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THE EFFECTS OF STUDY QUESTIONS AND GRADES ON STUDENT TEST PERFORMANCE IN A COLLEGE COURSE[1]

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Two experiments demonstrated the effects of study questions on student test performance in an introductory college course. Students in both experiments correctly answered study question items 20 to 30% more frequently than non-study question probes. Furthermore, mean performance on study question items was better than 90% during all phases of both experiments. The present experiments were also designed to study the effects of grades on test performance, and the relationship between long and short sets of study questions. The results of Experiment I clearly illustrated the importance of using grades to maintain high levels of student test performance. The results of Experiment II suggested that long sets of study questions may produce better performance on probe items than do short sets of study questions, but the effect was small.

Several educators (Bloom, 1956; Mager, 1962; Gagne, 1965; Block, 1971) have emphasized the importance of study objectives to promote and maintain high levels of student test performance. Furthermore, many investigators in the area of contingency management and personalized instruction in higher education (Born, Gledhill, and Davis, 1972; Keller, 1968; McMichael and Corey, 1969; Sheppard and MacDermot, 1970) have advocated the use of study objectives. However, few studies have analyzed their effects thoroughly and systematically.

Research by Miles, Kibler, and Pettigrew (1967) demonstrated that students who were given study questions in advance performed 15.2% better on unit examinations than students who were not given objectives. However, they made no attempt to control for changes in assignment or item difficulty between study and non-study question conditions, and they made no within-group or within-assignment comparisons. The present study used a within-group design and attempted to control for differences in item difficulty both between and within conditions.

In a more recent study, Jenkins and Deno (1971) compared test scores from several experimental groups that received study objectives and 90 min of formal instruction or study time with test scores of students who received no objectives, no instruction, and no opportunity to study the material. The experimental groups averaged 78.4% correct on a multiple-choice criterion test, compared with 68.9% correct for the control subjects. The outstanding performance of the control subjects should not be dismissed lightly. They averaged 68.9% correct, and they had not even been exposed to the course material. The use of objectives and instruction accounted for only a 9.5% increase in performance. The authors did not attempt to determine whether objectives, instruction, or both led to this relatively small increase in performance.

Jenkins and Neisworth (1973) also reported that objectives enhanced test performance. The

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authors randomly divided their class into two groups. One group received objectives that were related to test items 1, 3, 5, 7, and 9. The other group received objectives correlated with test items 2, 4, 6, 8, and 10. Students correctly answered 60.9% of the items when objectives were provided (range = 9 to 95) as compared with 34.2% for the same items when no objectives were provided (range = 0 to 75). The effect was large, but performance on study objective items did not indicate complete mastery of those objectives.

The studies discussed above suggest that study objectives facilitate test performance. However, the methodological problems cited mitigate against strong conclusions. Moreover, none of them demonstrated that thorough mastery of the material could be produced by using study objectives.

A second purpose of the present study was to investigate the use of a within-group, reversal design to isolate the effects of a specific variable in college teaching research. The variable selected was test grades. Similar to the literature on study questions, the use of grades in college teaching has been discussed extensively, but researched little. Thus, the present study was designed to investigate the effects of grades on student test performance.

EXPERIMENT I: STUDY OBJECTIVES AND GRADES

Experiment I investigated the effects of grades and study objectives on test performance.

METHOD

Subjects, Materials, and General Course Organization

Forty six students enrolled in an introductory child development course during Summer Semester, 1971, served as subjects. One instructor and a teaching assistant taught the course. The course was divided into three major content segments: (1) Cognitive Development and Socialization; (2) Experimental Analysis of Behavior; and (3) Biological Basis of Development. Each segment was divided into four units. A unit consisted of a 40-page reading assignment from the course texts[2] and a set of 14 five-alternative multiple-choice study questions. Students were not required to answer study questions, but they were informed in the course outline that many of the questions would be repeated on quizzes and hour examinations.

Two class days were devoted to each unit. One of these days was used for optional, nonrequired discussion meetings. Students were informed in advance that they would not be tested over material presented during the optional discussions. The second day of the unit featured a 12-item multiple-choice quiz and immediate feedback of the quiz results. Quizzes were collected immediately after they had been discussed. Each quiz item counted one point toward the student's course grade. Quiz scores were converted to letter grades as follows: 11-12 = A, 9-10 = B, 7-8 = C, and 0-6 = F. A 48-item hour examination was administered at the conclusion of each of the three major course segments. Each item counted one point toward the student's course grade. Hour-exam scores were converted to grades as follows: 42-48 = A, 34-41 = B, 26-33 = C, and 0-25 = F.

Students recorded quiz and hour-exam responses on IBM answer sheets that were graded by both a course assistant and an IBM Optical Scanner. Reliability between the two scoring procedures was 100%.

