday, and Friday of each week, a 1-hr lecture was delivered on each of these days unless the instructor was out of town. Students were informed that attendance was optional and would not influence their grade, even though attendance was recorded each class meeting by asking the students to sign their name to a paper passed around the room at the start of each lecture. The lectures were prepared and delivered by the senior author who has had 8 yr of university level teaching experience and is thoroughly familiar with the course content. These lectures were designed to supplement the reading assignments but not be a "re-hash" of them. During the first lecture of the course, and after each midterm examination, students were given the reading assignments that would be covered by the next examination, and a list of the lecture topics for each class day. The reading assignments were repeated at student request, but no special attempt was made to exert pressure on students to keep up with the reading assignments.

Keller section. Provisions were made for students to attend class at the regularly scheduled time for 1 hr on Monday, Wednesday, and Friday. On class days, proctors (advanced psychology majors who were familiar with the course material) were available for giving unit tests, handing out new study units, or supplying tutorial help as required. Each student in this section was assigned a proctor at the first class meeting. The student reported to this proctor each day he attended class.

The specific course format consisted of dividing the reading material into 16 study units each of which corresponded to the first 16 chapters of the Ferster and Perrott (1968) book, and selected readings from the text by Malott, Whaley, and Ulrich (1968). Each student was held responsible for knowing thoroughly the written material in each unit. This could be demonstrated by passing a unit test with a perfect score. Unit tests consisted of 8 to 10 sentence completion or fill-in items, and 2 to 3 short answer essay questions. To aid the students in preparing for these examinations, they were given a study unit for each chapter that contained the reading assignment for the unit, and questions to direct their reading. Generally, these study questions were a sample from those provided by Ferster and Perrott (1968). The student was instructed that when he felt that he had mastered the material, he should report to his proctor and ask for a unit test. If he passed the unit test with a perfect score he was given the next study unit; if his performance was unsatisfactory, he was asked to study the material again and take a different unit test over the same material. This was continued until all 16 units had been completed.

Although there were more testing days than unit tests to be taken, and there was some opportunity for students to progress at their own rate, it should be noted that a pacing requirement was imposed upon students in this section. To be eligible to take a midterm examination, students were required to complete all study units covered by that midterm. Because mid-

terms and the final examination were scheduled the same day for all four classes, the go-at-your-own-pace feature was therefore modified, but not eliminated.

Modified-Keller section. The modified-Keller section followed essentially the same format as the Keller section with a few notable exceptions. First, each student determined the size of each of his study units. The major text, *Behavior Principles*, was written with each chapter divided into three to five parts or subdivisions. This provided 57 convenient segments of reading material for which individual study units and test questions were written. The student could, then, determine the size of his study unit by combining in sequential order the number of study questions for which he felt he could conveniently prepare. Following mastery of the material he could be given a unit test that corresponded in length to the unit for which he had prepared.

Students in the modified-Keller section were also allowed to earn a maximum of 100 extra points—the maximum number of points that could be earned from a midterm examination. These points could be earned by doing a small experiment, reading and writing a report on material related to the course in an area of special interest to the student, *etc.* The only restriction imposed was that the subject matter of the project must relate to the course content and the project must be approved by the course assistant.

As in the Keller section, a student in the modified-Keller section was assigned a proctor, and received the same study guide questions. When the student felt he had completely mastered the material he wished to be tested on, he would report to the proctor for a unit test. If his performance was satisfactory, he would select the reading assignment and receive the study questions for his next study unit. If his performance was unsatisfactory, he was asked to review the reading material and then take another unit test over the same material. This was continued until all 57 segments of the course

were completed. The pacing requirement discussed regarding the Keller section also applied to the modified-Keller section.

Rotating section. The final class section was exposed to all three of the teaching procedures previously described. This group of students started in the Lecture-Discussion section and were then re-assigned to the other sections after the first midterm examination. At this time, half of these students were assigned to the Keller section and the remaining half were asked to report to the modified-Keller section. After the second midterm examination, these students were again re-assigned, and those in the Keller section now reported to the modified-Keller class and those in the modified-Keller section reported to the Keller class. Regardless of the section to which they were assigned, the instructional procedures in effect were those appropriate to the particular class they were attending.

