Control of Feedback in Computer-Assisted Instruction

☐ Doris R. Pridemore
James D. Klein

Doris R. Pridemore and James D. Klein are with the Department of Learning and Instructional Technology, Arizona State University.

Although considerable research has been conducted on both learner control and feedback, very little research has addressed the effect of giving learners control over the feedback that they receive. The purpose of this study was to examine the effect of learner control over feedback in a CAI lesson. Subjects used one of four CAI programs which provided either program control or learner control over verification or elaboration feedback. Results indicated that subjects who received elaboration feedback during instruction performed better than students who received verification feedback. Type of control did not have a significant influence on performance. However, when subjects selected feedback for items answered incorrectly during instruction, subjects under learner control/elaboration performed better on the posttest than subjects under learner control/verification. Implications for the design of CAI are discussed.

☐ While a great deal of research has been conducted on learner control and on feedback, few studies have been conducted to determine whether learner control of feedback affects student performance and attitude. Computers now make it possible to allow learners to control the amount of feedback in instruction, but it is not clear whether giving learners control of feedback is beneficial. Some writers have suggested that the "mere illusion of control" significantly improves motivation and performance (Perlmuter & Monty, 1977). Others have concluded "there is little support from the research literature that offering students control will lead to increased learning" (Carrier, 1984, p. 17).

Several researchers report advantages for allowing learners to have control in computer-assisted instruction (CAI). Learner control over the instructional strategy of a CAI program has been shown to positively influence retention of information and student interest (Newkirk, 1973). Learner control over review options (Kinzie, Sullivan, & Berdel, 1988) and contextual properties (Ross & Morrison, 1989) in CAI lessons has been shown to significantly increase test performance. Hansen (1974) found that learner control over feedback in a CAI lesson decreased student anxiety about learning, while others have reported that both feedback and learner control in CAI increased student performance and attitude (Schloss, Wisniewski, & Cartwright, 1988; Steinberg, Baskin, & Hofer, 1986).

According to Clariana, Ross, and Morrison (1991), feedback is an important variable that is often ignored in CAI. Researchers have reported that feedback increases learner performance and reduces program errors (Anderson, Kulhavy, & Andre, 1972; Kulhavy, 1977; Kulhavy, Yekovich, & Dyer, 1979).

Feedback is a unit of information with two components, verification and elaboration (Kulhavy & Stock, 1989). Verification is the simple, dichotomous judgment that an initial response was right or wrong. Elaboration consists of all substantive information contained in the feedback message. Collins, Carnine, and Gersten (1987) demonstrated that when verification and elaboration were given in CAI, performance was significantly higher for elaboration, while the time to complete the lesson was similar. In addition, a meta-analysis conducted by Bangert-Drowns, Kulik, Kulik, and Morgan (1991) indicated that elaboration feedback produced greater effects for learning than verification feedback.

The purpose of this study was to examine the effect of learner control over feedback in computer-assisted instruction. The independent variables were type of control (learner or program) and level of feedback (verification or elaboration). The dependent variables were performance on a posttest, attitude toward the program, and time to study feedback. In addition, information about subjects' choices of feedback was collected.

METHOD

Subjects

Subjects were 100 undergraduate education majors enrolled in an educational psychology class at a large southwestern university. Data for 93 out of the original 100 subjects were included in the analyses of the results because scores on one or more measures were unavailable for the remaining 7 subjects.

Materials

Materials used in this study were four CAI lessons, a posttest, and an attitude questionnaire.

The CAI lessons were developed using a software package called "The Presenter" (Behrens & Stock, 1990). All lessons provided the same information, examples, and practice on the concepts of reliability and validity. The lessons were based on the text *Topics in Measurement: Reliability and Validity* by Dick & Hagerty (1971). Information and examples were presented in sections of five screens of text, followed by eight multiple-choice questions with five alternatives. This cycle continued for a total of 25 screens of text and 40 questions.

