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ABSTRACT

In order to make formal instruction more responsive to individual needs, the following study implemented a procedure for transforming a conventional set of course materials into an interactive learning environment. The basic mechanism for interaction was a computer generated and computer administered quiz that sampled from concepts in the reading materials, provided immediate feedback, and identified concepts with which students were having difficulty. (Author/CK)

A Concept-Sampling Procedure for Quiz-Oriented Instruction

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Paper delivered at AERA

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In order to make formal instruction more responsive to individual needs, the following study implemented a procedure for transforming a conventional set of course materials into an interactive learning environment. The basic mechanism for interaction was a computer-generated and computer-administered quiz that sampled from concepts in the reading materials, provided immediate feedback, and identified concepts with which students were having difficulty.

The principal objective of the study was to demonstrate the feasibility of the model in Figure 1. The content of the course was organized around two books, Conditions of Learning by Gagne and Conditioning and Instrumental Learning by Smith and Moore. The content area consists of topics, roughly corresponding to chapters, and related concepts. For each topic a bank of items was prepared to test concept mastery. Students received study guides, later took one or more quizzes until meeting criterion, and then were permitted to "practice" the item-bank in preparation for a final examination randomly selected from the area item-bank.

In addition the study examined the effect of quizzes on learning and retention to determine whether exposure to an item in the context of active responding altered performance. Also studied was the relationship between items, concepts, and topics, primarily to develop a procedure for formative evaluation of the item-bank. Finally, affective reactions were observed, with a view to formative evaluation of the quiz procedure and its relation to the total course.

Method

Thirty students enrolled in a summer course in "Principles of Learning in the Classroom" served as subjects. Most were teachers in suburban Long Island communities. Eleven class meetings were held with topics arranged according to the syllabus in Appendix A.

Each class meeting was three hours in duration, beginning with an hour lecture on the topic for the following session. The lecture elaborated on a study guide that was handed out (Appendix B) in preparation for the next meeting. The class then divided into a discussion group and a lab group. The former discussed student reports, while the latter moved a short distance to the Stony Brook Computer-Assisted Instruction Laboratory for a quiz on the current reading assignment. After 45 minutes the groups exchanged places, and 45 minutes later the lab was open to anyone for quiz retakes.

Item bank. The development of a course "data base" proceeded in the following manner:

1) topics were selected and arranged according to the major emphases in the text materials. Gagne provided a comprehensive framework, with his hierarchy of learning types; so topics corresponded closely to chapters in his book. A total of eight topic groupings were prepared, one for each quiz (cf. Appendix A).

2) Concepts in each topic grouping were identified by subdividing appropriate text material into eight sectors roughly equivalent in length, each having a unity of focus. Whereas the number of topic groupings could have varied, the number of sectors was fixed at eight in order to use the sampling procedure described below. In half of the sectors a single dominant concept was identified, such as "problem-solving" (cf. Appendix C). In the other half a dominant sub-topic ("family concept") was identified, around which several concepts clustered (e.g., "conditions of problem-solving"). For purposes of this study "concept" was defined as a category or construct represented by a term (single word or short phrase) that received emphasis in the text material.

3) Items were prepared by attaching to the concept name a "property list", analogous to property lists that are assigned to "atoms" in the computer language LISP (McCarthy et al, 1962, Weissman, 1968). The elements of the "data base", therefore, were the concepts, not the items. Concept properties consisted of unique or critical features associated with the concept, which both differentiated it from other concepts and linked it to a larger structure, such as the sub-topic or topic groupings. These properties were converted to items in two modes:

a) From sectors with a single concept, eight statements were prepared as true and false items (Mode 1). These statements attached to the concept name (header) either relevant or irrelevant properties (cf. Appendix C). Half of the statements became true items (relevant features), the other half false (irrelevant).

b) From sectors with a "family concept" (concept-cluster), eight matching phrases were prepared (Mode 2). The task in this mode was to type the header word, or its first letter, that most closely matched the feature represented by the phrase.

Again, the number of items was fixed at eight by the constraints described in the following section.