Testing procedure. The primary measures of course effectiveness were the midterm and final examinations common to all sections. These examinations consisted of multiple choice items in which one, some, or all of the choices could be correct, fill-in items, and short answer essay or definition items. Each midterm included about 30 test items, and the final examination had 60 items. These examinations were constructed by the senior author without prior knowledge of the study questions assigned to students in the Keller and modified-Keller classes.

All examinations were given in the same room to all students at the same time. Each student was given a test to which a numbered slip of paper had been attached. The students were instructed to write only their name on the numbered slip, detach it, and return it to the course assistant. To prevent grader bias these slips were placed in an envelope until grading of the examinations was completed.

Scoring of the completed examinations was done independently by the three authors. Each exam reader scored each item on each examina-

tion and recorded his scores on a separate sheet for each student. When exam scoring was completed, a total score for each summary sheet was obtained and a mean of the three totals for each student was computed. This mean score served as the numerical grade the student received for the examination. Only at this stage were the numbered slips matched with the examinations so that the names and sections of the students were revealed to the authors.

At the conclusion of the course, the scores from the two midterms and the final examination were summed for each student and a distribution of total scores was obtained for those students in the lecture-discussion section. This distribution was divided in the traditional way into letter grades of A, B, C, D, and E (failing) by the senior author. Generally speaking, the location of a cut-off line in this distribution was based upon a number of considerations; *e.g.*, the senior author's personal standards of excellence for certain letter grades, relative student standing in the distribution, and gaps in the distribution. The total examination scores of the Keller, rotating, and modified-Keller sections were then compared with this distribution from the lecture section and final letter grades for all students were assigned using the cut off lines from the lecture-discussion section.

RESULTS

Examination Performance

Inter-grader agreement. To evaluate inter-grader agreement of total scores assigned each midterm and final examination, each grader's scores were correlated with those of each of the other two graders. Over the three examinations these Pearson *r* correlations ranged from +0.79 to +0.96, with a median correlation of +0.83.

Examination scores. Because of variation in the total number of points that could be earned on midterm examinations and the final examination, each student's score on each of the examinations was converted to a percentage score; that is,

$\frac{\text{points earned}}{\text{points possible}} \times 100$. This conversion permitted a direct comparison of examinations and facilitated further statistical analysis.

Unfortunately, the initial assignment of students to the four class sections was based on a list of students who pre-registered for the course, and not on the list of students who actually attended the first day of class. Eleven of the students who pre-registered failed to appear in the classroom and these pre-registration withdrawals quite markedly altered both the number of students and the distribution of GPAs in each of the class sections. In an attempt to adjust the class sections for initial differences in student quality, the data were subjected to analyses of covariance, with cumulative GPA the covariate. The data included in each of the following analyses were from students who completed the entire course; *i.e.*, partial data obtained from students who withdrew from the course or who failed to take one of the examinations for other reasons have been excluded from the following analyses.

A 3×4 (tests $\times$ class sections) analysis of covariance revealed a statistically significant main effect of both class sections ($F_{3,36} = 4.18$, $p < 0.05$) and examinations ($F_{2,74} = 5.02$, $p < 0.05$). A comparison of the four adjusted class section means using the Duncan Multiple Range Test showed the lecture-discussion section statistically different ($p < 0.05$) from each of the other sections, with no other statistically reliable differences. The statistically significant main effect of examinations is of little interest, and shows only that the three examinations were not of equal difficulty.

Table 1 shows, for each class section, the number of students completing the course, the mean GPA of those students and the standard deviation of that distribution of GPAs, the unadjusted mean score on each of the three examinations and the standard deviation of those exam scores, and the adjusted mean score for each examination. Although the lack of a statistically significant interaction ($F_{6,74} = 1.36$,

$p > 0.05$) between instructional procedures and examinations prevents a thorough analysis of the class section means over the three examinations, there is sufficient *a priori* interest in similarities and differences among the four sections on the first examination to warrant making comparisons of these means. A Duncan Multiple Range Test of the four class section means on the first examination revealed the Keller and modified-Keller sections were both statistically different ($p < 0.05$) from the Lecture and Rotating sections, with no other statistically reliable differences.