The differences in the CAI lessons were based on type of control (program and learner) and level of feedback (verification and elaboration). Under program control, the computer program administered one of the two feedback conditions automatically. Under learner control, subjects decided if they wanted to receive feedback. Under the condition of verification, a learner was told only if a response was correct or incorrect; under elaboration, a learner was told whether or not a response was correct, the correct answer, and a short explanation.

Subjects using the program-control/verification lesson were always provided with the feedback message, "Yes, you are correct" or "No, you are incorrect" after each practice question. Subjects using the learner control/verification lesson were asked, "Would you like to check your answer?" after each question. If the response was yes, the appropriate verification feedback was presented; if the response was no, the program continued with the next question or screen of text.

Subjects using the program-control/elaboration lesson always received verification information, followed by the correct answer and a short explanation after each practice question. Subjects using the learner-control/elaboration lesson were asked, "Would you like to check your answer?" after each question. If the response was yes, verification appeared as described above. The lesson then asked, "Would you like an explanation?" If the response was yes, the correct answer and an explanation appeared before the program continued; if the response was no, the lesson continued with the next question or screen of text.

In addition to the four CAI lessons, a posttest and an attitude questionnaire were de-

veloped. The posttest consisted of the same 40 questions previously given as practice but presented in a random order. The reliability of the posttest was calculated at .69 using the Kuder-Richardson 20 formula. The attitude questionnaire consisted of ten items measuring student satisfaction, enjoyment, perception of control, and feeling toward feedback. The questionnaire used a 5-point Likert-type scale. Both measures were administered on the computer. In addition, the computer automatically recorded the number of seconds each subject spent studying feedback messages. For subjects in the learner-control conditions, the number of times verification and elaboration were selected was also recorded.

Procedure

Before subjects arrived to participate in the study, an experimenter prepared the computer laboratory by installing one of the four lessons into each computer. Upon arrival to the computer room, each subject was randomly assigned to one of the four experimental conditions. All four of the conditions were present at each experimental session.

The experimenter gave a short introduction on general procedures and told subjects that instructions were included in the program. They were not told that the programs were different. Subjects were told that the lesson was on reliability and validity, and the importance of the material for them as future teachers was stressed. Subjects were also told that they would have to pass a test at the end of the lesson in order to receive points toward their final course grade. Subjects then proceeded with their individual lessons.

Upon completion of the lesson, subjects completed the attitude questionnaire and the posttest on the computer. They were given as much time as they needed to complete the lessons and the criterion measures. Most subjects completed the study within a 50-minute class period.

Design and Data Analysis

The design was a 2 × 2 factorial with type of control (learner or program) and level of feedback (verification or elaboration) as the independent variables. The dependent variables were performance, attitude, and feedback study time. Learner-control choices were also measured and analyzed.

Analysis of variance (ANOVA) was used to test for differences between groups on performance and feedback study time. A multiple analysis of variance (MANOVA) was used to test for differences between groups on the attitude questionnaire. The MANOVA was followed by univariate analysis for each question. An alpha level of .05 was set for all statistical tests. In addition, effect sizes (ES) were calculated. Conditional probabilities were calculated to determine (1) patterns of behavior for subjects in the learner-control conditions and (2) the probability of answering posttest questions correctly after verification and elaboration feedback were selected.

RESULTS

Performance

Mean scores and standard deviations for performance can be found in Table 1. These data indicate that the mean for subjects who received verification feedback was 25.11, while the mean for subjects who received elaboration

TABLE 1 ☐ Means and Standard Deviations for Performance

	TYPE OF FEEDBACK					
	Verification		*Elaboration*		*Totals*	
CONTROL	*M*	*(SD)*	*M*	*(SD)*	*M*	*(SD)*
Program	25.17	(4.72)	32.00	(3.66)	28.59	(4.19)
Learner	25.04	(4.79)	30.29	(5.18)	27.67	(4.98)
Totals	25.11	(4.76)	31.15	(4.42)	28.15	(4.63)

Note: Highest possible score was 40. Cell sizes were 24 for learner-control/elaboration and 23 for the other three conditions.

feedback was 31.15. The mean score for the program-control group was 28.59 and the mean score for the learner control group was 27.67.

