DOCUMENT RESUME

ED 295 637 IR 013 347

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TITLE Programming for Effective Concept Learning: Where Should the Branches Go and Why?
PUB DATE Jan 88
NOTE 11p.; In: Proceedings of Selected Research Papers presented at the Annual Meeting of the Association for Educational Communications and Technology (New Orleans, LA, January 14-19, 1988). For the complete proceedings, see IR 013 331.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Branching; College Students; Comparative Analysis; *Computer Assisted Instruction; Concept Formation; *Drills (Practice); *Feedback; Higher Education; Intermode Differences; *Programed Instruction; *Sequential Learning

ABSTRACT

The two studies detailed in this paper investigated the effects of adaptive sequencing of examples and adaptive feedback on concept learning using computer-based instruction. In the first study, two groups of undergraduate students progressed through a set of five behavior management concepts presented in the rational set generator framework. Subjects in the simple adaptive conditioning group were branched to easier examples when they made an error, but when subjects in the discrimination training groups made an error, they were branched to new examples--presented simultaneously--of both the concept that was missed and the one with which it was confused. However, posttests indicated no significant differences in scores between the two groups, contrary to expectations that the discrimination training group would perform better. The second study, which was an extension of the application of the rational set generator framework, investigated the effects of different types of wrong answer feedback on concept and rule learning. Four treatment groups completed programs with different levels of feedback following an incorrect answer--correct answer only, elaborated, forced repetition, and forced processing--and a fifth group completed a program without any feedback. Posttests indicated that subjects in the four treatment groups performed better than subjects in the no treatment group, but no statistically significant difference was observed between the four experimental groups. The text is supplemented by one figure. (10 references) (EW)

Manuscript for
Proceedings of Select Research Paper Presentations

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PROGRAMMING FOR EFFECTIVE CONCEPT LEARNING: WHERE SHOULD THE BRANCHES GO AND WHY?

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One of the strengths often cited for computer-based instruction is its capacity for providing adaptive learning experiences to students. These experiences may be adaptive in the sense that they provide differential instructional sequences to learners. Or they may be adaptive in the type of feedback they present in response to various answers given by learners. Both types of adaptation present questions to instructional designers as to which instructional sequences or what types of feedback will most effectively facilitate the desired learning.

In two studies to be reported in this paper, we investigate the effects of adaptive sequencing of examples and adaptive feedback on concept learning via computer-based instruction. According to Tennyson & Cocchiarella (1986), concepts are best learned when interrogatory examples of the concepts are systematically presented to develop both discrimination and generalization abilities in the learners. Thus, they recommend that 1) examples be presented in an easy to difficult sequence, 2) examples and nonexamples be presented within a specific context or problem domain (to enhance discrimination), and 3) examples be presented in a number of contexts (to enhance generalization). Finally, attribute feedback is recommended when it appears to be necessary.

In order to enable the systematic creation of examples that embody the recommendations listed above, Driscoll & Tessmer (1985) developed a technique they called the <u>rational set generator</u> (RSG). Examples generated using the RSG range in difficulty from easy to discriminate or generalize to difficult to both discriminate and generalize (see Figure 1). Empirical results have thus far confirmed the effectiveness of the RSG for designing concept examples for use in print instruction (e.g., Tessmer & Driscoll, in press).

Since the RSG is, in essence, a "shell" for creating examples that vary from one another in systematic ways, it also holds promise as a framework for sequencing interrogatory examples in computer-based instruction. For example, students may be presented all of level 1 (easiest) examples, followed by all of level 2 (harder) examples, and so on. Or the sequence may be adapted on the basis of the individual student's pattern of responses. That is, a student making a classification error on a level 2 example may encounter a level 1 example next, while someone answering the level 2 example correctly may go on to a level 3 example. Because the examples are theoretically related in a particular way, different patterns of achievement can be predicted by different instructional sequences.

