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ABSTRACT

Two versions of a computer-assisted instruction practice lesson on series resonant circuit analysis were compared. One was a program control version which required considerable time for students to reach criterion level. The other program was a revised student control version of the same lesson. In the program control version, quantity of practice was determined by an adaptive branching algorithm based on student performance; the student control version made practice prior to a criterion item optional. Subjects were 84 trainees in basic electricity/electronics at the Naval Training Center in San Diego. Those using the student control program showed a marked time savings over those using program control, and student control of training produced more uniform performance. Large time savings and increased test scores supported the hypothesis that a knowledgeable student can realistically estimate when he has mastered the practice material. (CH)

THE EFFECTS OF LOCUS OF CONTROL ON CAI PERFORMANCE

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One of the main objectives of Navy training has been to minimize time required for training while maintaining or improving the level of achievement. This has been accomplished, typically, through individualization of instruction either on-line or off-line over a cross-section of schools. The goal of this project was to determine whether time savings could be increased as a function of a change in the locus of control of learning from program control to learner control in a CAI practice lesson.

In a 1974 study, Judd, O'Neil, and Spelt aptly summarized the literature on learner control as "confused but interesting." They postulate some reasons for the confusion: (1) a lack of consensus on the definition of learner control, (2) no general agreement of factors to be varied under learner control, and (3) rarely any effect on learning from the manipulated learner control variables, probably because of confounding by other variables.

Merrill and Boutwell (1972) introduced a matrix of three qualitative instructional strategy variables crossed by three quantitative variables. Locus of control was one of the quantitative variables. Merrill (1973) refined the matrix which became the rationale underlying the TICCIT system and specified that two of the qualitative variables, presentation form and mathemagenic information, be under student control. Specifically, the matrix was operationalized in TICCIT by allowing the student control of quantity and sequence of instructional material.

This study provides evidence for Merrill's hypothesis and the usefulness of student control of instruction. It seems reasonable that a student actively involved in learning with an opportunity for testing his judgements can realistically estimate when he has mastered the material.

Prior studies concerned with learner control have emphasized control of sequencing, content, pacing, feedback, and presentation media. Studies by Dean (1969) and Slough, Ellis, and Lahey (1972) investigated student control of practice.

Dean investigated the effects of learner controlled practice on arithmetic problems by fourth, fifth, and sixth grade remedial students. He found that only the sixth graders under learner control spent significantly less time practicing than the program control group with no difference in test scores.

Slough, et al. (1972) also report significant time savings under student control of instruction when compared to a linear fixed-sequence program. The current study compares learner control with adaptive program control rather than linear program control.

This study used CAI material which taught well under program control but took too long to reach criterion. Two versions of the lesson were compared: the original program control version and a revised student control version. It was hypothesized that time savings could be increased as a function of student control of practice.

METHOD

The subjects were 84 trainees in the Basic Electricity/Electronics School, Naval Training Center, San Diego. The task was practice on series resonant circuit analysis and was presented on an IBM 1500 CAI system.

The experimental practice lesson was preceded by a lesson on circuit analysis theory. In the theory lesson, the student learned to solve for phase angle, impedance, and total voltage in polar form given reactance and resistance values. In addition to recalling and applying the formulas for impedance and total voltage, the student had to be skilled at using trig tables and solving trig functions.

The experimental lesson consisted of practice in solving for phase angle, impedance, and total voltage. All practice items used realistic circuit values and were randomly generated from computer algorithms.

Table 1 summarizes the differences between the program control version and the student control version.

In the program control version, quantity of practice was determined by an adaptive branching algorithm based on student performance.

The algorithm required a student to practice to a criterion of two problems correct out of four for each subset of problems. Each practice set consisted of two subsets of four different types of problems. Then the student was given a criterion item and branched on to the next objective.

In the student control version, practice prior to a criterion item was optional. If he missed the criterion item, he was forced to practice one problem for each type of question.

Both versions had an optional review at the end. An asterisk was displayed beside the type of problem in which a student needed more practice. The criterion for cueing a difficult area was three or more errors on that type question.

RESULTS AND DISCUSSION

Students in both the program control and student option groups had about 10 hours of prior experience with CAI. In addition, data for the student option lesson were obtained from a study of long term CAI in which the students had about 42 hours of prior CAI experience. Results for all three groups are shown in Tables 2 and 3.

TABLE 1

Differences Between Program Control and Student Control Versions

	Program Control	Student Control
Practice	Required	Optional
Practice Criterion	2 out of 4 correct (max 8)	1 problem for each type (max 4)
Error on Criterion Problems	Continue to next practice set	Do practice if not taken previously

TABLE 2

Training Time Means, Standard Deviations and Coefficients of Variation for Program Control and Student Control of CAI Practice

	Program Control	Student Control	
	Short Term (N=10)	Short Term (N=24)	Long Term (N=50)
$\overline{X}$ (min)	68.6*	34.4	38.8
SD	29.09	13.73	30.53
C (percent)	42.4	39.9	78.8**

*PC > ST, LT ($p < .05$)
**LT > PC, ST ($p < .05$)

TABLE 3

Posttest Score Means, Standard Deviations and Coefficients of Variation for Program Control and Student Control of CAI Practice

	Program Control	Student Control	
	Short Term (N=10)	Short Term (N=24)	Long Term (N=50)
$\bar{X}$ (min)	87	96.6	95
SD	21.76	7.99	11.02
C (percent)	25.0*	8.3	11.6

*PC > ST ($p < .01$)

The important comparison for locus of control is between the short term conditions. Table 2 shows that student control produced a very marked time savings over program control. The time savings also occurred for the long term students. This indicates there was no degradation in time savings with extensive prior CAI experience.

Variability was greater in the long term group than either the short term student control or short term program control groups. The coefficient of variation was used as a measure of relative variability and is the standard deviation divided by the mean. The larger variability may be due to greater experience with the use of student options since one prior module of instruction used it extensively.

Test scores for the criterion-referenced test are shown in Table 3. The scores are higher in the student control group although they are not significantly different. However, there is probably a ceiling effect on the distribution because the scores approach 100. For that reason a test comparing the means is not very powerful. A higher mean is correlated with reduced variability and data in Table 3 indicates that this is the case. Relative variability in scores is significantly smaller for the short term student control group. It appears that student control of training produces more uniform performance.

In conclusion, when the data is embedded in the context of Merrill's strategy matrix, the large time savings and increased test scores offer research evidence to support the hypothesis that a knowledgeable student can realistically estimate when he has mastered the practice material.

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