Behavioral Techniques to Increase Conceptual Mastery

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William D. Ellis III
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Contingency management involves the systematic arrangement of contingencies\(^1\) in order to achieve specified behavioral objectives (Malott, 1973). The application of contingency management to education is becoming more prevalent in today's college instruction. This educational technology involves the incorporation of learning principles derived from the animal laboratory to contingency management systems which are applied to the educational environment.

The first major development along these lines was initiated by Keller (1968). In general, students in his classes received a relatively high percentage of A's and B's, reported that they worked more and were required to understand basic concepts to a greater extent in comparison with classes taught with traditional methods, and yet gave a favorable reaction to the classes in terms of the same comparison.

Other studies replicating the type of contingency management used by Keller have been conducted by others with similar results, (McMichael and Corey, 1969; Malott and Svinicki, 1969; and Michael (unpublished)).

This new technology has moved toward solving several of the traditional problems of education. In many situations, students no longer need to rely on lectures and demonstrations as primary sources of information about course materials. Instead, well programmed and sequenced written materials are made available to the

\(^1\)A behavioral contingency is an "if-then" sequential relation between a behavior and its consequences (Malott, 1973).
student, broken into small units with clear specification of the responses which must be acquired for mastery of that material. The student is no longer limited because of poor note-taking skills or an inadequate vocabulary. Also, interaction with the material is not limited because of impending social consequation in the form of instructor criticism for the student's opinion (as would exist in a large lecture or discussion group situation).

Study guides or objectives covering the units are typically made available to the student which end the "guessing-game" as to the relevance of a particular segment of the material. Only the materials for which the student will be held responsible are required to be learned, which has an added advantage to the instructor, who can clarify specifically what it is he is trying to teach. These also provide bases by which the instructor can test to see if his teaching methodology has been effective.

In an effective educational system incorporating contingency management, the student's acquired repertoire is sampled frequently. This gives a constant source of information to the student as well as the instructor as to the amount of learning that has taken place. It is becoming more apparent to educators that constant feedback for the acquisition of any material is necessary for effective learning and retention of that material. Short-term consequences seem to produce a much more consistent rate of study behavior than long term consequences. Cumulative failure due to lack of learning of one specific unit is eliminated when a mastery criterion is established and the student is tested frequently. When the information provided
by test results indicates that remediation is necessary, the student is re-tested to prevent failure in any one specific area.

Although this educational technology has had substantial success in overcoming many teaching problems, it cannot be considered to be a complete answer to the ever-pressing problems inherent in the task of education. A classroom design can never be said to be totally successful unless it teaches 100% of the course content to all student participants. Although it seems that a framework for such a classroom design has been developed through analyzing student performance in terms of behavioral principles, contingency management procedures have been aimed primarily at teaching students to display a repertoire of correct responses to a limited pool of questions based directly on (an) assigned textbook (Miller and Weaver, 1973). In this respect, contingency managers in education have been highly effective. The effectiveness of contingency management as an educational technique, however, must be evaluated in terms of the type of repertoire the student acquires in classes using this type of format. If that repertoire consists of potential answers to only a limited sample of questions related to the concepts introduced in the classroom, then the student does not receive the full potential benefit of the educational process. Optimally, the student should be able to display a repertoire of correct responses to any instance of the concepts presented in class. Many more conventional classes have this goal as a terminal objective, but often are ineffective because of the inadequate teaching methodology used. If contingency managers in education are to become more successful in their efforts, they must
also adopt an objective of more "conceptual" learning. This objective becomes extremely relevant to a class which presents a number of new concepts which serve as a basis for future learning in that particular subject area.

Conceptual Mastery

Engelmann has defined a concept as "the set of characteristics shared by a set of instances in a given universe of concepts, and not shared by other instances in that universe." In the same text, he states that a concept has been taught when all instances of that concept are responded to in the same way,"... even though some were not in the teaching set, and any or all (non-instances) are responded to in a different way." (Engelmann, Becker, Thomas, 1971).

Whaley and Malott (1971) define conceptual behavior as "generalization within a concept or stimulus class (a set of stimuli, all of which have some common property) and discrimination among concepts or stimulus classes." Reese (1972) and Woolfenden (1972) used programmed instruction to develop conceptual learning with introductory psychology students. They measured the effectiveness of their programmed materials in developing the skills of making discriminations between novel examples of the concepts being taught. The response of identifying the examples as instances of concepts used in the program was measured relative to students in the class exposed to materials which presented the concepts and examples of them but not exposed to the programmed exercises. The results indicated a significantly higher level of "conceptual mastery" with the students exposed to experimental conditions.
Similar research has been conducted by Miller and Weaver (1973) in which students were required to identify the concepts illustrated in a number of novel examples of everyday behavior. The students' performance was measured as a function of their interaction with a "concept program" in which several elementary psychological concepts were defined and exemplified, and then required the student to identify the concepts illustrated in examples which followed. By the use of a generalization test given at several intervals throughout the course, the study demonstrated that the students' ability to correctly discriminate between novel instances of the concepts tested varied directly as a function of programmed materials which gave the students practice in generalizing the concepts learned to everyday examples. Studies of this type seem extremely relevant because they increase conceptual mastery with students who will be required to use the concepts they learn in a future environment. In order to do this, they must be able to define their environment in terms of the concepts that they learn, or at least the environment in which they will be expected to use those concepts.

Attempts to increase conceptual mastery become extremely relevant when educators acknowledge that it is their objective to prepare students to deal with future environments which require the use of concepts learned in the classroom. With an increased amount of conceptual mastery as a terminal objective, it becomes apparent that contingency managers in education must consider specifically what type of skills or responses the student should be able to emit in order to demonstrate a high level of conceptual mastery. Merely
identifying all instances of a concept or discriminating these from non-instances, does not seem to be a completely adequate indication of conceptual mastery. At this point, it seems relevant to define specifically which behavioral skills would constitute "conceptual mastery," that is, skills which would indicate that the student has the behavioral repertoire necessary to apply the concept to functional use.

