Learner Control Modes and Incentive Variations in Computer-Delivered Instruction

☐ Samuel Hicken
Howard Sullivan
James Klein

This study investigated the effects of two general approaches to the provision of learner control and of two types of incentive on achievement, use of options, time, and attitude using computer-delivered instruction. Posttest scores for the "FullMinus" treatment for learner control, where learners could selectively bypass elements of a full instructional program, were marginally higher than those for the "LeanPlus" treatment, where learners could opt to add elements to a core program ($p = .052$). The FullMinus treatment resulted in more positive attitudes while requiring no more time. Performance-contingent incentive groups had higher posttest scores than task-contingent groups ($p < .05$), with no greater investment of learner time and no negative effect on attitude. The findings relate directly to the design of instructional computer programs as well as to the design of future studies on learner control.

☐ Learner control has come to refer to the control of options such as pacing and sequence within instructional programs. Since 1980, research in learner control has been conducted almost exclusively using computer-assisted instruction (CAI). Although some generalizations have emerged from learner-control research, results have been inconsistent, particularly with respect to achievement and use of options.

In almost every CAI learner-control study, control over instructional elements has been implemented in one of two general ways: In some studies, learners could request additional elements; in other studies, learners could bypass elements. Carrier, Davidson, and Williams (1985) used the term "full" to refer to a treatment in which learners were directed to work through every element of an instructional program, and the term "lean" to refer to a program in which learners worked through only the core instruction. Extending this terminology, the two general approaches that have been used in learner-control studies could be referred to as "LeanPlus" and "FullMinus."

In the LeanPlus approach, a core instructional program is presented and learners may request added instruction. In the FullMinus approach, a full instructional program is the default, but learners can opt to bypass elements of instruction. The difference between these approaches may be important because an instructional system that expects the learner to actively solicit instruction versus one that

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permits the learner to bypass instruction may stimulate different mindsets, different cognitive processes, different interactions with the learner's state of motivation, and different consequent achievement.

In studies where additional elements have been elective (LeanPlus), learners could opt for instruction above and beyond the core program. In studies by Carrier (Carrier, Davidson, Higson, & Williams, 1984; Carrier et al., 1985; Carrier, Davidson, Williams, & Kalweit, 1986; Carrier & Williams, 1988), students could request additional definitions, examples, practice items, and analytical feedback. In a 1978 study by Campanizzi, learner-control subjects could solicit a content overview in addition to the regular instruction. Ross, Morrison, and O'Dell (1989) allowed the learner-control group to opt for additional examples.

In studies in which it was possible to bypass instructional elements (FullMinus), learners could opt to skip components of the full program. Examples are studies by Kinzie-Berdel (1988), Kinzie and Sullivan (1989), Kinzie, Sullivan, and Berdel (1988), and Schloss, Sindelar, Cartwright, and Smith (1988). In these studies, subjects in the program-control group were automatically routed to review after incorrect practice responses, while subjects in the learner-control group could opt to bypass review. Lopez and Harper (1989) allowed their moderate-learner-control group to bypass content review, while the high-learner-control group could bypass both content review and practice questions. In studies by Tennyson and Buttrey (1980) and Tennyson (1980), students in the learner-control group could decide when to terminate instruction and begin the posttest. Pollock and Sullivan (1990) allowed learners to bypass practice questions.

Different patterns of option use have emerged between studies in which learners could solicit additional instruction and those in which they could bypass instruction. In the series of studies by Carrier and her colleagues, subjects typically selected well below 50% of the available options and tended to select fewer options as the lesson progressed. Ross, Morrison, and O'Dell (1989) found that learners in the learner-control group selected minimal options.

In studies in which learners could opt to bypass instruction, Lopez and Harper (1989) and Pollock and Sullivan (1990) found that learners worked through 80% of all practice items. However, in a study by Kinzie and Sullivan (1989), learners who could bypass review of practice items chose to complete only about 35% of the items, a percentage comparable to that in the Carrier studies.