Quiz and Hour Examination Items

Each quiz consisted of 12 five-alternative multiple-choice items, six of which were sampled from the student's study questions (SQ items), and six of which were selected from the

[2]Course texts included *Readings in Developmental Psychology Today* (Cramer, 1970), *Child Development I: A Systematic and Empirical Theory* (Bijou and Baer, 1961), *Child Development II: Universal Stage of Infancy* (Bijou and Baer, 1965), and *Human Development Lecture Notes* (Semb, 1971).

instructor's item pool (Q items). About half of the items used in the present study had also been used with 496 students during the previous semester (Spring, 1971), so an attempt was made to equate items assigned to SQ and Q conditions in terms of their previous "difficulty". Difficulty was defined as the proportion of students who had answered the item correctly. Within each unit, previously used items were ranked in order of difficulty; items were then assigned randomly to SQ or Q conditions such that each condition had an equal number of difficult and easy items. The remainder of the quiz items (previously unused items) were randomly assigned to SQ or Q conditions.

Hour exams consisted of 48 items. Twelve items were selected from each of the four units that constituted a course segment. Three items per unit were chosen from each of the following categories: (1) study questions that had appeared on a unit quiz (SQH); (2) study questions that were repeated on the hour exam (SH); (3) quiz items that were repeated on the hour exam (QH); and (4) non-study, non-quiz questions (H). Items that had been used during the previous semester were matched for difficulty and randomly assigned to the four categories using the same procedure described for quiz items. Items that had not been used during the previous semester were randomly assigned to item categories.

Experimental Design

The experiment consisted of a within-group reversal design. Furthermore, comparisons were made within each unit between performance on study and non-study questions. The experimental conditions included:

Baseline (B). During baseline conditions (Quizzes 1, 3, 4, 5, 6, 9, 10, and 12), students earned one point per correct response on each quiz.

Differential reinforcement of other responses (DRO). During DRO conditions (Quizzes 2 and 11), students earned one point per incorrect response. That is, students earned points by responding to any of the four incorrect alternatives, but not the correct one. The instructor announced the DRO contingency for Quiz 2 at the time the quiz was distributed. The DRO contingency for Quiz 11 was announced through written instructions distributed with the unit's reading assignment.

Noncontingent points (NP). The instructor announced before Segment 2 began (both orally and through a written instruction sheet) that Units 7 and 8 included material that the instructor had never used before. He further explained that, rather than grade students on material about which he was uncertain, he would simply present the material and administer quizzes as usual, but that performance on the quizzes would not count toward the student's grade. Students received the maximum number of points (12) for Quiz 7 and Quiz 8 regardless of their performance. To receive full credit, however, students still had to report to class and take the quiz. This was done to ensure that students would actually take quizzes and not simply fail to report to class.

The hour exams also included a noncontingent point control during the second half of Segment 2. The instructor informed students before Segment 2 began that they would receive maximum credit for the second half of the segment regardless of their performance, as long as they responded to each item.

Results and Discussion

Study questions (SQ) and non-study questions (Q) were analyzed separately. Per cent correct for each item type on each quiz is plotted in Figure 1. During baseline, mean performance on study questions varied within a narrow range between 93 and 99% correct ($X = 96.2$). Performance on non-study questions was much more variable (range = 58 to 83), and was consistently lower than performance on study questions ($X = 72.0$).

During DRO conditions, performance on both types of items decreased to less than 10% correct. Furthermore, performance was poorer