To evaluate how students in each of the four class sections scored on each of the three test item types, a percentage score for each item type was obtained for each student on each examination, and these percentage scores were combined to produce for each student a mean multiple choice (MC), a mean fill-in (FI), and a mean essay score (ESS). These mean scores were then entered into a 3×4 (test item type $\times$ class section) analysis of covariance, with cumulative GPA again the covariate. This analysis revealed a statistically significant item type $\times$ class section interaction ($F_{6, 74} = 2.26$, $p < 0.05$) and a significant main effect of both instructional procedure ($F_{3, 36} = 4.18$, $p < 0.05$) and item type ($F_{2, 74} = 35.35$, $p < 0.05$).

A comparison of the adjusted means making up the interaction revealed no statistically reliable differences among the four class sections on multiple choice items, but the lecture-discussion section scored poorer than each of the other three sections on both fill-in and essay items. In addition, on essay items the mean score of the Keller section was statistically higher than the mean essay score of both the rotating and modified-Keller sections. The relevant means and standard deviations are shown in Table 2.

Total scores and letter grades. Upon completion of the course, mean scores obtained on each midterm and the final examination were summed for each student. Perfect performance

in the course was shown by a score of 400 points; 100 points for each midterm examination, and 200 points for the final examination. Before examining the total scores obtained by students in the Keller, modified-Keller, and rotating sections of the course, the senior author examined the distribution of points in the lecture-discussion section and determined the cut-off for the various letter grades. As mentioned earlier, once these cut-off points were determined for students in the lecture-discussion section they were also employed in assigning letter grades to students in the other three sections of the course. Figure 1 shows the distribution of total points earned in each section of the course and the frequency with which letter grades of A, B, C, D, and E were earned by students in each of the four class sections.

Fig. 1. Distribution of total points earned and final grade assigned to students in each of the four class sections.

Student Withdrawals

Excluding students who never attended class, the pattern of withdrawals from the various sections of the course was as follows. One student (GPA = 1.80) withdrew from the Keller section after obtaining passing grades on both midterm examinations because he fell far be-

Table 1
Means and Standard Deviations of GPA and Adjusted and Unadjusted Scores on Each Examination for Each Class Section

Class Section	n	$\bar{X}$ GPA	σ GPA	$\bar{X}$ Exam Score			σ Exam Score			Adj. $\bar{X}$ Exam Score		
				Exam 1	Exam 2	Exam 3	Exam 1	Exam 2	Exam 3	Exam 1	Exam 2	Exam 3
Lecture	12	2.52	0.56	72.8	69.8	65.2	12.2	13.8	13.1	74.5	71.5	66.9
Rotating	10	2.88	0.49	75.0	77.4	82.1	13.8	9.1	8.3	73.1	75.5	80.2
Mod-Keller	12	2.82	0.63	83.0	77.9	78.8	6.6	7.0	10.6	81.7	76.6	77.5
Keller	7	2.50	0.64	84.0	79.6	78.1	10.4	8.7	15.9	85.9	81.5	80.0

Table 2
Means and Standard Deviations of GPA and Adjusted and Unadjusted Scores on Each Item Type for Each Class Section

Class Section	<i>n</i>	$\bar{X}$ GPA	σ GPA	$\bar{X}$ Exam Score			σ Exam Score			Adj. $\bar{X}$ Exam Score		
				MC	FI	ESS	MC	FI	ESS	MC	FI	ESS
Lecture	12	2.52	0.56	77.6	69.9	60.3	10.4	14.9	13.8	79.3	71.6	62.0
Rotating	10	2.88	0.49	84.4	82.2	73.5	6.5	10.1	10.0	82.5	80.3	71.6
Mod-Keller	12	2.82	0.63	85.6	81.8	71.1	5.6	6.1	13.4	84.3	80.5	69.8
Keller	7	2.50	0.64	80.4	82.4	78.8	8.4	9.9	15.4	82.3	84.3	80.7

hind after the second midterm. One student (GPA = 2.24) in the modified-Keller section insisted on attending class with students in the lecture-discussion section after he had successfully passed unit tests over approximately three chapters of material. This student subsequently attended lectures, earned a low C grade on the first midterm, and finally withdrew from the course. None of the students in the rotating section withdrew until they were assigned to the Keller or modified-Keller sections. Following re-assignment, two students (GPA's = 1.21 and 2.00) dropped out of the rotating group after spending one and three weeks (respectively) in the non-lecture sections. One of these students (GPA = 1.21) insisted that he could not do well under the Keller procedures and was subsequently granted permission to remain with the lecture group. He performed poorly on each examination and earned a final grade of E. The other student officially withdrew from the course. There were no withdrawals from the lecture-discussion section.