A second factor that has not been directly investigated in learner-control research is motivation, specifically the incentive to perform. Given that learners may expend extra effort in making instructional decisions and that learner-control groups tend to leave instruction early (Tennyson & Buttrey, 1980), it is surprising that incentive options have not received greater attention in learner-control research. Gray (1987) suggested that the added cognitive burden of instructional decision-making may distract from learning, while Kinzie-Berdel (1988) speculated that differential effort may have been a confounding factor in her learner-control research. Of dozens of variables analyzed using data from the computerized TICCIT system, Merrill (1980) found that reported effort was the only factor that correlated significantly with performance.

Tennyson and Buttrey (1980) observed more than a decade ago that use of an actual classroom-related incentive—a grade—was missing from most learner-control studies. Whereas a grade would have provided a performance-contingent incentive, many studies have relied only on a task-contingent incentive, in which the learning task itself must be sufficiently motivating to promote subject performance.

More than half of the learner-control studies of the past decade have either reported the use of incentives or have used approaches from which incentives can be inferred. However, because incentive was not treated as an experimental factor in these studies, it is not possible to assess its impact on performance, attitude, or in-program behavior.

Two levels of incentive were investigated in the current study. Learners under the task-contingent incentive were told that they would receive class credit simply for completing a CAI program and posttest; learners under the performance-contingent condition were informed that they had to score at least 70% on the posttest to receive credit.

The current study examined the effects of two levels of learner control—LeanPlus and FullMinus—and two levels of incentive conditions—task-contingent and performance-contingent—on learners' achievement, attitude, use of options, and time on program. Typical option use patterns and variables that might be associated with performance were also of interest.

Because students may tend to accept given instruction, a major hypothesis in this study was that learners in the FullMinus treatment would use more instructional options, take more time, and achieve more than students in the LeanPlus treatment, who had to actively opt for additional instruction. It was also hypothesized that learners under the performance-contingent incentive would use more options, take more time, and perform better than learners under the task-contingent incentive, who need only complete the program. An additional area of interest was how learner attitude would be influenced by the two experimental factors.

METHOD

Subjects

Subjects were 111 undergraduate education students—87 females and 24 males—from a large southwestern university. They were from a single undergraduate education class with an enrollment of approximately 150 students. Each student was required to participate for course credit in at least one research study.

After blocking by sex, subjects were randomly assigned to one of four treatment groups which represented two levels of each of the independent variables: learner control (LeanPlus and FullMinus) and incentive (Performance-Incentive and Task-Incentive). The dependent variables on which subjects were measured were achievement, attitude, option use, and time.

Materials

Materials for the study consisted of a computer-delivered instructional program (which explained how to use the program in addition to presenting instruction), a posttest, and an attitude questionnaire. A one-page instruction sheet that explained how to operate the software was included with the computer-based program. The program, which covers foundational concepts and procedures of statistical inference (data types, samples, distributions, and hypotheses), was previously reviewed by content and instructional experts and field-tested in an instructional setting at a large mid-western university.