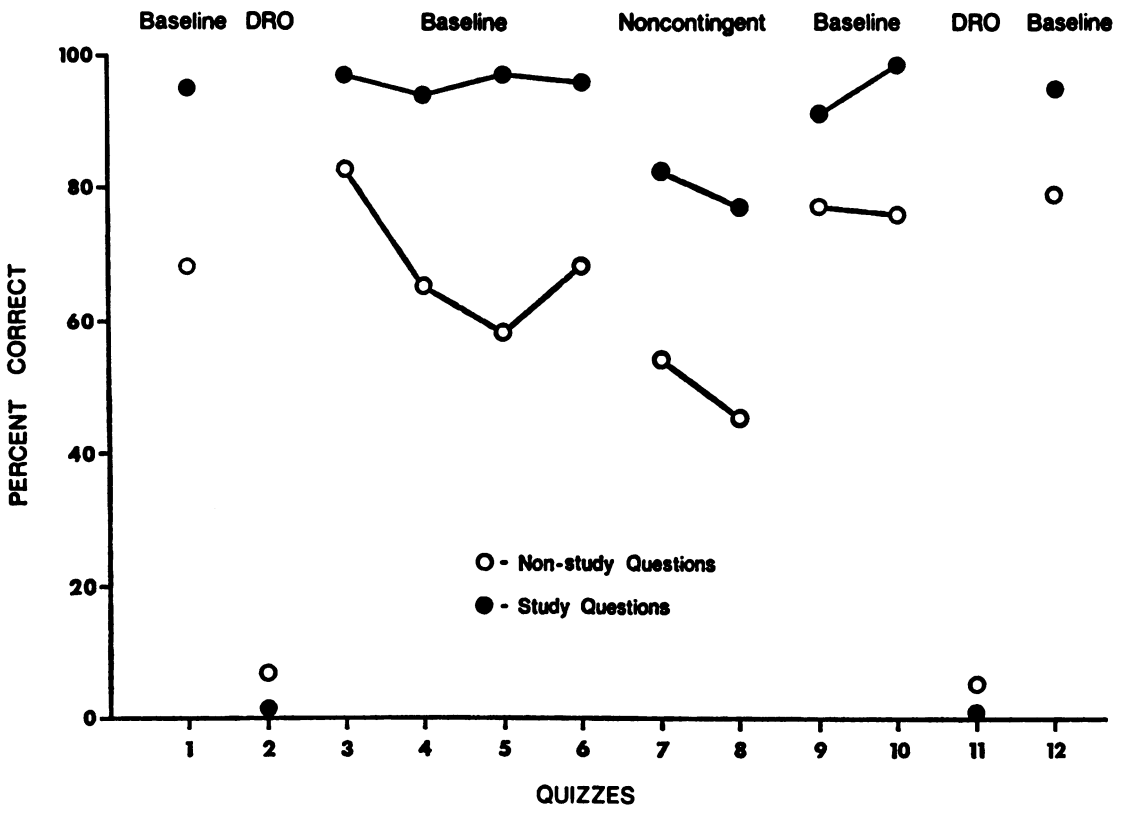

Fig. 1. Mean per cent of quiz items answered correctly for study and non-study question items during the three experimental conditions: baseline (B), differential reinforcement of other responses (DRO), and noncontingent points.

(more points were earned) on study question items than on non-study questions. "Chance" responding on a five-alternative multiple-choice test is 20% correct; the results for both DRO quizzes fall far below the "chance" level.

During the two noncontingent units, performance on study questions decreased from a baseline mean of 96.2 to 80.0% correct. Similarly, performance on non-study questions decreased from 72.0 to 50.7% correct. Forty two of the 46 students performed worse during the noncontingent units, two performed slightly better, and two remained at their baseline levels.

Results from the three hour-examinations are plotted in Figure 2. During the three baseline conditions, students correctly answered 97.1% of the items that had appeared on both the study guide and a unit quiz (SQH items). They correctly answered 92.2% of the items that were repeated from the study questions (SH items), but only 83.3% of the non-study questions that had previously appeared on a unit quiz (QH items). Performance on items that had not previously appeared as study questions or on a unit quiz (H items) was 64.4% correct.

Performance on the hour exam during the noncontingent portion of Segment 2 decreased anywhere from 14 to 25% from baseline levels in each item category. Furthermore, the relationships among item categories remained relatively constant. Average per cent correct for each of the four categories during the noncontingent portion of the hour exam was as follows: SQH—77.3, SH—68.8, QH—67.0, and H—44.0 per cent. Forty two of the 46 students performed worse during the noncontingent conditions, two performed slightly better, and two remained at their baseline levels.