First, there exists a skill of definition which is demonstrated when an individual can verbalize the essential characteristics of a concept, or in other words, define a concept. This skill requires that the individual memorize a given verbal passage, but does not indicate that the individual has any skills in responding to members of that concept.

Secondly, there is a skill of discrimination, which is measured by the fact that an individual can correctly discriminate between all members and non-members of the concept set, in that he responds in one manner to members of the concept set and in another manner to non-members of the concept set. This differs from the skill of definition in that a subject is responding to actual members and non-members of the concept set, and it does not necessarily require that the subject possess the verbal skills to define the concept in question. It is a measure which is frequently used to assess conceptual mastery of infrahuman organisms (Millenson, 1967).

Thirdly, there is a skill of identification, which is indicated by the fact that a subject can correctly identify the essential characteristics of an example of a given concept. This behavior may
be viewed as one which requires the two aforementioned skills as prerequisites, in that the subject must recognize a given example of a concept set as such by verbally identifying which characteristics of that example designate it as a member of the concept set. This requires both a skill of discrimination as well as a skill of definition.

Fourthly, there is a skill of production. This may be viewed as the last of a hierarchy of behavioral skills involving conceptual mastery and is indicated by the fact that an individual can generate a novel example of a given concept. In order to do this the individual must be able to identify the essential characteristics of the concept, and then use them to design an example of the concept set which was not in the teaching set (the set members and non-members used to initially teach the skill of discrimination in relation to the particular concept). This last behavioral skill is generally not considered essential when teaching concepts (Engelmann, Becker, Thomas, 1971) but seems to be important for obvious reasons. An individual who is practiced in the creative use of concepts will be much more likely to be able to use them in an engineering or application sense. This may not be an important factor with simple concepts but is more crucial with complex concepts; e.g. concepts about relationships among events in time and space. Consider the behavioral scientist who can observe a problem situation and recommend potential manipulation of a range of environmental variables; he will be more effective in his efforts than one who merely identifies existing environmental variables. The advance of any science depends directly upon the
"creative" use by its advocates of existing basic theorems or principles. This does not mean that, by following such a strategy in our teaching methodology, we will at last have answered the questions concerning the teaching of "creativity." However, it may provide students with an increased expertise in applying concepts learned in the classroom to situations in which it is required.

This analysis of the different skills involved in conceptual mastery does not imply that there is not an appreciable amount of interaction and generalization between the hierarchy of skills involved. However, to insure that complete conceptual mastery exists, contingency managers should specify explicitly what behaviors they wish to produce in the student's repertoire. Although many courses which introduce the student to new concepts assume that a production skill is being taught and establish this as a course goal, they are in fact teaching merely a skill of identification. In order to teach a skill of production, the class must directly incorporate exercises to accomplish this, instead of falsely assuming that students will reliably generalize the facts that they have learned to their own environment. This generalization may occur in exclusive instances in which the student has had a superior past history of education, but is hardly a universal phenomenon. A goal of contingency management in education is to teach as much as possible to as many as possible (Malott, 1972) and it would be inconsistent with this theory to hope that natural contingencies prevail which influence a creative use of concepts learned in the classroom.
Student-Led Group Discussion

With the development of "creative" conceptual mastery as an objective, the contingency manager should attempt to design an educational environment which would increase the probability of that type of behavior being emitted. Student-led group discussion is an educational device used by many who have acclaimed its academic value, often in terms of increasing conceptual mastery.

In a summary of research and techniques used by psychologists in college instruction, McKeachie (1968) reviewed the use of student-led discussions. From the studies observed he concludes that "It makes theoretical sense that this opportunity to expose one's own ignorance and vent one's feelings should contribute to learning (when one can get feedback from other students)." Research of this technique as compared to others used in the classrooms in the studies cited (lecture only, film presentation and demonstration, instructor-led discussion, etc.) generally agreed on the effectiveness of student-led discussion. In studies cited by McKeachie, Leuba (1963) described students involved in student-led discussion as "having a better understanding of the concepts taught"; Gruber and Weitman (1962) describe them as being "superior in 'curiosity' (question asking behavior), complex problems, and learning of new material;" Carpenter (1959) described the participants as being "more likely to major in the subject, accepting more responsibility for their own learning, showing more intellectual attitudes towards learning, and performing better on tests of scientific thinking, persistence in critical thinking, and resourcefulness in problem solving."
Clement (1971) concluded that students exposed to a procedure involving student-led discussion retained the beneficial effects of classroom discussion better than students involved in instructor-led discussion. Six groups of five students each were given an essay quiz after which they were divided into two equal groups, three groups involved in student-led discussion and the remaining three in instructor-led discussion. Immediately after the discussion all students were given the same quiz, and again six weeks later. Both groups improved on the second administration of the test which was attributed to the discussion, but the student-led discussion group retained the improvement on the third administration of the quiz, while the students in the instructor-led discussion did not. An increase in improvement of student attitudes towards the technique was also noted.

From a series of studies involving the applications of student-led discussion to the classroom, Webb (1973) found that those studies that revealed statistically significant differences favored the use of this technique in terms of effectiveness as an instructional device. The co-authors strongly emphasized the positive student and instructor preferences for courses taught with this approach. After compiling data from questionnaires given to the students, the main advantages were listed as:

1) "In relation to other methods, the discussion placed more emphasis on comprehension and understanding and less on memorization.

2) In the interaction during discussion, students came to see
several other points of view.

3) The students own ideas were clarified in the process of discussing with others.

4) The discussion forced students to think and organize their ideas.

5) As a result of the discussion students were more actively involved in their own learning.

6) The discussions generally forced more thorough preparation than regular class meetings.

7) The discussion led to a greater interest in the subject matter of the course when compared with other methods."

(Webb, 1973)

The instructors generally repeated those advantages, and listed a few of their own.

1) "The improved communication between students and teachers was particularly stressed.

2) The opportunity to listen as students discussed course materials in the relaxed atmosphere of a peer group was found to be very informative.