<u>The concept-sampling procedure</u>. Since an exhaustive check of each student on each concept would have required a quiz of excessive length, and since instructors generally regard a sampling of student performance as sufficient, only five of the eight concepts (i.e. single concepts or concept-clusters) appeared on each quiz attempt. (Each "attempt" corresponded to a different form of the quiz.) Moreover, only four of the eight items appeared, making a total of 20 items per quiz (cf. Figure 1).

Sampling was performed randomly at both levels from a total bank of 64 items (eight items by eight concepts). The five concepts appeared in four cycles, with a different random ordering and a different item number during each cycle. In theory, the size of the quiz bank permitted almost 4000 different combinations of 20 items. In practice, however, the amount of overlap was considerable, but generally well below 50%.

The algorithm for the concept-sampling procedure was programmed by the author in Coursewriter II for use with the IBM 1500 system consisting of cathode-ray tube terminals linked to an IBM 1800 computer and peripheral devices. The Coursewriter code was generated by means of an IBM 360-67 using QUIZ Generator, a modification by the author of the PL-I program CLUEG (Clue Generator) developed at the Stony Brook Computer-Assisted Instruction Laboratory.

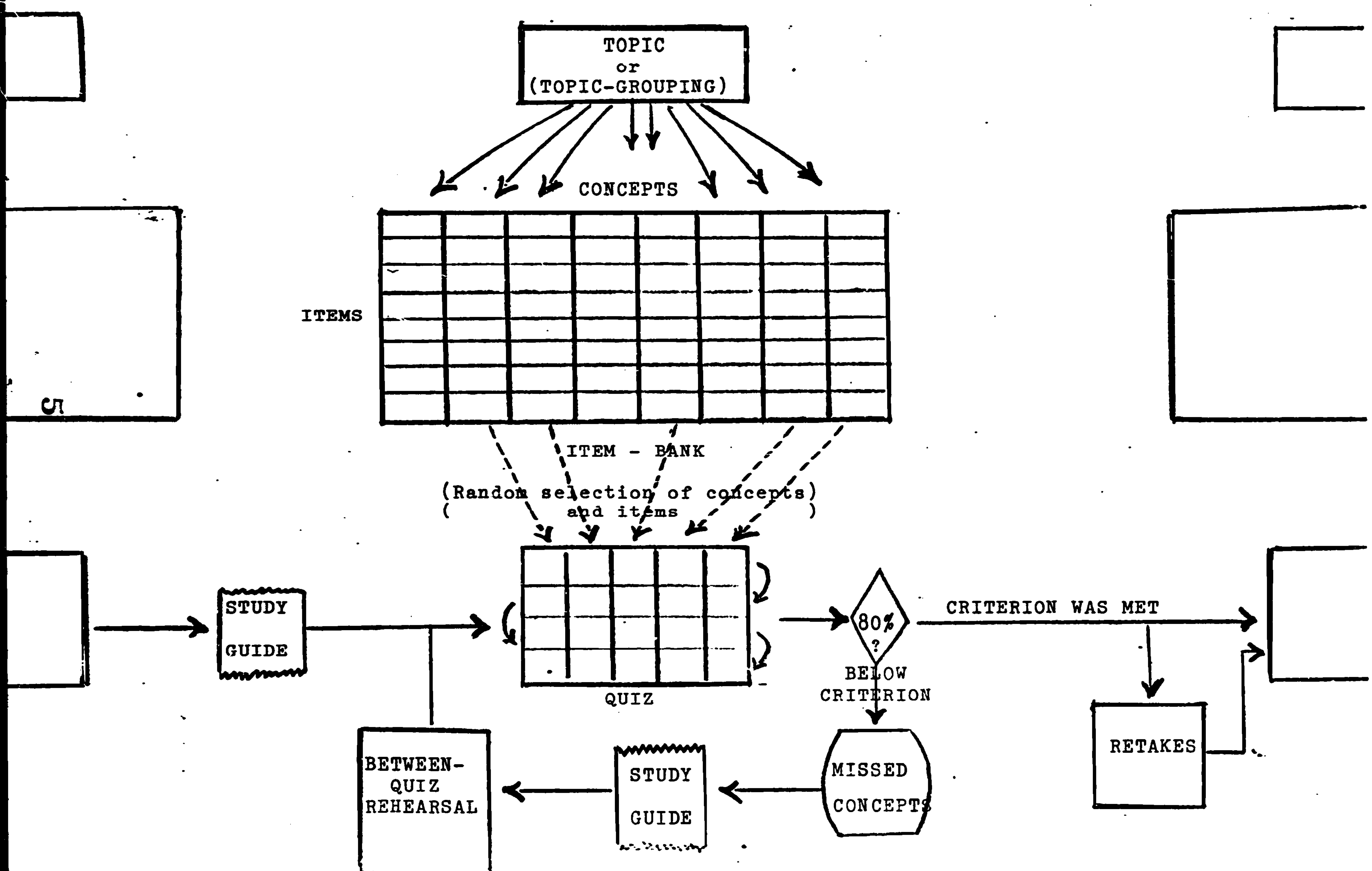

Figure 1. Concept-sampling procedure

Criterions for mastery and diagnosis. Two major kinds of decisions were made at the end of quizzes. Performance on the subset of concepts was taken to indicate the level of mastery of the topic. The topic mastery criterion remained at 80% throughout the course.

If the topic mastery criterion was not met, the concept mastery criterion was applied for diagnostic purposes. A major reason for allotting four items per concept on the quiz was to gather enough information to make diagnosis possible. The name of each concept on which the student made at least two errors was displayed in order to permit the student to consult a study guide. This guide, handed out with the reading assignment, provided page references for each concept.

Following a 10-minute pause in the program, the student was allowed to retake the quiz. During the interval he was encouraged to rehearse his knowledge of the topic, especially the displayed concepts, by reading, talking to other students or the instructor, or by going to a "practice terminal" where two or three students could make a practice run through a quiz together.

Scoring and pacing features. Continuous feedback was provided by displaying the desired response just below the student response and by showing the current score at the bottom of the screen along with the number of items remaining in the quiz. The scoring algorithm attempted to be sensitive not only to correctness of response but also to the student's estimate of his confidence in the correctness of his response.[1]