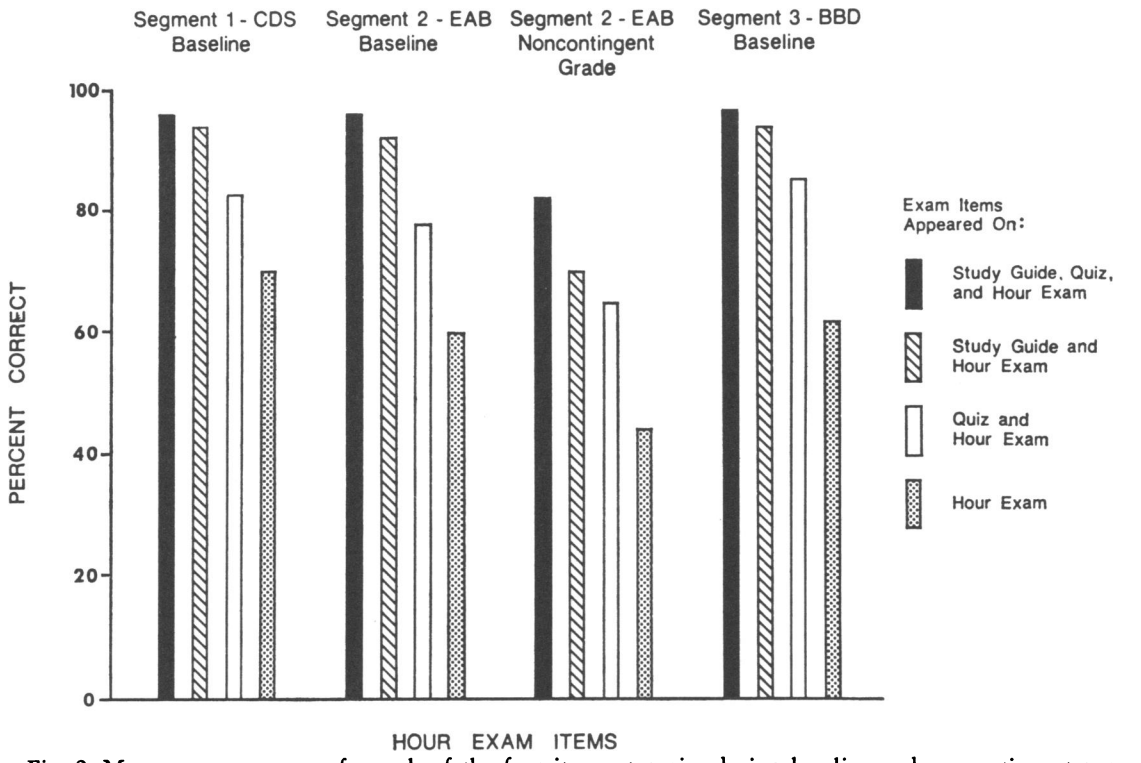

Fig. 2. Mean per cent correct for each of the four-item categories during baseline and noncontingent portions of the hour examinations.

Performances on items that had been used during the previous semester are analyzed in Figure 3. Item difficulty during Spring Semester did not vary more than 3% across categories—the mean across all categories was 58.3%. Quiz items (right side of Figure 3) were pooled across conditions in which no experimental manipulations occurred. Performance on study questions rose significantly from a Spring level of 59.3% to 96.7 during the Summer ($t = 11.03$, $df = 54$, $p < 0.001$).[3] At the same time, performance on non-study questions increased from 59.3 to 70.5% correct ($t = 2.35$, $df = 62$, $p < 0.05$).

Hour-exam items were analyzed only for the baseline conditions (left side of Figure 3). Performance on SQH items increased from 59.4% correct during the Spring to 97.3 during the Summer ($t = 10.72$, $df = 38$, $p < 0.001$), SH items increased from 59.1 to 92.3 ($t = 7.25$, $df = 30$, $p < 0.001$), QH increased from 57.0 to 83.5 ($t = 4.45$, $df = 36$, $p < 0.001$), and H items increased from 57.2 to 66.2% ($t = 1.07$, $df = 34$, $p > 0.25$).

What is important about these results is that a 30% increase in performance was obtained simply by giving students study questions in advance.[4] In terms of relative gains, study ques-

[3]The t-tests presented in Experiment I were calculated on the basis of the per cent of students who answered each item correctly during the Spring Semester compared with the per cent of students who answered it correctly during the Summer. Independent t-tests were used; thus, degrees of freedom (df) refer to the number of questions in each item category (Figure 3).

[4]The study question effect was replicated during Fall Semester, 1972, with 460 students (Semb, *unpublished*). Performance on study questions as well above 85% correct, even when only an hour exam was administered at the end of four units of materials with no intervening quizzes, and when oral lectures replaced written assignments. Performance on non-study questions averaged 60% correct, similar to the results reported in Experiment I of the present study.