3) The instructors came to know better what their students were thinking about and where they were having difficulties."

Malott and Rollofson (1972) supplemented an introductory psychology course operating within a contingency management framework with student-led discussion. The discussion topics were specified prior to the actual discussion itself and required that students prepare an oral presentation, which was graded by fellow students and monitored.
by a teaching apprentice by means of an electronic device. The student was not aware of when his presentation was being monitored by the assistant. An analysis of the results measured by performance on a final examination indicated that, contrary to other studies aforementioned, the discussion procedure had no statistically significant effect on improving the performance of the students subjected to this procedure. Another fact in opposition to other studies mentioned was that in comparison to other features of the course, the discussion component was rated unfavorably.

It would seem upon first observation, that the application of a highly structured student-led discussion paradigm, as is the case with most classes operating under the influence of a contingency management system, may not produce favorable results, both academically and attitudinally. The opportunity to be involved in a learning situation which resembles a "free" environment (i.e., the responses on the part of the student are not discreetly monitored or consequated) may be more enjoyable to the student than responding in an educational environment in which his behavior is monitored and consequated. Clement (1971) merely suggested a topic for the students to discuss, and in no way monitored or consequated the actual discussion behavior of the students involved. Class attendance was also not required, which suggests that his class shared few characteristics with one structured by contingency management, which attempts to specify all responses desired of the student, monitors the rate and accuracy of those responses, and differentially consequates them.

Methodological innovation in the classroom is greatly needed.
However, the use of contingency management in education, the highly controlled structuring of classroom activities, has frequently been shown to produce more efficient learning as well as an increase in positive student attitude (Keller, 1968; McMichael and Corey, 1969; Malott and Svinicki, 1969). Although it is not readily apparent why the results of the Malott and Rollofson study were not of a positive nature, it should not be assumed that the use of student-led discussion could not obtain positive results when applied to a highly structured classroom environment.

McKeachie (1968) agrees with this opinion in part by stating "The method apparently is seldom successful if students are simply told to go off and meet by themselves. The successful uses seem to occur when the instructor invests substantial amounts of time in planning, preparing materials, and even monitoring the discussion." Keller (1968) also agrees with this statement by defining the role of the instructor (in classrooms which adopt the use of contingency management) as that of an "educational engineer" with the responsibility of designing the educational environment in order to instruct "...the great majority, rather than the small minority, of young men and women who come to him for schooling in the area of his competence."

A Behavioral Analysis of Student-Led Group Discussion

It would seem naive to assume that the academic benefits obtained from student-led group discussion are merely a result of students congregating in an unmonitored situation to express opinions. In order to consistently obtain any beneficial results which might result, it is apparent that a more thorough analysis of this procedure is
required. In order to be consistent with contingency management technology it is necessary to behaviorally analyze student-led group discussion to determine which behaviors are desirable and which consequences control these behaviors.

Clement (1971) suggested that "the beneficial effects of discussion by the student-led (students) ... most probably was due to the increase in number of responses by each (student) and the greater likelihood of individualistic encoding of the material,..." Webb (1973) adds additional agreement by presenting the case that the student learns more as an active participant of the learning process. The fact that active participation or an increased number of responses on the part of the student is of academic value to the student becomes a more credible assumption when we consider the phenomenon from a behavioral standpoint. When the student emits high rates of vocal-verbal behavior which relate to classroom materials, he is invariably given an increased amount of feedback for this behavior from classmates and/or the instructor. This can act as a device which modifies the verbal behavior of the student to a desired terminal criterion much more efficiently than if the student were simply to read the material or listen to a lecture. In the latter instances, he only responds in regards to the material on a covert level and the only consequence for those responses are provided by the speaker himself. Although this may be adequate in some cases, normally the supplementary source of feedback provided by classmates more effectively shapes the terminal behaviors desired.

Perhaps the most evident reason that student-led discussion has
been effective as a teaching device is that the individual student is provided with a supplementary source of information from his discussion partner(s). Potentially, this strengthens responses already in the student's repertoire as well as providing the student with alternative responses to educational stimuli.

Little recognition has been given to an obvious consequence provided for the behavior of discussing class materials with peers, that of peer attention itself. This attention provided for verbalizing in a group discussion is generally a strong variable for any student. This fact can be emphasized when one observes the amount of audience control exerted in almost any student peer group. Normally only an elite clique of motivated students give social attention for oral responses related to class materials. By programming peer consequation into a classroom format, the instructor indirectly provides an effective variable which strengthens class related verbal behavior.

In summary, it is apparent that there are two essential behaviors which the contingency manager must evoke in order to ensure that an effective student-led discussion takes place:

1) the students should emit a high rate of verbal behavior (which pertains to the subject matter in question), and
2) the students should attend to their classmates verbal behavior, with some form of appropriate differential consequation.

It may not be apparent how to provide contingencies in the classroom environment which will maintain these behaviors, but there are a few
guidelines which can be followed to increase the probability of their occurrence.

1) The discussion behavior must be specified in the form of a terminal response on the part of the student. This specifies an objective or intended result of the discussion to the student, and provides a basis on which the results of the discussion can be effectively consequated.

2) That behavior must be prompted in the form of discussion guides which direct the form of the terminal response. By prompting discussion behavior on the part of the groups, periods of non-productivity and useless verbalizing irrelevant to the task at hand are eliminated. Students must be guided to emit a particular response before the quality of that response can be differentially consequated.

3) The discussion behavior should be frequently monitored and differentially consequated. This will provide a constant source of information to both the instructor and the student as to the amount of learning taking place. Informative feedback is a prerequisite for any effective learning to occur.

Effective discussion is a complex verbal response which will only occur, consistently as a result of effective contingencies (either natural or engineered) present in the student's environment. The concept the student is dealing with and the expected outcome of discussion must be defined. The outcome, on the other hand, must be differentially consequated in order to produce the desired criterion
of responding, and the consequences must be effective enough to maintain that responding.