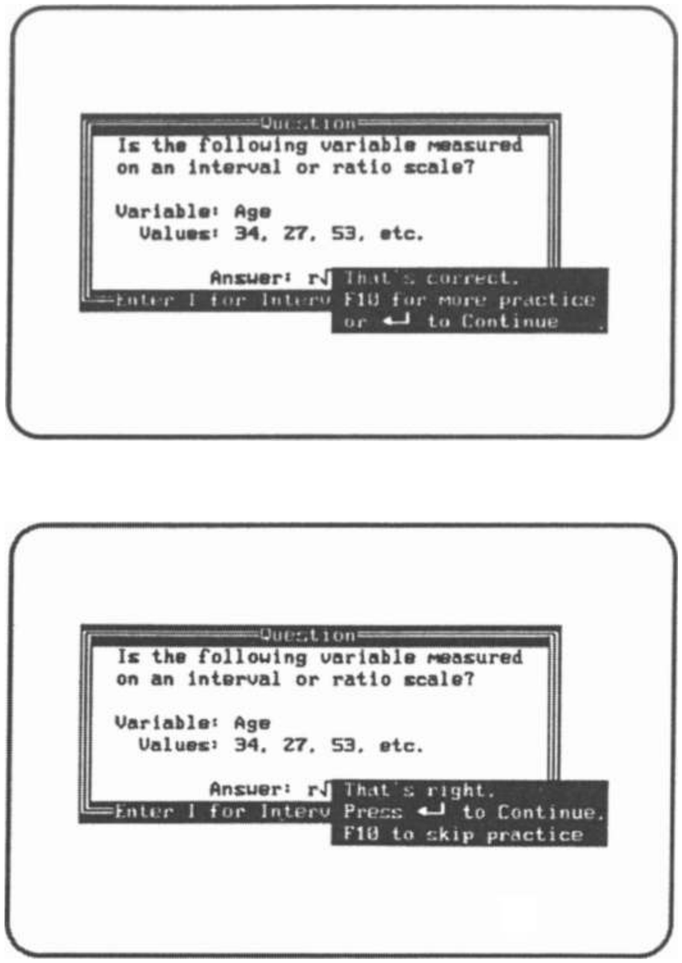
Each subject received a program diskette and the one-page instruction sheet; variations among the four treatments occurred entirely within the computer-based instructional program. For this research, the program provided no exit facility for learners; once they started the program, they had to complete it.

Differences in Treatments

The introductory lesson in the program informed subjects in the performance-contingent incentive treatment that they had to score at least 70% on the posttest to receive credit toward their grade. Subjects in the task-contingent groups were informed that merely completing the program ensured them credit. In truth, all subjects were to receive credit regardless of performance, and at the end of the posttest the program displayed any score below 70% as "71%."

Differences between the LeanPlus and FullMinus treatments occurred throughout the instruction with respect to control over three instructional elements: examples, practice items, and review. Figure 1 shows a typical practice item for LeanPlus and FullMinus treatments. As shown in the correct-answer feedback window at the lower right of each screen, pressing the F10 key allowed LeanPlus subjects to opt for an additional practice item, while the same key allowed FullMinus subjects to skip further items related to the current learning objective.

FIGURE 1 □ Typical Practice Items for LeanPlus (top) and FullMinus (bottom) Programs



Control of examples and review was analogous to the control of practice—subjects used the F10 key to solicit or bypass optional elements. Review screens progressed from general to specific, so learners who did not view particular screens would not miss out completely on review of particular concepts or procedures.

Common Features of the Treatments

Because all experimental treatments were designed to be instructionally sound, a minimum number (usually one or two) of examples, practice items, and review screens were required rather than optional. With respect to practice, for instance, a learner was never offered the option to view an additional item (LeanPlus) or to bypass items (FullMinus) until he or she had completed the minimum number required for that objective or subobjective.

The instructional portion of the program was composed of 219 display screens consisting of content, examples, practice items, and review. All learners viewed the 79 content screens common to the treatments. Learners in all treatment groups could opt for a minimum of 12 and a maximum of 35 examples, a minimum of 46 and a maximum of 90 practice items, and a minimum of 5 and a maximum of 15 review screens.

Recordkeeping

The program recorded the examples, practice, and review options selected by each learner as well as the time taken by the learner on each element. The program also recorded responses to practice items, responses to assessment instrument items and overall time. Both the posttest and the attitude questionnaire were administered on-screen during the computer session, and data were collected directly on the diskette.

Criterion Measures

Criterion measures consisted of a 32-item embedded final exam and an 11-item post-instruction questionnaire. The posttest was administered directly following the lessons. Posttest items, which were identical in format to practice items in the instructional program, consisted of multiple-choice, constructed response, and graphic-manipulation items. Items assessed recognition and recall as well as rule and concept learning. The alpha reliability coefficient of the posttest was .82.