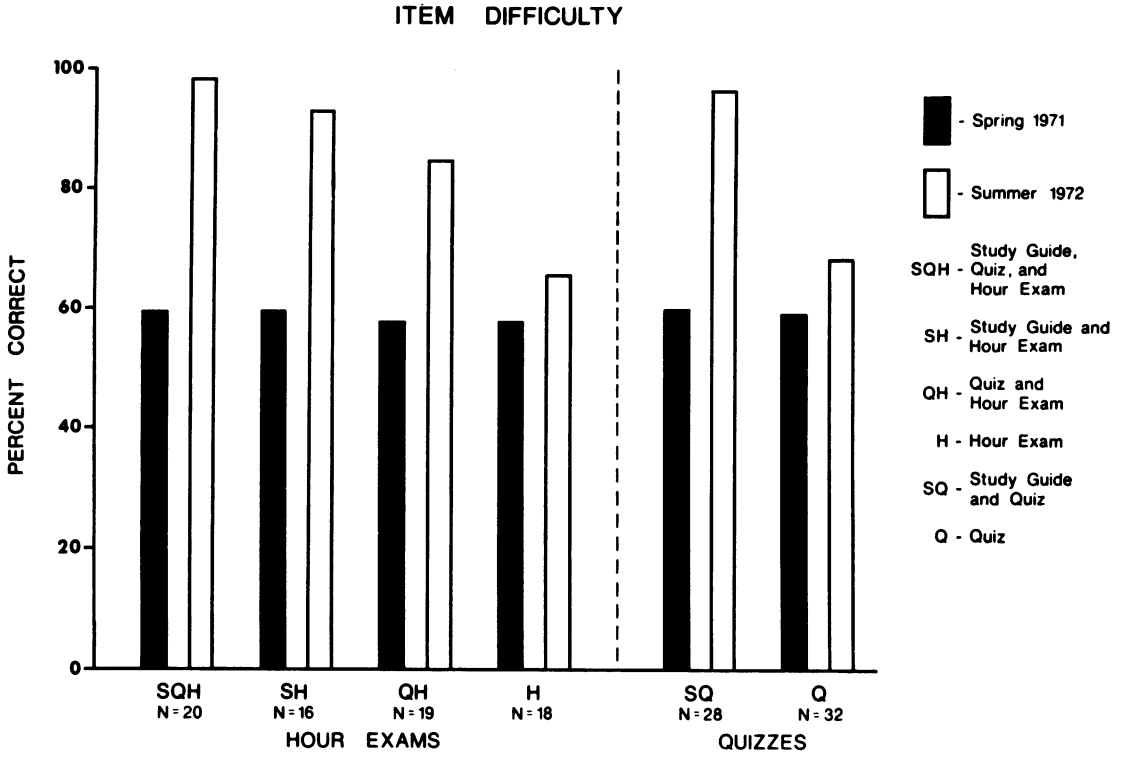

Fig. 3. Mean per cent correct for items used during Spring and Summer Semesters. N indicates the number of items in each category.

tions were answered correctly 50% more frequently than non-study questions. The increase held whether items were sampled on a short unit quiz or a more comprehensive hour examination.

The results from Experiment I are similar to those reported by Miles *et al.* (1967) in which students answered study questions far more frequently than non-study questions. However, there are two important differences. First, the magnitude of the effects in the present study (nearly 30% increases) is much greater than that in Miles (15% increases). Second, students in the present study answered nearly all of the study questions correctly (over 90%), as compared with 69% in the Miles study. These differences may have arisen because students in the present study were given the entire study question, whereas Miles gave students only the stem portion of multiple-choice study questions. Another possible factor is that Miles used a slightly larger item pool (80 items per segment), as compared with 70 items per segment in the present study. Both of these factors may have contributed to the differences in performance reported, but they remain empirical questions that deserve further investigation.

Experiment I also suggests that grades (points) are important consequences for correct responding. When students were told that they would receive points for incorrect responses (DRO), performance decreased to nearly 0% correct. Furthermore, when students were instructed that points would be given noncontingent upon performance, performance on all types of items decreased between 15 and 25%. The implication of these findings is that highest performance levels are produced when a grade contingency is imposed on behavior. Although this may not be a surprising finding, it is clearly an experimental demonstration of the functional relationship between grades and student test performance. Finally, the within-group reversal design used in Experiment I may pro-

vide a model for investigating other variables in college instruction.

EXPERIMENT II: THE EFFECTS OF SHORT-ANSWER STUDY QUESTIONS ON TEST PERFORMANCE IN A COURSE TAUGHT BY PERSONALIZED INSTRUCTION

Although the results from Experiment I demonstrated the importance of study questions, their use in personalized systems of instruction (PSI) has not been researched systematically. The use of study questions is not one of the five major features of PSI as originally outlined by Keller (1968). Yet, several investigators (Born *et al.* 1972; McMichael and Corey, 1969; Sheppard and MacDermot, 1970) have stressed their importance as part of the PSI package.

The purpose of Experiment II was to isolate the effects of short-answer study questions on test performance in a PSI course. It was also designed to investigate the difference between long and short sets of study questions, and the difference between student-answered and instructor-answered study questions.

METHOD

Subjects, Setting, and General Course Organization

Students enrolled in an introductory course in child development (N = 607) served as subjects. One instructor, two teaching assistants, and 45 undergraduate-student proctors managed the course. Proctors received course credit for their efforts in direct proportion to the number of hours they worked.

To complete the course, students had to pass a series of 20 quizzes with a score of 90% correct or better on each quiz. Students could take each quiz as many times as necessary to meet the criterion. Quizzes were available in a small lecture room between 8:30 a.m. and 3:30 p.m. Monday through Friday, and between 7:00 p.m. and 9:00 p.m. Monday through Thursday. Unlike many PSI courses, students in the present study were not assigned to a specific proctor. Rather, the student reported to any proctor who was available.

The course was both student-paced and instructor-paced in that the student could work as fast as he wished, but he had to maintain a minimum rate of progress or withdraw from the course. The minimum progress criterion was designed to prevent a large number of students from having to take many quizzes during the last few days of the semester. Students who completed the course received a grade of A.

Study Questions and Quizzes

The course was divided into four major segments, each of which was subdivided into four units. A unit consisted of a 30-page reading assignment taken from course texts[5] and a series of short-answer study questions. The instructor furnished written answers for half of the study questions. The other half were left unanswered, and students were instructed to find answers in the readings. Twelve units had 16 study questions, eight of which were answered. The remaining four units had 32 study questions, 16 answered and 16 unanswered. Questions were randomly assigned to categories.

The first four quizzes in every segment were defined as "content" quizzes. The fifth was a "review" quiz that covered the preceding four content units. Each content and review quiz contained 10 short-answer questions. The first eight items were selected randomly from the study questions such that there were four answered and four unanswered items. The remaining two questions were selected randomly from the instructor's pool of eight non-study questions per unit. Different forms of each quiz were computer-generated for each student.