In more specific terms, there are a few direct steps which the educator can take to obtain desirable discussion behavior. Initially, in order to get students to emit high rates of verbal behavior relevant to the subject matter, they should be divided into small groups. This will provide for an increased demand for productivity on the part of each individual because of increased opportunities in which to respond. It should also reduce frequent periods of inactivity on the part of any one student, as is the case with a large number of students in a single group in which only one can speak at a time. It should also help to decrease discussion on the part of any two or more students which is not relevant to the task at hand. In addition, it is initially not desirable to punish verbal discussion (in the form of criticism) through direct monitoring of the oral presentations. However, to increase the chances that discussion will be relevant to subject matter it is necessary to monitor some output or result of that discussion behavior. This can be conveniently accomplished by grading discussion performance on the basis of written output which is produced by the discussion. In retrospect, there are several reasons for doing this:

1) An oral presentation or quiz leads to many problems for the student because of the aversive nature of such an exam, in that there frequently exists potential aversive consequences in the form of verbal criticism from the instructor. Most students have had little effective training in oral presentation.
2) The grader is limited in that he must be able to instantly analyze crucial points of often complex verbalization on the part of the student, and writing has the added benefit that the grader can discriminatively monitor the results of the discussion.

3) From past experience of the author, grading of the actual discussion itself by occasionally listening to discussion of the material by using electronic devices provides for an aversive system from which the individual will frequently try to escape. This will be done by discriminating between monitored and unmonitored situations and responding inappropriately to the latter or by using obfuscatory verbalization in the former situation. This type of monitoring might be useful to give guidance to the discussion or to determine if effective discussion is occurring, but it should in no way be used as a sole means of grading the discussion.

These features should accomplish the behavioral objectives of an effective discussion. Although, one or more students will be required to write, they will be motivated to talk about the subject matter in order to produce the written output. In order to get the students to provide information and attend to the other student(s)' verbal behavior, a group contingency can be incorporated when grading the written output. This places a contingency on each student in the group to:

1) Give differential feedback to his partner(s) concerning the
correctness of their responses, thus acting as a source of information for students who are not as adept.

2) Actively participate in the discussion and not simply to rely on the behavior of others for his grade.

Possibly the greatest advantage of incorporating educational devices such as student-led discussion into the classroom is the development of an oral-auditory repertoire on the part of the student. This type of repertoire is traditionally expected to be spontaneously acquired by students as a by-product of listening to, reading, and writing about course materials. Although this does occur to a limited extent, it is much more efficient for the educator to define the behaviors he wishes his students to acquire, and then arrange contingencies which increase the probability of that behavior occurring. It is also a repertoire required of professionals engaged in practice which involves the subject matter being taught in the classroom, and yet is often overlooked by present teaching methodology.

By initiating contingencies in the educational environment the contingency manager increases the probability that the specific behaviors which he wishes to produce will occur on a much more reliable basis. Instead of allowing appropriate behavior to be controlled by existing natural contingencies (which may be very weak), he has a much stronger influence in actually controlling their emission by following this sort of strategy. The field of education must be adept at applying this strategy to all educational techniques if it hopes to satisfy the ever-increasing demands of those it educates.

Student-led discussion is a device which can be used to prompt
students to generalize the concepts they learn to their own or novel situations. As such, it is an educational technique which needs to be examined empirically for its effectiveness in teaching conceptual mastery skills. Perhaps one of the most frequently mentioned advantages of student-led group discussion is that it generates a more thorough "understanding" of the materials involved, or, in other words, conceptual mastery (McKeachie, 1968; Clement, 1971; Webb, 1973). This could indicate an effective means of teaching for those instructors who are searching for a device to motivate students to extend their knowledge beyond the factual information learned through other means.

Clement (1971) has suggested that students, through student-led group discussion, may learn concepts more efficiently if they are applied to his own situation. It would seem logical, then, to allow the student to make discriminations (and consequeate those responses) between instances and non-instances of the concept in his own novel situation. In turn, the inability of the instructor to make class materials "relevant" to the student has been one of the major complaints of the latter in recent demands for a better education.

It would appear, then, that an optimal strategy in designing a student-led discussion paradigm would be to increase the probability of students relating materials to their own environment. The extension of factual information to novel examples (instances of the concept in question) is a desired goal of any classroom which attempts to teach conceptual learning. If this goal is facilitated by the
student responding in terms of situations familiar to him, then the educational design should strive to encourage that behavior. Although it may be redundant in a class whose goal is "focused on recall of specific course content, ... the student-led discussion is advantageous when the (class) requires facility in applying concepts to new situations" (Clement, 1971).

The purpose of the present study was to investigate the effects of student-led group discussion structured by contingency management in comparison to students working on an individual basis on the skill of production, and the interaction between the training of conceptual mastery skills of definition and discrimination, identification, and production.
METHOD

Subjects:

The subjects were students in four sections (approximately 26 students in each section) of the introductory psychology course at Western Michigan University.

Materials:

Quizzes were used which defined a basic principle of psychology (Malott, 1973), specified the basic components of that principle, and then instructed the student to either generate original examples of the principle, or analyze given examples (Reese and Woolfenden, 1973) by specifying the components of each in terms of that principle. The midterm and final examinations which were given as an evaluative measure of the present investigation (see Appendix A) included both types of questions for each basic principle tested.

Procedure:

All students were initially told that they were going to be involved in a program which was different from normal class procedure in that they would be engaged in activities such as concept analysis, creative writing exercises, and/or student-led group discussion. They were told that these activities would take place instead of portions of the normal class exercises, such as television lectures and laboratory work. All students were given the option to participate and all of those who did not wish to do so were placed in the Control Section, which was conducted the same as the remainder of the class sections not involved in the present experiment. These
students' test scores and other data were not included in the analysis of the Control Section data. The rest of the students in the study were then randomly assigned to one of four sections:

A) Group Production
B) Individual Production
C) Individual Identification
D) Control Section

A. Group Production: The students in this group were instructed to choose a discussion partner who he/she was to keep for the rest of the school term.