Learning may also be affected by the type of feedback students receive when they classify examples incorrectly. Some sort of corrective feedback is generally recommended (Kulhavy, 1977), and Alessi & Trollop (1985) recommend increasingly informative feedback after each successive wrong answer, although they admit that empirical support for this recommendation is unclear. Since feedback on concept attributes may be important to correct classification errors, and it was unclear how this might best be provided, this offered a second variable of interest related to the RSG.

Dempsey (1986) designed a template for programming the RSG, and Driscoll & Dempsey (1987) implemented this template with microcomputers and conducted a validation study with concept instruction in educational psychology. To build on those results and begin to investigate the questions of interest discussed above, the current studies were undertaken.

Study 1

The primary question investigated in the first study was: Will an adaptive sequence of interrogatory examples that provides specific discrimination training be more effective for teaching concepts than a simple adaptive sequence? Siegel & Misselt (1984) taught foreign language word associations using a drill and practice CAI program and found that students made fewer errors when they were provided with adaptive feedback combined with discrimination training than when they received adaptive feedback alone.

In the present study, a set of five behavior management concepts (e.g., positive reinforcement, extinction, etc.) were taught using, on IBM microcomputers, the RSG framework for presenting interrogatory examples. Forty-six undergraduate students randomly assigned to the simple adaptive condition progressed to more difficult examples when they gave a correct response, but were branched to a lower level (easier) example when they made an error. Forty-one students in the discrimination training condition progressed in the same way to more difficult examples when they responded correctly. However, upon making an error, these students would be branched to new examples, presented simultaneously, of both the concept that was missed and the one with which it was confused. Then they, too, would next see an easier example than the one on which they erred. Feedback presented for correct and wrong answers was the same for both groups. Both groups were also required to correctly answer the most difficult example of each concept before they could exit the instructional RSG.

Achievement was examined using a 15-item posttest assessing classification of new examples of the five concepts. The examples that comprised this test were established by a previous study to parallel the difficulty levels of the examples in the practice RSG. This test was administered via the microcomputer immediately after the student had successfully completed the instructional RSG. Instructional time and the average number of examples seen by students in each group were also recorded.

It was expected that students in the discrimination training condition would perform better than those in the simple adaptive condition, since they would have received instruction designed specifically to correct a discrimination confusion. Time and number of examples attempted by students were examined because those in the discrimination training group might, by virtue of the extra instruction it contained, encounter more examples and spend more time than students in the other group. If this were to occur, a question of instructional efficiency vs. performance might ensue.

<u>Results</u>. Contrary to prediction, there were no significant differences in either instructional (on the practice RSG) or posttest performance between the two groups. On the posttest, students in the simple adaptive condition scored, on the average, 91.9 percent correct (standard deviation, 10.1) while those in the discrimination training group scored, on the average, 92.1 percent correct (s.d. = 9.6). Performance did improve, however, from instruction to the posttest, with students overall correctly answering, on the average, 78.2 percent of the instructional items and 92.1 percent of the posttest items. This improvement was significant ($T = 11.29$, $df = 86$, $p < .01$).

No significant differences appeared between groups on instructional or testing time, although students in the discrimination training group took an average of 2 seconds longer per question than the other group. Since this group made an average of 2 1/2 % more errors on the first attempt than the simple adaptive group, it is likely that the additional time they took came from answering a few more questions.

<u>Discussion</u>. From our perspective, it seemed that the results observed in this study represented a ceiling effect occurring in student performance. On the average, students missed only one question on the posttest. With such high scores to begin with, there was no room for improvement that could be attributed to the instructional manipulation. What the results perhaps do tell us is that the basic RSG instruction did its job

well, and well enough with that particular set of concepts and class of students to require no additional instructional conditions.

Study 2

In Study 2, our purposes were to extend the application of the RSG framework and investigate the effects of different types of wrong answer feedback on concept and rule learning. In this study, we developed and formatively evaluated 4 successive RSGs--one set of concrete concepts, two sets of defined concepts, and one set of rules--for a lesson on drugs. The RSG template was programmed for PLATO and the lesson was implemented as part of a general biology lab taken by mostly freshman college students.