The learner questionnaire was administered directly after the final exam. Items in the questionnaire, which were measured on a 5-point Likert scale from "strongly disagree" to "strongly agree," addressed learner attitudes toward the program and included specific items related to treatment variables. The questionnaire was identical for all groups except that 3 of the 11 attitude items varied between treatments to reflect the conditions of each subject's particular treatment. The alpha reliability coefficient of the questionnaire was .62.

Procedures

Students had listened in class to a brief description of the study and had been asked to sign up for participation. Those who signed up were assigned to one of the four treatment groups: LeanPlus Performance-Incentive, LeanPlus Task-Incentive, FullMinus Performance-Incentive, or FullMinus Task-Incentive. Each subject was given the appropriate computer diskette for the assigned group and the instruction sheet.

Subjects were allowed a two-week period in which to complete the instructional program. Because no exit facility was provided, the program had to be completed during a single computer session. Subjects were informed the instruction would take approximately 90 minutes. Twenty IBM Model 30 personal computers were made available all day in an educational computing lab. Subjects completed the program on their own time during the two-week period.

Design and Data Analysis

A 2 × 2 (control × incentive) posttest-only experimental design with random assignment (after blocking by sex) was used. All tests were performed using an alpha of .05. Before statistical analysis, between one and three subjects were randomly eliminated from three of the four groups to create a balanced design, as advised by Glass & Hopkins (1984), resulting in 24 subjects in each cell of the analysis of variance (ANOVA). Both posttest performance and attitudinal data were analyzed with ANOVA techniques; appropriate multivariate analyses were performed first, and univariate tests were performed if multivariate significance was found.

En route option selection data and data related to time spent on the program were analyzed using ANOVA based on treatment groups. Option selection data were also analyzed graphically and via principal components analysis to investigate selection patterns. Relationships between the variables were analyzed for correlations and by multiple regression.

RESULTS

Posttest Performance

Table 1 shows mean posttest scores by learner-control mode and type of incentive. The average score for learners in the two FullMinus groups was 25.75, compared to 23.90 for learners in the LeanPlus groups, a difference that

TABLE 1 □ Posttest Scores by Learner-Control Mode and Type of Incentive*

	Type of Incentive		
Learner Control Mode	TASK	PERFORMANCE	*Total*
LeanPlus			
M	23.04	24.75	23.90
SD	4.82	4.49	4.69
FullMinus			
M	24.63	26.88	25.75
SD	5.23	3.81	4.67
Total			
M	23.83	25.81	24.82
SD	5.04	4.26	4.75

*n = 24 for each interior cell; n = 48 for all totals except grand total (lower right cell), where n = 96. All scores are out of maximum of 32 possible.

approached statistical significance, $F(1, 92) = 3.87$, $p = .052$ (effect size = .40). The main effect for incentive was significant, $F(1, 92) = 4.40$, $p < .05$ (effect size = .43), with Performance-Incentive groups (M = 25.81) performing better than Task-Incentive groups (M = 23.83). The interaction effect was not significant.

Option Use

Number of Options Used

Of the 140 examples, practice items, and review screens, 62 were mandatory and 78 were optional. Four variables related to option use included use of both mandatory and elective elements: number of examples used, number of practice items used, number of review screens used, and total number of these elements used. Four option-use variables measured use of elective elements only: number of optional examples used, number of optional practice items used, number of optional review screens used, and total number of options used.

LeanPlus subjects used options by actively soliciting them; FullMinus subjects used options by choosing not to bypass them. For each of the eight option-use variables, a percentage variable was computed relating the number used either to the total number of that type of element (for the first four variables) or to the total number of that type of optional element (for the last four variables).

Because of the danger of spurious results in testing a large number of variables, a procedure suggested by Stevens (1986) was used. Variables assumed to be correlated were grouped for preliminary multivariate analysis of variance (MANOVA). If a significant multivariate effect was found, univariate tests followed at the same alpha level.