During two class session per week, the two-student groups were given a quiz which required them to generate original examples (involving human behavior) illustrating principles or concepts they were concurrently exposed to in the normal class readings. (See Appendix B). The pairs of students were allowed to formulate answers to the quiz as a group, but were not allowed to discuss the material with other groups in the classroom. Their performance on the quizzes was graded using a group-contingency; that is, each student in the group was assigned the same score on the quiz worth a total possible of ten points. The quality of ongoing discussion was not directly monitored but indirectly in the form of written answers on the exams. The groups were instructed that only one individual in the group would be allowed to write out the answers to the quizzes, in order to prevent a divided individual effort on the part of each group member. The students were given 35 minutes in which to complete the quiz, with the option of leaving the class
early if they finished the quiz before the time had elapsed (and they had taken an examination over the assigned readings for the day).

Data were taken on the amount of discussion behavior emitted by each group using a time sampling technique (Hall, 1971). This technique involves dividing the observation session into equal intervals, and recording whether the behavior being observed is occurring or not at the termination of the interval. Because it was not possible to monitor each discussion group instantaneously, they were observed at the termination of the interval in consecutive order according to an unassigned seating location. The total amount of time required to complete the quiz, and the score on each quiz were also recorded.

On task behavior was recorded according to the following definition:

At least one individual in the group has a writing instrument (pen or pencil) in direct physical contact with his/her hand and also in direct physical contact with an answer form for the quiz, or is vocally verbalizing to his/her partner.

Reliability of data recording was assessed on 50% (one half) of the sessions by having an independent observer record the amount of discussion behavior concurrently with the teaching assistant, who recorded data for each session.

Either the teaching assistant or the experimenter was present during all sessions in order to answer questions and guide discussion progress if help was required by the students.

B. Individual Production: The students in this group worked on the above-mentioned quizzes, but on an individual basis as opposed to a group basis. No talking between students was allowed during the session. Data were taken on the amount of time required to complete
The quiz and the score obtained on the quiz for both sections.

Grading of both sections' quizzes was performed by a single grader. The answer forms had an assigned number which corresponded to a number on the quiz form that contained the student's name and section letters. The answer forms were then separated from the quiz form and shuffled prior to grading to prevent grader bias to either sections' or students' quizzes.

All other procedures were the same as for the Group Production section.

C. Individual Analysis: The students in this group also took quizzes on an individual basis, but the quizzes were of a different nature. (See Appendix B). The current concepts or principles were defined and broken into basic components on these quizzes, but the students were required to analyze given examples of the concepts or principles by identifying these basic components in each example. A teaching assistant graded these quizzes. All other procedures were the same as in the above sections, except that data were not taken on the amount of time required to complete the quizzes, because their comparison with the quizzes given to the other experimental sections would be invalid due to the difference in response requirements.

D. Control Section: Three students designated prior to the investigation that they did not want to participate in any educational innovation different from the regular class format and were consequently kept with the control section. The students in this section participated exclusively in the normal class format, which
included daily readings (outside of class) and quizzes (as did all students in the experimental sections), and either a television lecture or rat laboratory experiment. They did not participate in any planned group discussion, generation of original examples of concepts or programmed analysis of them.

All sections were given midterm and final examinations which measured conceptual mastery skills on the principles used on quizzes for the experimental groups. All students had prior exposure to these principles, but the control group did not have the supplementary conceptual exercises dealing with them. The repertoire measured by the examinations was the skill of producing examples of the concepts, analyzing these examples, and other provided examples in terms of basic components of the concepts.

All students were examined on an individual basis, in an attempt to measure the instructional merit of each experimental condition. Examination scores were used as an assessment of that merit. Test scores from those who were absent on the day of the midterm and final examinations were not included in the section averages, since they were able to find out what the examination content might be prior to taking it. Despite this, only a total of two students out of one hundred-two were absent on each midterm and final examination dates.
RESULTS

The percentage of time spent on task as measured by the time-sampling technique ranged from a mean of 79.9% to 100% with a mean for all bi-weekly sessions of 89%. Percent reliability ranged from 86% to 100%, with a session mean of 93%.^2

Since time allotments for class are normally a limited and valuable commodity, the mean amount of time required to complete the same exercises was recorded for the Group Production and the Individual Production sections. This was done to determine if costs for either method in terms of time required might outweigh any benefits which resulted. These data were not recorded for the first two sessions.

The mean amount of time spent to complete the exercises for the Group Production section was 20.31 minutes, and the Individual Production section spent an average of 18.97 minutes.

The quiz scores showed a mean score of 8.89 for the Individual Production section and a mean score of 9.37 for the Group Production section, with a total possible of 10 points. A one-way analysis of variance indicated no significant difference (p > .05) between the two groups. However, as seen in Figure 1 on page 29, an interesting phen-

^2Data were not taken on the 8th of the 14 total sessions because of the absence of the teaching apprentice, who acted as the primary observer and was involved in duties such as passing out and collecting quizzes, and answering questions. Since the experimenter was left to assume these duties, there was not time to consistently record data at the appropriate intervals.
Figure 1. Mean scores on bi-weekly session quizzes for students in the Individual Production and Group Production sections.
omenon occurred from the 9th through the 14th sessions. The Group Production section had previously scored consistently higher on the bi-weekly exercises, but at this point the Individual Production section obtained a mean score slightly higher than the Group Production section, and did so on every other consecutive session up to termination of the study. Since no programmed independent variable was introduced at this point in time, it was difficult to determine exactly what the cause for the deviation from the previously established pattern was.

Examination Performance

Table 1, presented on page 32, indicates mean scores, percentages, standard deviations, and test-component (identification and production) percentages for the four sections on the midterm and final examinations. A one-way analysis of variance was computed on the obtained test scores of the various sections separately for both examinations, which revealed a significant difference between the four instructional procedures on both examinations (midterm: $F = 11.52, p > .001$; final: $F = 5.99, p > .001$).