Student Examination Performance Within the Rotating Section

The rotating section was included in the design of the present investigation to determine the feasibility of making an intra-subject evaluation of the teaching procedures used. Unfortunately, intra-subject variability in examination scores was sufficiently great to preclude an analysis at the level of individual students. However, in an attempt to determine whether the various teaching procedures affected good students and poorer students in this section similarly, each of the three sets of examination scores for the entire class was rank ordered, with the lowest score receiving a rank of 1. The rotating class was then divided and the ranks of the five students scoring at the top of the class on the first examination were averaged for each of the two remaining examinations, and the ranks of the five students scoring in the lower half of the class on the first examination were similarly averaged. These mean ranks are shown in Figure

2. Generally speaking, the examination performance of students in the upper half of the class was not differentially affected by the different teaching procedures, possibly because of a ceiling on the test scores. However, the change to personalized instructional procedures produced an increase in the lower half of the rotating class. From these data it would appear that the major contribution of personalized instructional procedures is that they develop higher levels of excellence in "good" to "poor" students—a result that tends to justify "top-heavy" letter grade distributions (like those in Figure 1) to skeptical colleagues.

Fig. 2. Mean class standing on each exam of students scoring in the upper and lower half of the rotating class on the first examination. The reader should note that the lowest exam score was assigned a rank of 1, and that higher ranks are associated with higher examination scores.

Patterns of Progress Through the Course

The students in the modified-Keller course might have been expected to show a variety of patterns of progress through the reading assignments. One student in the modified-Keller section attended class only on alternate testing days and consistently completed two chapters at a time; *i.e.*, the equivalent of two units of work

in the Keller section. Another student in the modified-Keller section employed the contrasting provision and took one complete unit and a part of another to make up for missed classes at the end of the course. Other than these two exceptions, all students in the modified-Keller section elected to study and take examinations over one chapter at a time. Therefore, although there were opportunities for differences in individual rate of progress, the students in the modified-Keller section tended to progress through the course in a manner like the students in the Keller section where a study unit corresponded to a single chapter in the book.

One further difference between the modified-Keller and Keller sections is of interest. Although students in the modified-Keller section were allowed to design and execute their own projects for academic credit, only three students took advantage of this option, and all three contracted to turn in a paper for extra points. In all three instances, the students had earned A grades on the basis of their examination performance, and additional points from the project were not needed to obtain a grade of A.

DISCUSSION

Earlier reports of the impact of Keller-type instruction on students in university level classes have indicated a higher withdrawal rate than usually occurs in more traditionally taught courses (Keller, 1968; McMichael and Corey, 1969; Sheppard and MacDermot, 1970; Born, 1971). In the present investigation, there is also slight evidence of a higher drop rate. Excluding pre-registration withdrawals, no students withdrew from the Keller section, one student withdrew from the modified-Keller section, and two students withdrew from the revolving section. Interestingly, the two students who withdrew from the revolving section did not withdraw until they were requested to rotate to Keller-type classes. The fact that the median GPA of students withdrawing from the personalized sections was 1.91 (range from 1.21-2.42),

whereas the median GPA of students completing the course was 2.66 (range 1.21-4.00), is important considering the claim that personalized instructional procedures generate higher quality student performance than more traditional lecture-discussion techniques. The possibility exists that performance in personalized courses is superior on the average because academically poorer students tend to withdraw from classes taught in this manner.

Evidence that the additional effectiveness of the Keller instructional method cannot be accounted for solely on the basis of differential withdrawals was obtained from an analysis of examination scores earned in the various sections of the present course. Since the analysis of covariance presumably corrected the class section means for differences in the GPA distributions, the obtained differences are not simply a consequence of the fact that poorer students tend to remain in the lecture-discussion section of the course.