Correlations between individual option-use variables were all significant, $p < .001$, the lowest correlation between any of the variables being .80. The eight option number variables were treated as dependent variables in a multivariate test, as were the eight percentage variables. Both multivariate tests showed high multivariate significance ($p < .001$) on the learner-control factor, so univariate results were examined.

Table 2 shows the percentage of options used by learner-control mode and by type of incentive. (The table does not reflect the use of mandatory examples, practice, or review.) The overall mean percentage used by all groups was 56%. The average percentage of options used for learners in the FullMinus treatment was 80% compared to 32% for learners in the LeanPlus treatment, a highly significant difference, $F(1, 92) = 76.80$, $p < .001$ (effect size = 1.79). The average percentage of options used was 58% for the Performance-Incentive subjects and 54% for the Task-Incentive subjects—a nonsignificant difference. The interaction effect was also nonsignificant.

While FullMinus groups used more options, LeanPlus groups exercised more program

TABLE 2 ☐ Percentage of Optional Examples, Practice, and Review Used by Learner-Control Mode and Type of Incentive*

	Type of Incentive		
Learner Control Mode	TASK	PERFORMANCE	*Total*
LeanPlus			
M	29	35	32
SD	25	31	27
FullMinus			
M	79	81	80
SD	29	21	25
Total			
M	54	58	56
SD	37	35	36

*$n = 24$ for each interior cell; $n = 48$ for all totals except grand total (lower right cell), where $n = 96$. All percentages are out of 78 optional examples, practice, and review.

choice in the sense that they selected more options than the FullMinus groups bypassed. The average number of options selected by learners in the two LeanPlus groups was 24.71 (32%) compared to 15.50 (20%) options bypassed by learners in the FullMinus groups, a significant difference, $F(1, 92) = 4.56$, $p < .05$ (effect size = .44).

Patterns of Option Use

Within the instructional program, there were 37 points at which learners could control the use of options. Figure 2 shows the percentage of options used at each of the 37 junctures by learner control and incentive. The consistently greater percentage used by FullMinus over LeanPlus subjects is evident from the figure.

A principal components analysis, including oblique rotation, was undertaken to identify "typical" patterns of option use across all groups. The analysis examined the correlations between individual learner option-selection patterns to find groups of individuals whose patterns were similar. Analyses were specified that resulted in two-, three-, four-, and five-factor solutions, which forced the analysis to place individuals within a set of two common patterns, three common patterns, and so on. The individual selection patterns identified in the solutions were examined for loadings at the .20, .30, .40, and .50 level so that the degree to which each individual learner fit one of the general patterns could be estimated. At each loading level, individual learners' actual patterns identified as "fitting" a general factor were averaged to render a picture of the "typical" pattern for that group.