To evaluate what type of skill (identification or production) attributed to differences in scores between the sections, an analysis of variance was computed on scores obtained on each of the two components of both exams. On the midterm examination, the results of the test on the identification component indicated a significant
Table 1. Total mean scores, total percentages, standard deviations, analysis component percentages, and production component percentages for all sections on the midterm and final examinations.
### TABLE I

EXAMINATION PERFORMANCE

<table>
<thead>
<tr>
<th>Section</th>
<th>Total Mean Score</th>
<th>Total Percentage</th>
<th>Standard Deviation</th>
<th>Analysis Component Percentage</th>
<th>Production Component Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIDTERM</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>28.45</td>
<td>59.90</td>
<td>8.68</td>
<td>62.33</td>
<td>57.42</td>
</tr>
<tr>
<td>Individual Analysis</td>
<td>40.35</td>
<td>80.70</td>
<td>6.65</td>
<td>80.33</td>
<td>81.0</td>
</tr>
<tr>
<td>Individual Production</td>
<td>39.56</td>
<td>79.12</td>
<td>9.78</td>
<td>75.0</td>
<td>84.86</td>
</tr>
<tr>
<td>Group Production</td>
<td>39.08</td>
<td>78.16</td>
<td>5.67</td>
<td>80.0</td>
<td>78.57</td>
</tr>
<tr>
<td><strong>FINAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>34.80</td>
<td>69.60</td>
<td>5.51</td>
<td>80.0</td>
<td>64.87</td>
</tr>
<tr>
<td>Individual Analysis</td>
<td>38.09</td>
<td>76.18</td>
<td>7.12</td>
<td>81.40</td>
<td>73.01</td>
</tr>
<tr>
<td>Individual Production</td>
<td>40.23</td>
<td>80.46</td>
<td>6.29</td>
<td>87.0</td>
<td>77.89</td>
</tr>
<tr>
<td>Group Production</td>
<td>42.46</td>
<td>84.92</td>
<td>6.16</td>
<td>85.4</td>
<td>84.75</td>
</tr>
</tbody>
</table>
difference in scores obtained on that part of the test ($F = 10.53, p > .001$). Extended-Tukey tests revealed significance between each experimental section and the control section, but there was none found between any of the experimental groups. There was no significance found between any of the groups on the final examination in the identification component ($F = 0.86, p > .461$).

Analysis of the test component scores which indicated production skills on the midterm produced results similar to those for the identification component. A one-way analysis of variance revealed a statistically significant difference ($F = 11.48, p > .001$). However, this difference existed between each experimental section and the control section but not between any of the experimental sections, as computed by Extended-Tukey tests ($p > .05$). Analysis of this component on this component on the final examination also revealed a significant difference ($F = 6.84, p > .001$). Extended-Tukey tests revealed that the significance existed between the Control and the Individual Production sections and the Control and the Group Production sections ($p > .05$). There was no statistically significant difference between the Control and Individual Identification sections or among any of the three experimental sections. All of the test component data for the midterm and final examinations have been compiled and presented in Figure 2 on page 35.

The students in the three experimental sections subjectively
Figure 2. Mean percentages for the concept analysis and original example production components of the midterm and final examinations.

C: Control Section
IA: Individuel Analysis
IP: Individual Production
GP: Group Production
evaluated the exercises they were engaged in during the experimental sessions on six different dimensions: the worth of the exercises, their relevance, the amount of interest they generated, their information providing value, the amount of "understanding" they produced concerning the material, and the type of thinking (rote or creative) they provoked. These data are presented in Figure 3 on page 38.

The Group Production section rated each dimension more favorable than either of the other two experimental sections. A one-way analysis of variance conducted on each dimension revealed statistically significant differences in four of the six dimensions, excluding the amount of interest generated, and the amount of understanding produced, although the mean scores were in fact numerically more favorable in all instances (p > .05).

Generalized effects of the experimental variables were measured by analyzing scores obtained on the regular classroom midterm and final examinations, which all students took as a measure of the effectiveness of regular classroom activities (readings and quizzes, lectures, and laboratory experiments) beyond the experimental exercises. A one-way analysis of variance computed on the scores of each exam indicated no statistically significant differences on either the midterm (F = 0.95, p > .05) or the final (F = 1.51, p > .05) regular exams.

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Figure 3. Mean student ratings on six dimensions of the final evaluation of the experimental exercises.
DISCUSSION

The data obtained indicates that on task behavior was emitted during a proportionately large ratio of time allotted. Although not directly or consistently monitored, the behavior as observed by the experimenter, was generally of a vocal nature and almost always dealt with the assigned concepts. When testing for the effects of group discussion as an educational tool, it is important to first insure that discussion behavior is emitted and that any benefits assumed to be the results of group discussion are not exclusively the result of previously acquired educational skills.

Relative to the 50 minute class periods scheduled for the students involved, the mean difference of 1.34 minutes required by the Group Production section over the mean time spent on the same exercises by the Individual Production section does not seem critical in determining the efficient use of available resources.

That the Group Production section initially (sessions 1 through 8) scored higher on the exercises might be explained by the fact that two students were combining their efforts in answering the questions. After practice at the particular skills involved in completing the exercises, however, the Individual Production section students' scores were roughly equal to the Group Production section students'. After exposure to the type of exercises presented in the experimental sessions, the Individual Production students' scores improved over time, while the Group Production students' scores remained at the same level. There are two possible explanations for this. First,
it may be that after exposure to exercises which require skills such as the production of original examples of concepts, the individual student may acquire the repertoire necessary to correctly emit these skilled behaviors with an accuracy similar to the combined efforts of more than one student. Or secondly, it could be that, because the performance of the Group Production students was initially very close to the maximum possible, the combined efforts of the two students as a group could not appreciably increase in quality as the individual students' efforts did.