The pace at which students first encountered the array of quizzes was set by the class rather than by the individual. The quiz on the reading assignment for the day was presented to everyone, and it was necessary to meet criterion on that quiz before retaking previously encountered quizzes. While pacing was therefore in the hands of the instructor, the progress of the class as a whole was the determining factor in whether to advance to a new topic or to schedule a "catch-up" session.

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[1]For lack of a more sophisticated capability, a simple confidence rating ("high" to "low") was requested at the end of each item. The topic mastery criterion was arbitrarily set at 80% or 160 points. Thus criterion could be met by 16 correct responses on one quiz attempt if the student expressed high confidence in each response. Each item could yield ten points: seven for being correct, three for high confidence. Low confidence added nothing if correct, but if incorrect the effect of the rating scale was reversed; low confidence added three points and high confidence none, with intermediate values similarly inverted.

Quizzes encountered at previous sessions were available after the current quiz was mastered or at extra sessions. It was necessary to pass the earliest unmastered quiz before proceeding to later ones. Students were informed that the final examination would be restricted to items in quiz banks, with approximately half of them paraphrased. Once criterion was met on all quizzes so far presented, a student was allowed to "practice" any of them in preparation for the final.

The position with regard to pacing is a major departure from the Keller model (1968a, 1968b) which closely parallels procedures used in this study. Although emphasizing the use of undergraduate tutors - human support rather than machine support - Keller stresses mastery requirements, repeated testing, immediate scoring, and reliance upon the written word rather than lectures. However, he also emphasizes self-pacing that permits a student to take any quiz he is ready to take. Several considerations led the present study to take a different course:

1) Operational problems, given the limitations of the system and the program, were deemed insuperable unless students began each session with the same quiz.

2) Many items proved to be ambiguous, as in typical teacher-made (non-standardized) tests. By concentrating on one set of items at a time, students were able to support each other in interpreting these items as well as items that were non-ambiguous but still too difficult.

3) Class-pacing also gave a focus to each session and permitted the quiz to act as a catalyst for group discussion.

<u>Final examination and other measures</u>. Students were required to meet criterion on every quiz to be assured of a "C", but their quiz scores were otherwise ignored. To help lagging students and to encourage review, the quiz item-bank was mimeographed and distributed one week following initial presentation. Quiz sessions were oriented to a final examination, much as orchestra rehearsals to a concert. Half of the course grade was determined by the exam, half by class reports and discussion.