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[5]Course texts included *Readings in Developmental Psychology Today* (1970), *Elementary Principles of Behavior* (Whaley and Malott, 1971), and *Human Development Lecture Notes* (Semb, 1971).

Research Design

Experiment II featured a within-assignment, within-group experimental design. Within each unit there were three types of questions: instructor-answered study questions, student-answered study questions, and non-study questions. The number of study questions was investigated with a within-group design in which 12 units included 16 study questions, and four units contained 32 study questions.

Reliability

Proctors graded quiz responses as either correct, incorrect, or ambiguous. Students were interviewed over ambiguous responses to determine if their answers were acceptable or non-acceptable. To obtain a measure of grader reliability, the course instructor graded one quiz from each student at the end of the semester using the same code for written responses—correct, incorrect, or ambiguous. Reliabilities were taken on 607 quizzes. There were 313 tests on which no disagreements occurred, 267 on which there was one disagreement, 28 on which there were two disagreements, and four on which three disagreements occurred. Average reliability, calculated by subtracting disagreements from agreements and dividing by agreements $\times$ 100, was 94.2%.

Results and Discussion

Results from the 16 content quizzes are plotted in Figure 4. Per cent correct includes only those items graded as correct by proctors on the student's first-taking of a unit quiz. Data on quiz retakes are not included in the present analysis. Performance on instructor-answered study questions varied between 93.4 and 98.0% correct, with a mean of 96.2%. Performance on student-answered study questions was slightly more variable (range = 81.1 to 96.2), and averaged 91.9% correct. Performance on non-

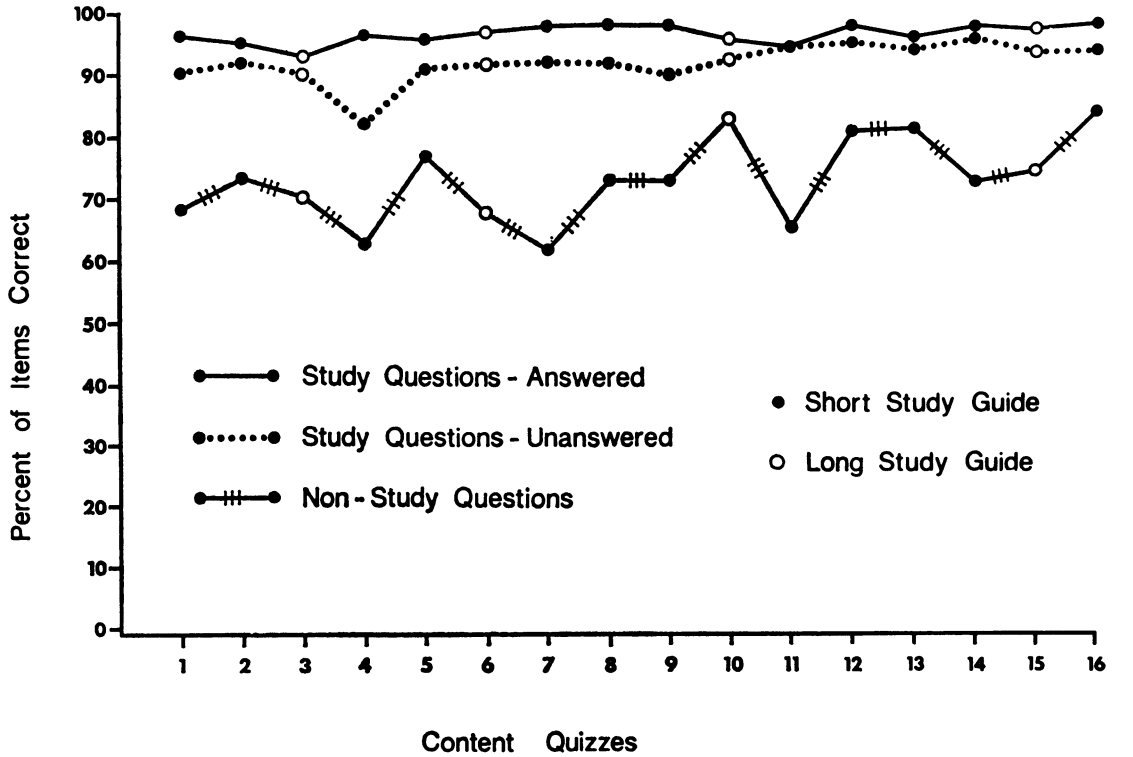

Fig. 4. Mean per cent correct for each item category on content quizzes.