The results from the test scores on the midterm examination indicate that all three experimental groups had acquired the skills of identification of concept components as well as skills of production of examples of those concepts superior to the control section, but that there were no significant effects among the different types of classroom activities that the experimental students were involved in. It is interesting to note that the scores obtained on bi-weekly session exercises were not indicative of how the individual student in the Group Production section performed on the cumulative examination. Another point of interest lies in the fact that the Individual Analysis section scored essentially the same as the Group Production and Individual Production sections on the component of the examination which measured production skills. This occurred despite the fact that the Individual Analysis section did not have programmed experience with this type of exercise. This would seem to indicate a "task-transfer" phenomenon, which means that materials designed to produce skills such as identification may also indirectly foster
others such as production. This effect may also be observed by the fact that students in the Control Section, who had a programmed history of answering only multiple-choice questions requiring discrimination skills, scored essentially the same as the three experimental groups on the identification component of the final examination. All three experimental groups had had experience in answering this type of question.

Analysis of the production component data further validate the midterm results in that they both concur that there was little or no beneficial academic results obtained by using the student-led group discussion format in the classroom under study relative to students exposed to the same material on an individual basis. These results also concur with the study conducted by Malott and Rollofson (1972) but do not agree with others (McKeachie, 1968; Clement, 1971; Webb, 1973) as to the effect of a student-led group discussion procedure on academic gains. The reason for this might have been the fact that the contingencies present in the students' environment in question made the discussion sessions dissimilar from others in that it structured the discussion behavior by requiring a specific type of response as opposed to letting the student discuss the material in an unmonitored fashion.

Studies which have reported a beneficial result from using student-led discussion generally do not use educational methods which define a desired terminal response on the part of the student, directly monitor responding, or employ programmed variables to
consequate that responding. The reported benefits may in fact be inaccurate due to the lack of credible monitoring procedures. If educators are going to refine and use educational devices like student-led group discussion effectively on a consistent basis, it is necessary to operantly analyze the behaviors which are considered to be valuable results of a student-led discussion and arrange contingencies in the students' environment to insure that those behaviors are emitted. If an educational technique is not or cannot be subjected to this type of analysis, then it must be assumed that it will not be a useful technique for those who carefully design an optimal educational environment for the student.

The benefit of the present investigation seems to exist in the type of conceptual mastery skills which students in the Individual Production sections acquired relative to the Control section. The materials designed for the experimental sessions produced a statistically significant difference in the ability to generate original examples of the concepts which were covered by the normal class activities. As stated earlier, this type of skill would seem to be valuable for those who will be required to apply concepts learned in an educational setting to an applied setting which requires a creative use of the concept. The development of "creativity" in regards to educational materials used in the classroom is not a phenomenon which will consistently occur due to the natural contingencies present. If we want behaviors to occur which indicate that students are creatively using materials learned in the classroom, we must design contingencies which support that behavior. The data
produced by the present investigation indicate that explicit concept training is significantly better than passive exposure to the material. However, it should be noted that as far as can be concluded from this study, there is not a significant difference in teaching conceptual productivity by giving explicit training in either concept analysis or concept production, on either an individual or group basis. This is important when a simple cost-benefit analysis is conducted. Materials which require students to generate original examples are more costly in terms of time and labor to construct and monitor than those which merely require a student to identify or analyze given examples, especially if there is a large student populace. Although the present results are not necessarily universal in nature, they seem to indicate that the type of concept training employed may not produce differential conceptual mastery skills.

However, a reason for using a student-led discussion format in the classroom to develop productive skills, as indicated by the present study, is the student evaluation of this technique relative to others in the study. As Keller (1968) stated:

"The kind of change needed in education today is not one that will be evaluated in terms of the percentage of A's in a grade distribution or of differences at the 0.01 (or 0.001) level of confidence. It is one that will produce a reinforcing state of affairs for everyone involved—a state of affairs that has heretofore been reached so rarely as to be the subject of eulogy in the
literature, and which, unfortunately, has led to the mystique of the "great teacher," rather than a sober analysis of the critical contingencies in operation."

Conclusions:

The present study investigated the effects of student-led group discussion relative to students working on an individual basis on the skill of production of original examples of concepts introduced in the classroom, and the interactions between the training of conceptual mastery skills of definition and discrimination, identification, and production. The results of midterm and final examinations on the skills learned indicated that over the period of the investigation, all students acquired essentially equal identification skills, but a statistically significant difference existed between the Control Section and both the Group Production and Individual Production Sections in terms of the ability to generate original examples of the concepts learned in class. Differences were not found between the student-led discussion group and the individual exercise group as far as productive skills were concerned. Overall student evaluations, however, favored the student-led group discussion format in comparison to the individual study format.
APPENDIX A

Examples of Midterm and Final Exam Questions

I. Reinforcement may be defined as the process of presenting a stimulus or event (reinforcer), following a response, with the resultant increase in the likelihood of that response. There are three essential characteristics to this concept:

1) the response
2) the stimulus or event (reinforcer), and
3) the future likelihood of the response

Specify each of the three characteristics in the following example:

Little Tommy pointed to the donut shop as he and his mother approached. "Mommy, can we get some donuts?" She stepped on the brakes, wheeled the car into the parking lot, and bought a dozen delicious treats. Several days later they were again passing the Donut Shop. "Mommy, can we get some more donuts?" Again mother complied. Several weeks and twelve dozen donuts later, Tommy was asking for them daily.

1) the response is
2) the reinforcer is
3) the future likelihood of

Now give an original example of reinforcement which involves human behavior from your own or a fictional environment. After you have thoroughly explained your example, specify each of the three characteristics as you did above.
II. **Negative Reinforcement** may be defined as the process of removing a stimulus or event (negative reinforcer following a response, with the resultant increase in the likelihood of that response.

There are three essential characteristics to this concept:

1) the response
2) the stimulus or event
3) the future likelihood of the response.

Specify each of the three characteristics in the following example:

Bowser barked continuously during Bruce's piano lessons. Since Bruce was paying for the lessons with trading stamps, it was too costly to allow the dog to interrupt. One day while Bowser was howling to the tune of "The Blue Danube," Bruce locked him in the basement where he could not be heard. Since then, Bruce locks Bowser in the basement whenever he howls.