Like each quiz the final exam followed a concept-sampling procedure, except that two concepts were randomly selected from each of the eight topics and three items randomly chosen from each concept, for a total of 48 questions. Approximately half of the questions were paraphrased, while the other half had only differences in format when compared to the original quiz items.

Midway through the course, a test anxiety instrument was administered consisting of ten items on a four-point scale. At the final class meeting preceding the exam an evaluation instrument containing both scaled and free response items, was administered by a colleague.

Results

Some data is available in quantitative form, although much of the yield of the study was in the form of impressions shared by the investigating team consisting of the instructor and three colleagues.

Quiz and final exam data. Table I indicates that data is available for 639 quiz attempts. Operational difficulties in implementing the quiz model persisted until the fourth quiz, when the system finally stabilized at an average of 2.4 attempts per student. As a result, and because data for the third quiz is incomplete, only the last five quizzes were compared with performance on the final exam.

Quiz Number	Number of Attempts	Average Attempts Per Student
1	113	3.8
2	135	4.5
3	24[1]	___[1]
4	71	2.4
5	76	2.5
6	72	2.4
7	76	2.5
8	72	2.4
TOTAL	639	2.4[2]

[1]Incomplete data

[2]For Quizzes 4-8

Table I. Number of attempts by quizzes, with averages per student.

Because of overlap on successive quiz attempts, some students encountered the same item twice. For the sample of items used on the final exam, the mean proportion correct on the first quiz attempt was .60, with a significant gain on the second quiz attempt (.82, t=2.95, $p < .01$). Data therefore support the claim that exposure to quiz items and conditions that intervened between item presentations resulted in learning.

Because of the random assignment of concepts and items, some students encountered a given exam item during quiz attempts while others did not. The proportion of correct responses on final exam items drawn from the last five quizzes was computed for each group of students. The mean proportion correct for those exposed to an exam item previously during quiz attempts fell just below the 80% topic mastery criterion (.78). The mean for those not exposed was lower, but not significantly (.75,t= .66). The data provide no evidence for better retention when items were practiced under quiz conditions than when they were not.[2]

Besides investigating the effect of the quizzes, the study examined the validity of the item-bank. According to the model, if an item was correct on the final exam, another item testing the same concept should also have been correct, and vice versa. Likewise, performance on one concept should correlate with performance on the other concept from the same topic. Table II presents the number of significant correlations within and between the 16 concepts represented on the final exam. With three items per concept, each cell has a maximum of nine except on the diagonal, which has only six since correlations of each item with itself were excluded. No pattern is evident to indicate equivalence of concept items.

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[2]Not included in these results are practice terminal data, since students did not identify themselves during practice quizzes. Data was recovered from performance tapes by a PL-I program (SIFT) written by the author to produce summary data by items and students along with error matrices for input into EQUIP, a FORTRAN program also written by the author to compare both exam and quiz performance and performance on separate quiz attempts. Exam error matrices were supplied by TESTAID, a test scoring and item analysis program written by Dr. Robert Brennan (Stony Brook) and Joe Crick (University of Massachusetts).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1																
2	1															
3	3		1													
4			3													
5	1	2	2	1	3											
6	2	1	3	2	2											
7					2											
8	2		1	1	3	4	1									
9		2	1		3	2		2								
10			2	1	1			1	1							
11		1	2	1	1	2			1							
12	2		2	2		2		1		2	1					
13	1		3	1		2	2		1	1	1	2				
14			2	4	3	2	2	2	1	1		2		1		
15					3		1		2					1	1	
16				2	2	1	1	1	1					1		

Table II. Number of significant correlations of items within and between concepts on the final examination, partitioned by topics (quizzes).

Similarly, Table III presents no pattern of equivalence within topics.

	1	2	3	4	5	6	7	8
1	1							
2	3	4						
3	3	8	5					
4	2	2	9	1				
5		4	6	3	1			
6	2	7	5	1	3	1		
7	1	10	7	6	4	5	1	
8		2	6	3	3		2	1

Table III. Number of significant correlations of exam items within and between topics (quizzes).

However, a relationship is suggested between topics two and three and the others. Over 60% of all significant correlations among exam items (89 of 130) involve items from the second and third topics. The information in these topics appears to have much in common with each of the others, rather than representing distinctly different concepts.