The finding that academically less successful students withdrew from the personalized courses is at odds with findings of Sheppard and MacDermot (1970), who reported that the average GPA of students withdrawing from their personalized courses was comparable to the average GPA of students completing the course. In the past few years the senior author has taught several personalized beginning psychology courses, and students withdrawing from these courses have typically come from the pool of poor to mediocre students (Born, 1971). For example, in the most recent course, the average GPA of the 27 students who withdrew was 1.99, and the average GPA of the 71 students completing the course was 2.62. Thus, withdrawal by poorer students seems to be characteristic of our classroom procedures, and it would be important to know precisely which features of the Sheppard and MacDermot course alter this pattern of withdrawals. As in the case of Sheppard and MacDermot, the most frequent comment by students withdrawing from our courses was that they are "too much work" (Born and Herbert,

1970), and we have assumed that withdrawals are related to study habits; *i.e.*, students who typically study regularly tend to carry a higher GPA and find the personalized course procedures require no special change from their regular study routine, whereas students who study infrequently might tend to earn a lower GPA and find the course demands considerably more work. The Sheppard and MacDermot finding suggests there may be other interpretations of the higher withdrawal rate associated with personalized courses.

At the time of the second midterm examination, two students were absent because of illness and were allowed to take the same exam several days later. Both of these students were in the lecture section. On the last day of class, in discussing the course procedures and preliminary results in lecture, both of these students indicated that they were not in fact ill at the time of the second exam, but rather that they had not finished reading all of the assigned material and feigned illness to gain additional time to study. Although each of them had read the major textbook, a study of the related readings, the content of which was also included on the examinations, had not been completed. Also, two other students from the lecture class who took the examination at the regularly scheduled time reported that in spite of intensive "cramming" they also did not have time to study the related readings carefully, but did manage to skim read that portion of the assigned course work. Since students were required to complete unit examinations before taking the midterms in the personalized classes, the need for intensive cramming was eliminated. Likely, the forced pacing of study behavior in the personalized classes is a major factor in the differences in examination performance obtained in the present experiment.

Although valuable data were gathered by including the rotating section in the present experiment, some problems developed with students in this section which should be considered in future classroom investigations employing intra-subject designs. These problems were as-

sociated with complaints about the course from several students. A potential source of these complaints comes from the fact that students in this section were subjected to a different teaching procedure about every three weeks. One consequence of this frequent re-assignment to a new classroom and teaching staff was that these students failed to develop the personal friendships with the teaching staff that emerged in each of the other sections. Thus, although their instruction was "individualized" it was not necessarily "personalized".

Generally speaking, the data related to how different class sections scored on different examination item types confirm and extend the findings of other investigators. Both McMichael and Corey (1969) and Sheppard and McDermot (1970) found that personalized procedures produce better student performance on multiple-choice items, and the latter investigators found these same students perform better on essay questions as well. Although there were no statistically reliable differences among the class sections on multiple choice items in the present experiment, the lowest mean performance was obtained from students in the lecture section. On fill-in and essay items, however, the lecture section was significantly poorer than each of the other sections. Possibly superior performance by students in the non-lecture sections on items that required written responses resulted from the fact that unit tests in the personalized classes required students to compose written answers, and there were, therefore, many opportunities for proctors to "shape" examination writing skills. Because there were no multiple choice questions on unit tests there were no similar opportunities to develop skills in answering multiple choice items. Not inconsistent with this suggestion is the fact that students in the Keller section performed better than students in all sections on essay items. Because there were fewer students in this section, proctors presumably had more time to spend with each individual student and could do a more thorough evaluation of student mastery of course material.

Although not previously mentioned, an extensive questionnaire was completed by each student at the end of the course. Generally, the questionnaire revealed the same general findings reported by Gallup (1969) and Sheppard and MacDermot (1970); the personalized courses were judged to be a great deal of work, virtually free of cheating, and demanding a higher level of mastery than would be required in a similar class taught with the lecture method. Eighty five per cent of the students completing the personalized classes indicated that they enjoyed the class and would recommend it highly to their friends; only about half of the students in the lecture section indicated they would make a similar recommendation. Among students in the rotating section, the only group exposed to both lecture and personalized procedures, four out of 10 indicated a preference for lecture. However, for reasons mentioned previously these latter data should be interpreted cautiously. All things considered, personalized instruction would appear to be an important step in the direction of solving some of the serious problems in higher education.

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