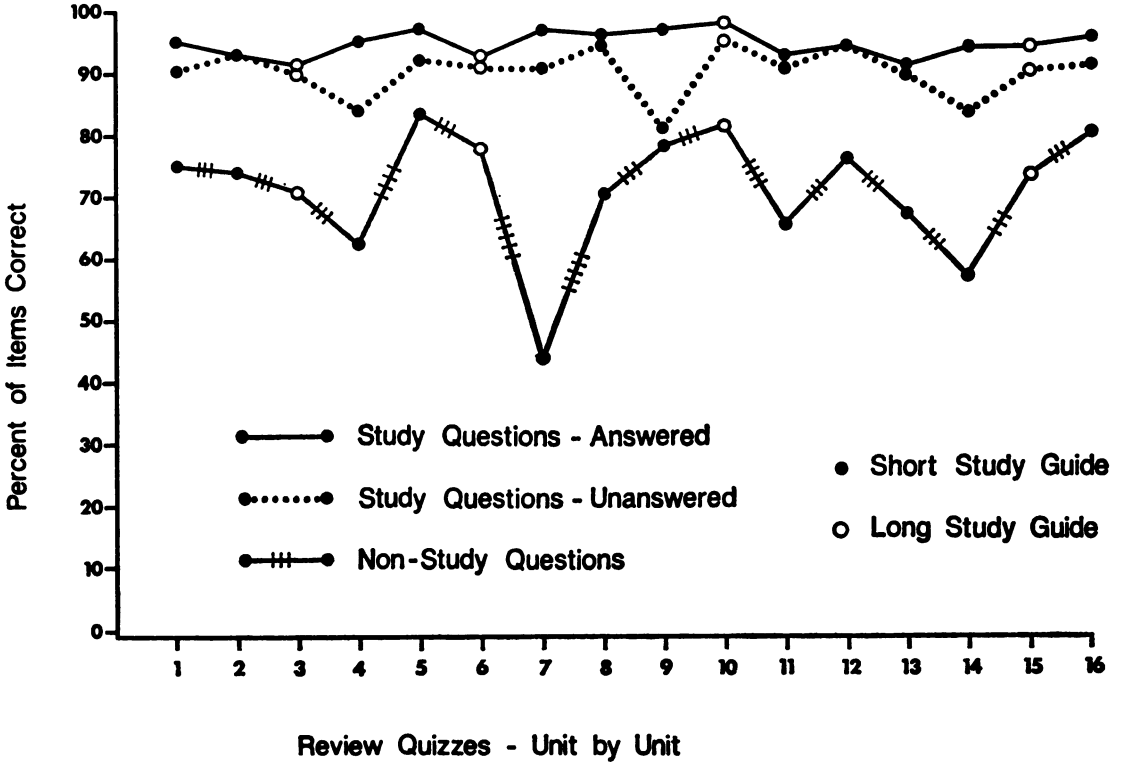

Fig. 5. Mean per cent correct for each item category on a unit-by-unit analysis of review quizzes.

study questions was highly variable (range = 61.9 to 84.3), and averaged 73.8% correct.

A unit-by-unit analysis of performance on the four review quizzes is presented in Figure 5. Again, per cent correct includes only those items that were graded correct on first-take review quizzes. Variability in all three-item categories was higher than it was in respective categories on content quizzes. Mean per cent correct on answered study questions was 95.6, as compared with 92.7 for unanswered study questions, and 74.3% for non-study questions. These differences were nearly identical to those reported for the content quizzes.

Finally, a comparison between long (N = 32) and short (N = 16) sets of study questions is presented in Figure 6. There were no consistent differences in performance between long and short study guides in any of the item categories, although there was a tendency for students to answer more of the non-study questions correctly in the long study guide condition.

The results of Experiment II again illustrate the powerful effect of study questions on test performance. It is not surprising that students mastered nearly all of the answered study questions. However, it is encouraging that they averaged over 90% correct on unanswered study questions. The tendency for students to answer more of the non-study questions correctly in the long study guide units suggests that increasing the number of study questions may enhance performance on novel probes (non-study questions). An important extension of the present study would be to use even longer study guides to determine if performance on probe items increased as a function of an increased number of study questions.

GENERAL DISCUSSION

The results of Experiment I clearly illustrated the importance of grades in maintaining high levels of student test performance. It should be