<u>Questionnaire and test anxiety data</u>. Though the work load in the course was regarded as heavy, students tended to favor the use of quizzes and reported a strong preference for computer-assisted, interactive testing over the use of pencil and paper tests of a similar nature (Table IV).

	Per Cent (N= 27)
Amount learned from course	
not much	10
some	33
a lot	57
Effort expended on course	
very little	3
about the usual	17
a great deal	80
What feature of the course was most helpful to your learning?	
quizzes (lab work)	52
reading	37
other (study guides, lecture, class discussions)	11
Did you improve your skill in reading?	
yes	27
no	40
don't know	33
Would you have preferred the same test scheme, but with paper and pencil (i.e. no running score and no immediate indication of the right answer)?	
yes	7
no	93
don't know	0
Was the confidence rating scheme important to you?	
yes	23
no	70
don't know	7

Table IV. Questionnaire items and results at the conclusion of the course.

Students also reported on the average that about 33% of the items were "so ambiguous that you made a mistake that you really shouldn't have made". The most popular "between-quiz strategy"(for the ten-minute interval between attempts) was "practicing a quiz with others" (60%).

The amount of effort expended significantly correlated with which feature was considered most helpful (.34, $p < .05$), with all who preferred the quizzes indicating a great deal of effort spent on the course.

The average test anxiety rating on a four-point scale was 2.3, indicating moderately strong anxiety as a whole. However, only a few significant correlations with other measures were found in the data. The upper third on the final exam disagreed while the lower third agreed (.51, $p < .01$) with the statement, "In the past when taking a final exam, I have found myself so nervous that I forget facts which I really know." Also, those high on the anxiety scale as a whole showed a preference for practicing with others between quizzes. Finally, test anxiety and amount learned had a significant negative correlation (-.34, $p < .01$).

General observations. While several students noted the motivating effects of immediate feedback, even more expressed dissatisfaction with feedback that consisted of only the answer. Items were often viewed as cryptic, often lacking just one or two words to make the rationale for the answer clear.

As the questionnaire data indicated, the practice terminal appeared to hold a strong attraction for students, not only to help them with later quiz attempts but as an opportunity to interact among themselves. Lively discussions often accompanied these brief encounters. Also, in support of questionnaire reactions to the confidence rating feature was an observed tendency to register "high confidence" more or less automatically, cancelling any effect the rating might have. Even the opportunity to change one's answer at the time of the rating request went largely unused.

Students expressed dissatisfaction with the timing of quizzes in relation to lectures. In the opinion of many, rather than attempting to provide orientation for the upcoming quiz, lectures and class discussions would have been more helpful if they had been restricted to the quiz for that session.

Discussion

The study demonstrated the feasibility of a concept-sampling procedure but it perhaps suggested more questions than answers. Learning gains during the quizzes can most readily be attributed to a short-term practice effect. The absence of a quiz effect on final exam scores appears to confirm this interpretation. Evidently more is needed during the quiz than simple exposure to concept properties and correct answer feedback. One suggestion is to use complete sentences rather than phrases in presenting the concept property. Other suggestions are discussed below ("Extensions of the model").

The pattern of final exam responses failed to support any claim that items were equivalent within concepts or that concepts were closely related within topics. However, two of the topics appeared to relate closely to all other topics. These topics made use of a different book than did the others, and explicated concepts of classical and operant conditioning that were critical but largely implicit in the other book. To the extent that concept-sampling reflected underlying relationships between topics, the item-bank achieved at least a crude kind of validity. More significant, though, is the opportunity that a concept-sampling model provides for formative evaluation and continuous revision.

Apart from course content, two major questions arose during the study: (1) how to relate quizzes more effectively to the total course and (2) how to amplify the model so that quizzes themselves provide better support for learning. The first question involves both course components and pacing. Concept-sampling in this case was geared to three basic and two auxiliary components. The basic components provided continuous access to the course data base: a) a syllabus indicating the topics in the domain, b) study guides to indicate concepts, and c) item-handouts, to set forth concept properties. Quizzes came between b) and c), with no apparent difficulties.