The question of appropriate and effective feedback for CAI lessons is one that has not yet been fully answered. Wager & Wager (1985) assert that more effort has gone toward developing formatting guidelines than to synthesizing learning research for guidance in determining effective feedback. Of particular importance, perhaps, is what learners do with the feedback that is provided. Suppes & Ginsberg (1962) suggested that students should be required to type in a correct answer after an error has been made and feedback provided, and this is a strategy routinely programmed into some CAI lessons. However, Siegel & Misselt (1984) offer the opinion that such a strategy is unlikely to be facilitative of learning unless the student is in some way forced to make the connection between the correct answer and the question.

In the present study, we argued that the type of desired learning outcome should dictate the feedback provided in the lesson. Moreover, both depth of processing studies and studies of elaboration techniques suggest that students who, in some way, more deeply process or elaborate the correct answer following an error should show superior performance to those who do not.

Therefore, we developed four levels of feedback to follow an incorrect response. The lowest level was declarative in nature and required no additional response from the student (e.g., "No, the correct answer is ___. Press return to continue."). The second level involved an elaboration of the correct answer, but still required no additional response from the student (e.g., "No, the correct answer is ___. The reason this is correct is ___."). The third level required students to repeat the correct answer after it was given; how this action was performed depended on the nature of the outcome [e.g., "Type the (name) of the correct answer" (identity items) vs. "Type the letter of the correct answer" (classification questions)]. Finally, the fourth level required some additional processing to be done by the student. This was accomplished by the presentation of a simple multiple choice question following the correct answer that required an answer before the student could continue. These questions, too, depended on the type of learning outcome (e.g., for a defined concept, "The correct answer should include attributes A, B, and C. Which of the examples below contains all of these attributes?").

A "No Treatment" control group was also included in this study to ascertain whether the instruction itself actually had the desired effect. This group did not participate in the instruction, but did take the posttest at the same time it was administered to the experimental groups.

While the course from which students were selected for participation in this study is typically large, on the order of 1100 students per semester, students were not randomly selected. Rather, the coordinator of the course, which is a laboratory course, identified 3 lab instructors she believed would be the most cooperative and perhaps interested in what we hoped to do. Then, for each lab instructor, three lab sections of 20 or 22 students each were randomly selected, two to be designated "experimental" and the third to be designated "control." Thus, we hoped to control as much as possible for a potential "teacher effect."

Since we were not permitted to require participation in the experimental groups, we offered the inducement of "extra points" that students could apply toward their overall grade in the course. Of 120 possible experimental subjects, therefore, 55 students actually participated, spread randomly and approximately equally across the four experimental groups.

Students completed the PLATO-delivered instructional RSG outside of their regular laboratory class times, but took an 18-item objectives-referenced posttest as a part of a regularly scheduled class quiz. This paper-based posttest was developed and evaluated by the experimentors, and given to the lab instructors to administer.

It was expected that all experimental students would perform better as a group than the control students. Within the experimental group, it was anticipated that groups receiving elaborated feedback or feedback that required a response would perform better than the group receiving only the correct answer feedback. In addition, of the two groups required to make a response, those students forced to process the feedback were expected to outperform those who merely repeated the correct answer.

Results. As expected, students who undertook the PLATO RSG instruction performed better on the posttest than those who did not (80.0% to 56.5% ; T = 7.23, df = 96, p < .01). However, no significant differences in performance were observed among the four experimental groups. The posttest means and standard deviations for all groups are displayed in Table 1.