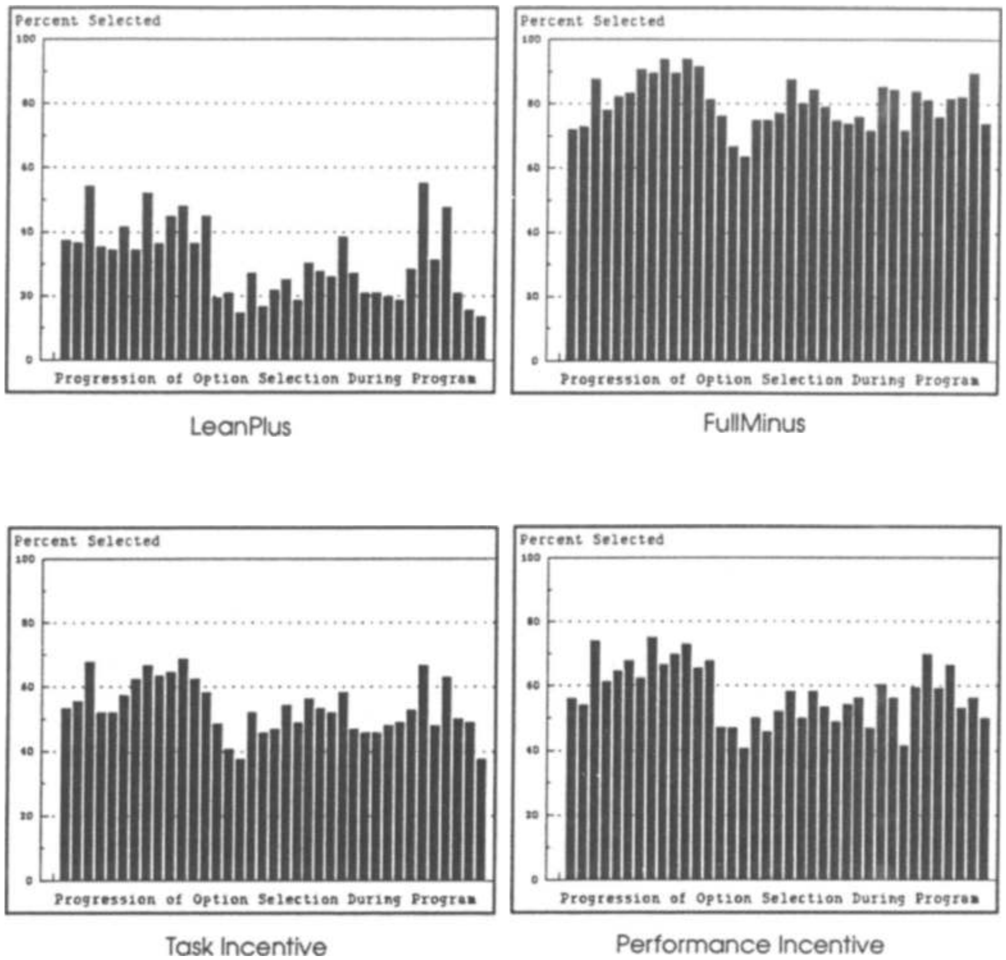
The most distinct patterns emerged for the three-factor solution. At the .30 loading level, 80 out of the 96 subjects' individual patterns fit into a typical pattern. Twenty-two subjects (28%) fit the first pattern, in which nearly all options were used; 16 subjects (20%) fit the second pattern, in which almost no options were used; and 42 subjects (52%) fit the third pattern, in which a moderate number of options was used (primarily at the beginning of the program).

The major constituency difference in the first pattern was that 17 FullMinus subjects fit compared to 5 LeanPlus subjects; the opposite was true in the second pattern, in which only 2 FullMinus subjects were included as opposed to 14 LeanPlus subjects. The final pattern was fairly well balanced: 17 FullMinus and 25 LeanPlus. The patterns did not show major differences based on type of incentive. The constituencies were similar at the .50 loading level, except that the number of subjects fitting each pattern was reduced.

Option Use and Posttest Performance

All the option-use variables correlated positively and significantly with posttest performance. The highest correlation was between

FIGURE 2 □ Option Selection Patterns by Learner-Control Mode and Type of Incentive



percentage of all options used and posttest performance, $r = .38$, $F(1, 94) = 15.91$, $p < .0001$.

Time on Program

The overall time spent on the program by learner-control condition was 102.47 minutes for the FullMinus treatment and 102.61 minutes for the LeanPlus condition, a nonsignificant difference. Overall time by incentive condition was 103.87 minutes for the Performance-Incentive subjects and 101.20 minutes for the Task-Incentive subjects, also a nonsignificant difference.