1) the response is

2) the negative reinforcer is

3) the future likelihood of

Now, give an original example of negative reinforcement which involves human behavior from your own or a fictional environment. After you have thoroughly explained your example, specify each of the three characteristics as you did above.
III. Punishment may be defined as the process of presenting a stimulus or event (punisher), following a response, with the resultant decrease in the likelihood of that response.

There are three essential characteristics to this concept:

1) the response
2) the stimulus or event (punisher), and
3) the future likelihood of the response

Specify each of the three characteristics in the following examples:

Ralph went to this draft board to apply for conscientious objector status. When the head dude heard what Ralph wanted, he removed Ralph's student deferment, and classified him 1-A. Ralph has not returned to his draft board since then.

1) the response is
2) the punisher is
3) the future likelihood of

Now, give an original example of punishment which involves human behavior from your own or a fictional environment. After you have thoroughly explained your example, specify each of the three characteristics as you did above.
IV. **Extinction** may be defined as the withholding of punishing or reinforcing consequences with the resultant increase or decrease in the future likelihood of the behavior. There are three essential characteristics to this concept:

1) the behavior

2) the consequence which is withheld, and

3) the future likelihood of the behavior

Specify each of the three characteristics in the following example:

Jasper wanted a date with Loosie Lucy, the new girl in school. He got her phone number from a stall in the boy's john and called her at 7:00 that night. No answer. He tried again at 7:30. Still no answer. Still desperate, he called her ten more times, but no one answered the phone. Finally, Jasper gave up and settled down in front of the late show.

1) the behavior is

2) the consequence which is withheld is

3) the future likelihood of the behavior is

Now, give an original example of extinction which involves human behavior from your own or a fictional environment. After you have thoroughly explained your example, specify each of the three characteristics as you did above.
V. **Superstitious Behavior** may be defined as any behavior whose likelihood of occurrence changes as the result of accidental consequation of that behavior.

There are three essential characteristics to this concept:

1) the behavior
2) the accidental consequence, and
3) the future likelihood of the behavior

Specify each of the three characteristics in the following example:

One day Newtone, the science-nut, was sitting under an apple tree, pondering the world's problems. Suddenly he jumped up and exclaimed, "Today I shall discover a new scientific principle!" But as he jumped up, he shook the tree and an apple crashed down on his head, knocking him out cold. Since that fateful day, Newtone never again said that he would make a scientific discovery. (I hope you realize the gravity of the situation...)

1) the behavior is

2) the accidental consequence is

3) the future likelihood of the behavior is

Now, give an original example of superstitious behavior from your own or a fictional environment. After you have thoroughly explained your example, specify each of the three characteristics as you did above.
APPENDIX B

Examples of Bi-Weekly Quizzes

Reinforcement may be defined as the process of presenting a stimulus or event (reinforcer) following a response with the resultant increase in the likelihood of that response.

There are three essential components to this concept:

1) the response
2) the stimulus or event which follows the response (the reinforcer), and
3) the increased likelihood of the future occurrence of the response.

The components can be specified in any instance of behavior which involves the use of reinforcement.

For example:

Johnny's mother has had trouble getting him to pick up his belongings in his room. Several attempts at sitting down and explaining to Johnny that he must do his part of the family work had been unsuccessful in getting him to improve his work habits. John's mother tried a last desperate attempt. She promised him a trip to the zoo every Saturday afternoon if his room was picked up at the end of each day. Within a short period of time, John's room was found to be clean at the end of every day.

1) the response is picking up the articles in the room
2) the reinforcer is a trip to the zoo
3) and the future likelihood of picking up the articles in the room is increased.

Specify each of the three components in each of the following examples. 2.5 points will be given for each correct analysis.
1. Every year Porgie would help Adolph defoliate his victory garden. After this year's defoliation, Porgie was awarded a medal for courage and valor in the face of the enemy—the man-eating Venus Fly Traps. Porgie began helping Adolph in the garden more often and each time he was given another medal at the end of the day. After a short while and several medals, Porgie was helping Adolph in the garden about once a week.

2. Like all other dogs, Odee loved to eat. However, he often howled while eating, which disturbed his owner, Bruce, who had been taught never to talk with a full mouth. Whenever Odee howled during dinner, Bruce immediately took away the dog's food. He would return it only after Odee had stopped howling for five minutes. Odee soon stopped howling while he ate his food.

3. During his entire life, Roy had never won a contest. Therefore, he rarely entered any. However, when he heard about the Name-the-Pony Contest, he felt an irrepressible compulsion to enter. After winning the contest, he and his freshly named pony, Trigger, rode around town every day, entering any contest they could find.

4. Big Dale, a dealer in one of the Las Vegas casinos, rarely gambled because he knew that the odds were always in favor of the management. But one day Dale happened to drop some spare change in a slot machine. BONG! BONG! BONG! The machine continued BONGing as it spilled out the jackpot. In the weeks that followed, Dale played the slot machines more than ever before.
Reinforcement may be defined as the process of presenting a stimulus or event (reinforcer), following a response, with the resultant increase in the likelihood of that response.

Give original examples involving reinforcement which come from your own or a fictional environment. After you have thoroughly explained your example, specify the following characteristics of each:

1) the reinforcer (stimulus or event),
2) the response, and
3) the future likelihood of the response (increased or decreased)

To insure that all of your examples are original, make sure that you do not use the same response or reinforcer for any two examples:

For example:

Johnny's mother has had trouble getting him to pick up his belongings in his room. Several attempts at sitting down and explaining to Johnny that he must do his part of the family work had been unsuccessful in getting him to improve his work habits. John's mother tried a last desperate attempt. She promised him a trip to the zoo every Saturday afternoon if his room was picked up at the end of each day. Within a short period of time, John's room was found to be clean at the end of every day.

1) the reinforcer is a trip to the zoo
2) the response is picking up the articles in the room
3) the future likelihood of the response is increased

3 points will be given for each correct example.
1 bonus point will be given for 3 correct examples.
References


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