TABLE 1: Average posttest performance in terms of percent correct for four experimental and a no-treatment control group

Experimental Treatment Groups	Mean	S.D.
CA only	78.6	18.8
Elaborated (CA + explanation of CA)	81.2	15.5
Forced repetition (CA + "type CA to continue")	84.8	9.3
Forced processing (CA +	76.7	16.4
No Treatment Control Group	56.5	16.6

An analysis of covariance, with the course final exam score serving as the covariate, was conducted on posttest scores for the experimental groups. While the final exam score explained approximately 15% of the variance [F (1,52) = 9.25, p < .05], the main effect for group explained only 2% [F (3,52) = .44, ns]. In view of these overall results, no additional planned comparisons were undertaken. We also observed that students' scores under one of the three teachers were consistently lower than other students, but this effect did not appear to interact with expected effect of type of feedback on performance.

Discussion. The results of this study offer little in the way of definitive answers to the question of what is appropriate and effective feedback for CAI lessons teaching concepts and rules. In effect, it demonstrated only that adaptive practice with some sort of feedback is better than none at all, or at least that which students will do on their own left to their own devices. Perhaps we may also conclude that feedback specifically designed according to the type of learning outcome is effective.

It is interesting, however, that students forced to answer an additional question after they made a wrong response performed less well than all other groups. We can only speculate at this point that they may not have followed directions in this condition as much as we expected. That is, we observed in this class of students a general distaste for reading. Since the forced processing condition required much more reading than any of the other conditions, students may have pressed any answer to continue rather than taking the time to read and answer the additional question.

General Discussion

Taking these two studies together, what can be concluded? Unfortunately, less than we had hoped. In both studies, the RSG framework, shown previously to be useful in print instruction, appeared to be equally effective for use in computer-based instruction. Students learned from their practice on the instructional RSGs, and produced, as a consequence, very acceptable performances on posttests covering the same material.

Given that neither experimental manipulation conducted in these studies produced statistically significant effects, we are left with questions. Will type of adaptive sequence, or type of feedback, have the predicted effect on performance under other conditions? Of so, what are they? Or, does the RSG framework have strong enough effects itself on performance to mask other potential effects?

We anticipate that planned future investigations and replications may help to answer these questions and may shed some light on the original problem with which we began this research: Where should we put the branches in CAI lessons to facilitate concept learning, and why?

References

Allessi, S.M. & Trollop, S.R. (1985) Computer-based instruction: Methods and development. NJ: Prentice-Hall.

Dempsey, J.V. (1986) Using the rational set generator with computer-based instruction for generating concept examples: A template. Educational Technology, 26(4), 43-46.

Driscoll, M.P. & Dempsey, J.V. (1987, February) Developing and testing a method for enhancing concept learning in computer-based instruction. Paper presented at the annual meeting of AECT, Atlanta, GA.

Driscoll, M.P. & Tessmer, M. (1985) The rational set generator: A method for creating concept examples for teaching and testing. Educational Technology, 25(2), 29-32.

Kulhavy, R.W. (1977) Feedback in written instruction. Review of Educational Research, 47, 211-232.

Siegel, M.A. & Misselt, A.L. (1984) An adaptive feedback and review paradigm for computer-based drills. Journal of

Educational Psychology, 76, 310-317.

Suppes, P. & Ginsberg, R. (1962) Application of a stimulus sampling model to children's concept formation with and without overt correction response. Journal of Educational Psychology, 63, 30-36.

Tennyson, R.D. & Cocchiarella, M.J. (1986) An empirically based instructional design theory for teaching concepts. Review of Educational Research, 56, 40-71.

Tessmer, M. & Driscoll, M.P. (in press) Application of the concept tree and rational set generator as design strategies for coordinate concept classification. Educational Communications and Technology Journal.

Wager. W. & Wager, S. (1985) Presenting questions, processing responses and providing feedback in CAI. Journal of Instructional Development, 8(4), 2-8.

Figure 1

Model Matrix of a Computerized Rational Set Generator
(from Dempsey, 1986)

GENERALIZATION

DISCRIMINATION	LEVEL 1	LEVEL 2	LEVEL 3
CONCEPT A	A1	A2	A3
CONCEPT B	B1	B2	B3
CONCEPT C	C1	C2	C3