Analysis of the posttest data indicated that level of feedback had a significant effect on performance $F(1, 89) = 39.47$, $p < .05$, $MS_e = 21.41$, ES = 1.09. Subjects who received elaboration feedback performed better than those who received verification feedback, regardless of the type of control provided. The differences for type of control and the feedback by control interaction were not significant.

Attitude

Analysis of the ten-item attitude questionnaire data revealed a significant MANOVA effect for level of feedback, $F(10, 80) = 4.93$, $p < .05$. Follow-up univariate analyses indicated a significant difference between feedback conditions for item 10 ("I would have liked to have more feedback about my answers"), $F(1, 89) = 39.48$, $p < .05$, $MS_e = 1.04$, ES = .55. Subjects who received verification ($M = 1.35$, $SD = 0.71$) indicated a greater desire to receive more feedback than those who received elaboration ($M = 2.66$, $SD = 1.22$). No other significant differences were found on the attitude questionnaire.

Feedback Study Time

The means and standard deviations for feedback study time were calculated in seconds. The largest differences in feedback study time were between subjects who received verification ($M = 70.96$, $SD = 20.56$) and those who received elaboration ($M = 287.67$, $SD = 124.61$). The mean for subjects who received program control was 165.07 ($SD = 152.35$) and the mean for those who received learner control was 195.76 ($SD = 130.23$).

Analysis of the data for feedback study time revealed a significant effect for level of feedback, $F(1, 89) = 132.60$, $p < .05$, $MS_e = 8225.63$, ES = .75. Subjects who received elaboration spent an average of 217 seconds more when studying feedback than subjects who received verification. Type of control did not significantly affect feedback study time.

Learner-Control Choices

The means and standard deviations for the number of times subjects in the learner-control groups selected feedback after the 40 practice questions were calculated and analyzed. Subjects in the elaboration group selected feedback 91% of the time ($M = 36.25$, $SD = 3.95$), whereas those in the verification group selected feedback 74% of the time ($M = 29.74$, $SD = 9.80$). Analysis of these data revealed a significant effect for level of feedback, $t(45) = 3.1$, $p < .05$, $ES = .94$.

Selection of feedback was related to subjects' initial response to each practice item. Subjects in each learner-control condition correctly answered 62% of the items during instruction. When a practice question was answered correctly, subjects in the elaboration group selected feedback 96% of the time and those in the verification group selected feedback 83% of the time. When a practice question was answered incorrectly, selection of feedback dropped to 83% for subjects in the elaboration group and 52% for those in the verification group.

Data were also analyzed to determine the relationship between choosing feedback for incorrect items and posttest scores. When subjects in the elaboration group answered practice questions incorrectly and selected feedback, they subsequently answered the corresponding posttest items correctly 66% of the time. When subjects in the verification group answered practice questions incorrectly and selected feedback, they answered the corresponding posttest items correctly only 28% of the time.

DISCUSSION

The purpose of this study was to investigate the effects of learner control over feedback in an instructional computer program. Results suggest that students who received

elaboration feedback during instruction performed better than students who received verification feedback. This is consistent with other research which indicates that elaboration, rather than verification, produces greater effects in learning (Bangert-Drowns et al., 1991; Collins et al., 1987).

There are several possible reasons why elaboration affected performance in the current study. One likely reason is that performance was improved due to the increased amount of information in the elaborated feedback message. Students who received elaboration were provided with the correct answer and an explanation of that answer after each practice question. However, subjects in the verification condition were only told whether their answers were correct or incorrect. It is likely that students who received elaboration used this additional information to correct errors made on practice items.

This idea is supported by the results found for feedback selections. During instruction, students in both learner-control groups answered the same number of practice items correctly. When a practice item was answered incorrectly, students who had control over elaboration were more likely to select feedback than those who had control over verification. Furthermore, when students in the learner-control groups answered practice questions incorrectly and selected feedback, the probability of getting the answer correct on the posttest was much greater for subjects in the elaboration group. Hence, students with control over elaboration were able to use the additional information contained in the feedback message to increase their performance.