Problems arose, however, with lectures and class reports. The former were designed to orient students to a topic in advance. As it turned out, lectures were perceived as interference because students concentrated on passing the current quiz. Class reports, on the other hand, were designed to prompt discussion that would promote transfer. Instead, too much time and energy were required to present reports to allow for sufficient discussion. Also, participation was minimal by those not presenting reports. The consensus of the class pointed in the direction of lectures and discussions more closely tied to the quizzes, somewhat in the manner of a recitation session focused on practical problems related to the concepts under study.

The class-pacing strategy gained at least some support from questionnaire and observational data. The preference for practicing with others suggested that many individuals needed others who were going at the same pace. Moreover, the strategy seemed to promote discussions at higher levels than initial assimilation of the material.

In a few cases students who repeatedly fell short of criterion were able, after shifting to new assignments, to return, meet criterion, and gradually decrease the number of attempts they need to pass new quizzes. Since they tended to view the course structure rather rigidly, a self-pacing strategy would likely have left these students in a morass of frustration.

Extensions of the model. To heighten the effect of the quizzes, a number of suggestions arose out of the study. As a result, the procedure has already been modified to include a feedback comment along with the answer to each item. A step beyond this modification, however, is a facility for asking probing questions that can identify and correct difficulties with a given concept.

Also needed are additional between-quiz activities that can relate vocabulary drill or single-concept modules to assessments of student need during the course of a quiz.

Finally, cumulative quiz profiles could be useful to both students and teachers for recognizing areas that need individual attention on a tutorial or small group basis. A student history file continuously maintained by the computer is needed to make instant teacher reports possible and to supply the contingencies for adapting quiz conditions (concepts, criteria, correction procedure, etc.) to each individual.

Additional variables for study. Because the quizzes appeared to function as catalytic agents in promoting student discussions, the question arose as to the effect of pairing students into teams throughout the course. A later study is considering this question from the standpoint of both computer-administered quizzing and "flash-card" quizzing administered by students themselves.

The instructor's role in the context of a quiz orientation has yet to be given adequate consideration. By transferring the bulk of the task of evaluating students to an impersonal entity (the quiz), the instructor found himself more free to relate to students as a helpful ally rather than as a potential threat. Students also did not appear to be reluctant about admitting their mistaken notions.

A more sophisticated use of confidence testing merits study as a vehicle for gaining precision in the estimate of a student's level of mastery. Recently developed techniques of computer-administered confidence testing require fewer items to provide as much or more information (Shuford, et al, 1966).

Summary

An exploratory study, following a concept-sampling procedure in the context of frequent computer quizzes, has demonstrated the feasibility of the technique and has raised a number of research questions. While results were not striking and refinements are needed, the procedure represents a step toward a working instructional model that involves both students and instructors at a deeper level than cursory exposure and regurgitation. The task of such a model is to define and order the basic elements of a total course, to provide a framework in which to diagnose and treat learning difficulties, but above all to open up to each student a responsive learning environment despite a growing scarcity of resources.

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Appendix A.

Course syllabus, showing the context of the quizzes.

"Principles of Learning in the Classroom"

Required Texts: Gagne, The Conditions of Learning
Smith and Moore, Conditioning and Instrumental Learning

one of the following (see "Section Reports" below):

Bruner, Toward a Theory of Instruction
Johnson, Learning: Theory and Practice
Skinner, The Technology of Teaching

Course Outline:

I. Learning

- A. Theories
- B. Types
  1. associative learning
  2. verbal learning
  3. concept learning
  4. problem-solving
- C. Process
  1. retention
  2. hierarchies

II. Instruction

- A. Models
- B. Objectives
- C. Entering characteristics
- D. Design
- E. Evaluation

Procedures:

The course will have three components: class meeting, section meetings, and lab sessions. In general, the time will be scheduled as follows:

4:00-5:00 Class meeting (lectures and films)
5:00-6:30 Section meetings, lab sessions

Section A
5:00-5:45 Section Meeting
5:45-6:30 Lab session

Section B
5:00-5:45 Lab session
5:45-6:30 Section meeting
6:30-7:00 Catch-up lab session

Section meetings will have two functions: 1) to give each individual an opportunity to present a report (typically from one of the alternative required texts), and 2) to provide a forum for discussing the regular assignments.

Lab sessions will occur in the Computer-Assisted Instruction Laboratory, where diagnostic quizzes on the day's assignment can be provided individually. Catch-up sessions will allow students to retake quizzes until they reach the criterion (minimum) level for acceptable performance.