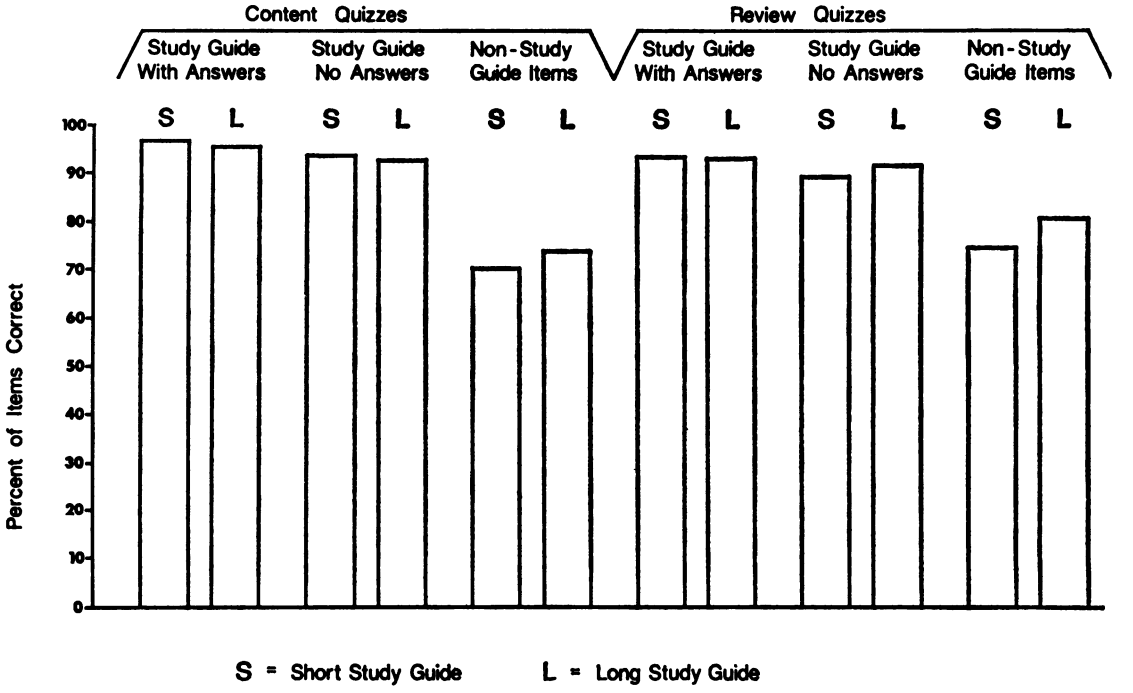

Fig. 6. Mean per cent correct for each item category for long (L) and short (S) sets of study questions.

pointed out, however, that all of the manipulations performed in Experiment I included instructions to students about the relationship between performance and grades. The effects of instructions were not separated from the actual grade contingencies imposed upon students for political reasons. For example, it would have been politically unwise for the instructor to announce that points would be awarded for incorrect responses *after* a DRO quiz had been administered. Because most college instructors inform students in advance about how they will be tested and graded, the same model was adopted in the present study.

The results of both experiments clearly demonstrated that students answered study questions correctly on quizzes and exams 20 to 30% more frequently than non-study questions. These findings are similar to those reported by Miles, Kibler, and Pettigrew (1967), Jenkins and Deno (1971), and Jenkins and Neisworth (1973). Unlike the previous findings, however, students in the present study mastered nearly all of the study questions at 90% correct or better. Increased performance and near mastery of study questions remained invariant despite changes in the testing format and type of questions used. Furthermore, the present studies used within-assignment and within-group designs, and an attempt was made to keep previous item difficulty constant at least during Experiment I.

Critics might argue that students learned nothing more than correct answers to a finite pool of study questions. It is interesting to note, however, that performance on non-study questions (probes) during all phases of Experiment I was better than it had been on the same items during the previous Spring Semester (Figure 3). This suggests that students did not simply memorize answers to study questions—if they had, one might have expected poorer performance on non-study questions. Although it cannot be argued that study questions led to improved performance on non-study probes, it is certainly the case that it did not lead to inferior performance. In Experiment I, students were given a total of 168 multiple-choice study questions, 108 of which were samples on either a

unit quiz, hour exam, or both. Perhaps 168 study questions are too few for an introductory college course, but that remains an empirical question.

The results of Experiment II also argue against the critics of study questions. Students in Experiment II were given a total of 320 study questions, nearly twice the number provided in Experiment I. Although direct comparisons between Experiments I and II cannot be made because different teaching procedures and different types of questions were used, average test performance on non-study probes was higher during Experiment II than it had been during Experiment I. Furthermore, it is interesting that the magnitude of the study question effect was approximately the same in both Experiment I and Experiment II. Finally, students in Experiment II performed better on non-study probes during the long study guide conditions than they did during short study guide conditions (Figure 6). These results suggest that study questions may produce better learning, but further experimentation is needed to determine more precisely the relationship between study questions and performance on probe items.

The results of Experiment II indicate that performance on instructor-answered study questions is slightly better than performance on student-answered questions. This might imply that an instructor ought to eliminate reading assignments and rely solely upon instructor-answered study questions for course content. The results of Experiment II do not support such an interpretation. Experiment II compared two types of study questions, both of which were answered correctly at high accuracy levels. The difference between instructor-answered and student-answered study questions, although consistent, was small. Furthermore, no research has assessed the effects of either type of question on probe performance.

The overall study question effect is important for at least three reasons. First, students answer study questions correctly far more frequently than non-study questions as measured by test performance. Second, they can be used to produce near mastery of material as defined by performance on test items sampled directly from the study question pool. Finally, it is likely that they are a major academic variable in both semi-traditional and personalized instruction approaches to college teaching. Although the comparison between study questions and non-study questions in a PSI course has not been made, it is certainly an area for future investigation.

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