Another factor that may have contributed to the positive effect for elaboration is the increased time spent in studying feedback. Students who received elaboration spent more time studying feedback than those who received verification. Additionally, students who received verification indicated a desire to have more feedback during instruction.

While a positive effect was found for level of feedback, type of control did not influence performance or attitude in the current study. Results do indicate that when learners who are given control over elaboration exercise their option for feedback, performance will be positively influenced. Perhaps learners who are provided with control of feedback in CAI would benefit if given advice concerning when to exercise their options.

The results of this study suggest some implications for the design of CAI. Instructional designers should consider providing different feedback messages in CAI lessons depending on student responses. Verification feedback could be provided to students when their initial response to an item is correct, but it seems vital to provide elaborated feedback when an initial response is incorrect. CAI has the capability to provide differing feedback messages depending upon student responses.

The current study also has some implications for future research on feedback and learner control. Future studies should investigate whether different feedback messages will increase performance when the feedback is based on student responses. Research on the effect of verification and elaboration feedback should be conducted on differing learning outcomes. Furthermore, future research should examine whether learner control based on student responses during practice will affect performance. Implementation of these suggestions will assist us in determining the conditions under which different types of feedback and learner control provide the greatest benefits. □

REFERENCES

Anderson, R. C., Kulhavy, R. W., & Andre, T. (1972). Conditions under which feedback facilitates learning from programmed lessons. *Journal of Educational Psychology, 63*, 186–188.

Bangert-Drowns, R. L., Kulik, C. C., Kulik, J. A., & Morgan, M. (1991). The instructional effect of feedback in test-like events. *Review of Educational Research, 61*, 2, 213–238.

Behrens, J. T., & Stock, W. A. (1990). PRESENTER: *Microcomputer programs for text-based experiments* (Technical Report ZN-16). Tempe, AZ: Instructional Science Research Facility, Arizona State University.

Carrier, C. (1984). Do learners make good choices? *Instructional Innovator, 29*(2), 15–17, 48.

Clariana, R. B., Ross, S. M., & Morrison, G. R. (1991). The effects of different feedback strategies using computer-administered multiple-choice questions as instruction. *Educational Technology Research & Development, 39,* 5–17.

Collins, M., Carnine, D., & Gersten, R. (1987). Elaborated corrective feedback and the acquisition of reasoning skills: A study of computer-assisted instruction. *Exceptional Children, 54,* 254–262.

Dick, W., & Hagerty, N. (1971). *Topics in measurement: Reliability and validity.* New York: McGraw-Hill.

Hansen, J. B. (1974). Effects of feedback, learner control, and cognitive abilities on state anxiety and performance in a CAI task. *Journal of Educational Psychology, 66,* 247–254.

Kinzie, M. B., Sullivan, H. J., & Berdel, R. L. (1988). Learner control and achievement in science computer-assisted instruction. *Journal of Educational Psychology, 80,* 299–303.

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

Kulhavy, R. W., & Stock, W. A. (1989). Feedback in written instruction: The place of response certitude. *Educational Psychology Review, 1,* 279–308.

Kulhavy, R. W., Yekovich, F. R., & Dyer, J. W. (1979). Feedback and content review in programmed instruction. *Contemporary Educational Psychology, 4,* 91–98.

Newkirk, R. L. (1973). A comparison of learner control and machine control strategies for computer-assisted instruction. *Programmed Learning and Educational Technology, 10,* 82–91.

Perlmuter, L. C., & Monty, R. A. (1977). The importance of perceived control: Fact or fantasy? *American Scientist, 65,* 759–765.

Ross, S. M., & Morrison, G. R. (1989). In search of a happy medium in instructional technology research: Issues concerning external validity, media replications, and learner control. *Educational Technology Research & Development, 37*(1), 19–33.

Schloss, P. J., Wisniewski, L. A., & Cartwright, G. P. (1988). The differential effect of learner control and feedback in college student's performance on CAI modules. *Journal of Educational Computing Research, 4,* 141–150.

Steinberg, E. R., Baskin, A. B., & Hofer, E. (1986). Organizational/memory tools: A technique for improving problem solving skills. *Journal of Educational Computing Research, 2,* 169–187.