Section Reports: Each student will select one "report topic" from those listed in the assignments below. Reports will be presented on the day indicated during section meetings.

Course Requirements:

1. Reading of the Gagne and Smith & Moore texts.
2. Performance at the criterion level on each assignment quiz.
3. Section report and participation in section discussions.

Assignments:

June 23-Introduction to the course; Learning; Theories and Types, Gagne, pp. 1-69.

June 28-Associative learning: signal learning, Gagne, pp. 94-104; Smith & Moore, pp. 1-65

Report Topics
"Why teachers fail" - Skinner, Chapter 5
"Tensions in psychology" - Johnson, article 9

June 30-Associative learning: operant learning, Gagne, pp. 104-122; Smith & Moore, pp. 66-138

Report Topics
Principles of programming learning - Skinner, Chapter 4
Is the concept of reinforcement circular? - Johnson, article 8

July 5-Verbal learning, Gagne, pp. 123-154

Report Topics
The serial-position effect and spelling - Johnson, article 13
Chomsky's difficulties with Skinner - Johnson, article 17, parts 1-5

July 7-Concept learning, Gagne, pp. 155-194

Report Topics
"Words, meanings, and concepts" - Johnson, article 19
Concepts as rules - Johnson, article 18

July 12-Problem-solving, Gagne, pp. 195-236

Report Topics
A behavioristic approach to problem-solving - Skinner, Chapter 6
A cognitive approach to problem-solving - Bruner, Chapter 1

July 14-The learning process: retention, Gagne, pp. 70-93

Report Topics
Cognitive structures and retention - Johnson, article 21

July 19-The learning process: learning hierarchies, Gagne, pp. 237-276

Report Topics
"The acquisition of knowledge" - Johnson, article 20
Mental growth and readiness - Bruner, Chapter 2

July 21-The process of instruction: models, objectives, Gagne, pp. 302-328

Report Topics
Instruction and learning: differences in theory - Bruner, Chapter 3, (also, Johnson - article 23)
Basic variables in school learning (Carroll's model) - Johnson, article 22

July 26-The process of instruction: entering characteristics - Gagne, pp. 277-301

Report Topics
What motivates students? - Bruner, Chapter 6
Mathemagenic (inspection) behavior - Johnson, article 15

July 28-The process of instruction: design - Gagne, pp. 328-380

Report Topics
Skinner's principles in review - Skinner, Chapter 10
Optimization - Johnson, article 24

Appendix B.

Study guides, showing quiz topics or topic groupings.

STUDY GUIDE #1

<u>Varieties of Learning</u>
Gagne, pp. 1-69

Give special attention to Chapter 1. Keep Chapter 2 in mind during the remainder of the course, since it presents a cogent summary of topics that will be developed later.

Be able to recognize identifying properties of the following concepts as used by Gagne.

Learning	(G: 1-7)
The associationist tradition	(G: 7-8)
Trial-and-error learning	(G: 8-11)
A conditioned response	(G: 11-13)
Insight	(G: 14-17)
Reinforcement theory	(G: 17-19)
A learning prototype	(G: 19-20)
Components of a learning situation	(G: 33-35)

STUDY GUIDE #2

<u>Classical Conditioning</u>
Smith and Moore, pp. 1-65
Gagne, pp. 94-104

A host of terms appears in these pages, often with only subtle differences between the concepts represented. Look especially at contrasts between related terms like the following:

Habituation-learning-sensitization	(S&M: 1-11)
US, CS, UR, CR	(S&M: 18-25)
Types of conditioning (backward, forward, etc.)	(S&M: 25-30)
Measures of conditioning	(S&M: 33-36)
Extinction-inhibition-disinhibition-spontaneous recovery	(S&M: 36-42)
Stimulus generalization	(S&M: 42-45)
Characteristics of classical conditioning	(S&M: 56-65)
Signal learning	(G: 36-38, 95-104)

STUDY GUIDE #3

Operant Conditioning
Smith and Moore, pp. 66-136
Gagne, pp. 104-22

More key terms in modern learning research are presented, many that look identical to terms in classical conditioning. Note, however, that concepts are often considerably different.

Concentrate on the following:

Operant vs. classical conditioning	(S&M: 15-17, 66-81)
Reinforcement--primary, secondary, generalized	(S&M: 81-85)
Reinforcement schedules	(S&M: 85-97)
Simulus and r4sponse generalization, discrimination, shaping	(S&M: 97-108)
Negative reinforcement and punishment	(S&M: 108-120)
Positive and negative reinforcers	(S&M: 12-15, 108-115)
Independent variables in conditioning	(S&M: 121-136)
Stimulus-response learning	(G: 38-42, 104-121)

STUDY GUIDE #4

Chaining and Verbal Learning
Gagne, pp. 42-47, pp. 123-154

Even though Gagne's point of view may not square with yours, focus on what he claims about the following:

Chaining	(42-45, 123-128)
Conditions of chaining	(128-131)
Problems in chaining	(131-134)
Verbal association	(45-47, 134-135)
Verbal associates	(13-14, 136-140)
Conditions of verbal learning	(136-142)
Interference	(143-147)
Meaningful verbal learning	(147-154)

STUDY GUIDE #5

Discrimination, Concept, and Rule Learning
Gagne, pp. 47-59, 155-213

Again the viewpoint is primarily behavioristic, but notice the role assigned to cognitive structures in Gagne's discussion of the following:

Discrimination learning	(47-51, 155-165)
Conditions for "Type 5 learning"	(165-171)
Concept learning	(51-56, 171-180)
Conditions for concept learning	(180-188)
Concrete and relational concepts	(172-175, 189-194)
Rule learning	(56-59, 195-200)
Conditions for rule learning	(200-203, 210-213)
Rule hierarchies	(203-210)

STUDY GUIDE #6

Problem-solving and Retention
Gagne, pp. 59-62, 214-233, 70-93

After a close look at the most complex form of learning, you will begin to consider charatteristics common to all types of learning (in Gagne's view). Concentrate on these areas:

Problem-solving	(59-62, 214-221)
Conditions for problem-solving	(221-224)
Discovery and creativity	(223-229)
Learning strategies	(229-233)
Phases in learning	(70-74)
Phases in retention	(74-78)
Kinds of remembering	(78-85)
Functions of remembering	(86-93)

STUDY GUIDE #7

Hierarchies and Readiness in Learning

Gagne, pp. 65-66, 237-301

Throughout the book, you have noted references to the effect of prior learning on present learning. Gagne is known for his hierarchical model of learning, and here he illustrates what he means. He also refuses to accept the conventional notion of readiness, as you will see in the following:

Learning prerequisites	(65-66, 237-242)
Learning structures and math	(242-256)
Learning structures and science	(256-264)
Learning structures and language	(264-275)
Attentional sets	(277-281)
Motivation	(281-289)
Developmental stages	(289-301)
Cumulative learning	(289-301)

STUDY GUIDE #8

Instruction

Gagne, pp. 302-380

All we have studied has been pointing toward this assignment. Notice how principles of learning come to bear on the following:

Introducing instruction	(302-309)
Presenting instruction	(309-319)
Instructional procedures	(319-333)
Transfer	(333-339)
Evaluation	(339-343)
Kinds of instructional media	(345-363)
Using media	(363-367)
Modes of instruction	(367-379)

Appendix C.

Sample page of item handouts,
with illustrative concepts and items

(I. Mode 1.)

Problem Solving

T 1. generates higher order rules

T 2. depends on previously learned rules

F 3. is required in order to identify colors

F 4. responses are chained, and thus the final solution is not considered until late in the process

F 5. is a sequence of logical steps that form a new rule

T 6. is more resistant to interference than discrimination learning

T 7. occurs when new plans are made for desegregation

F 8. happens gradually, after frequent repetition of the individual steps

(II. Mode 2)

Type each first letter that fits the condition for problem-solving:

<u>c</u>ontiguity   <u>g</u>uidance   <u>r</u>ecall

<u>p</u>reviously learned rules   <u>n</u>one

c 1. connecting various rules and the problem situation

n 2. describing the solution itself

g 3. excluding plausible rival hypotheses

p 4. relevant experience

r 5. making particular rules "vivid"

g 6. recognizing the goal in the problem situation

n 7. repetition

g 8. providing cues about the solution situation