A MANOVA was performed that included as dependent variables: time spent on examples, time spent on practice, time spent on review, time spent on options, time spent on common elements, and time spent on the posttest. Time differences were found on specific components of the program. FullMinus subjects spent 18.39 minutes and LeanPlus subjects only 8.85 minutes on the various optional elements of the program, a highly significant difference of nearly 10 minutes, $F(1, 92) = 31.38$, $p < .001$ (effect size = 1.16). In contrast, LeanPlus subjects spent nearly 10 minutes longer—93.76 minutes compared to 84.08 minutes—than FullMinus subjects on the common, mandatory elements of the program, a difference that approached statistical significance ($p = .074$). A further test showed that the average time per screen for learners in the LeanPlus treatment was 30.24 seconds, compared to 25.50 seconds for learners in the

FullMinus treatment, a significant difference, $F(1, 92) = 6.30$, $p < .05$ (effect size = .50).

Attitudes

The 11 items on the attitude questionnaire were measured on a 5-point Likert scale, with a score range of 0 for "strongly disagree" to 4 for "strongly agree."

Three attitude items showed significant differences between treatments. A significant main effect for learner-control mode, $F(1, 92) = 4.36$, $p < .05$ (effect size = .43), revealed that LeanPlus subjects ($M = 3.63$) liked the option to add instructional elements better than FullMinus subjects ($M = 3.21$) liked the option to bypass instruction. A second significant main effect for learner control revealed stronger motivation to study more statistics for the FullMinus treatment ($M = 1.77$) than for the LeanPlus treatment ($M = 1.15$), $F(1, 92) = 6.78$, $p < .05$ (effect size = .56). A significant learner control by incentive interaction, $F(1, 92) = 5.61$, $p < .05$, was obtained for how well subjects liked the program overall, with LeanPlus Task-Incentive subjects ($M = 2.42$) liking it better than the LeanPlus Performance-Incentive subjects ($M = 1.34$), and FullMinus Performance-Incentive subjects ($M = 2.50$) liking it better than FullMinus Task-Incentive subjects ($M = 2.29$).

Tukey-B multiple comparisons of cell means (Glass & Hopkins, 1984) revealed that the mean score of the LeanPlus Performance-Incentive group was significantly lower than the mean of each of the other three groups, and that the other three means did not differ significantly from each other.

Posttest score was moderately correlated with three attitude items: confidence in deciding when to use options ($r = .42$, $p < .01$); reported effort to learn ($r = .35$, $p < .01$); and liking the program overall ($r = .31$, $p < .05$). Of the three variables, only reported effort seemed to be primarily a cause rather than an effect of achievement. Reported effort was considered in a multiple regression in which percentage of options used was another predictor and posttest score the dependent variable. Percentage of options used entered the equation first, with $F(1, 94) = 15.91$, $p < .001$, $R = .3804$, then reported effort entered, $F(2, 93) = 14.97$, $p < .0001$, $R = .4935$, indicating that reported effort accounted for significant additional variance in posttest scores.

DISCUSSION

This study examined the effects of two general approaches to the provision of learner control and of two types of incentive on achievement, use of options, time, and attitude in computer-delivered instruction. Both learner-control mode and type of incentive were found to have an impact on learner behavior.

Learner Control

Subjects in the FullMinus groups scored marginally higher on the posttest than subjects in the LeanPlus treatment ($p = .052$). In considering this difference, one should recall that 62 of 140 example, practice, and review screens were mandatory in both the FullMinus and LeanPlus programs. Given the strong relationship found between option use and posttest performance, it is likely that, had there been more optional and less mandatory instructional elements, the performance advantage of FullMinus over LeanPlus might have increased. The finding that FullMinus subjects used (did not bypass) 80% of the optional elements while LeanPlus subjects opted for only 32% of available options is consistent with results from previous studies by Carrier and her colleagues (Carrier, 1984; Carrier et al., 1984; Carrier et al., 1985; Carrier et al., 1986; Carrier & Williams, 1988) and by Lopez and Harper (1989) and Pollock and Sullivan (1990).

Although FullMinus subjects worked with more options than LeanPlus subjects, it would be imprecise to conclude that learners in the FullMinus treatment "chose" more options than learners in the LeanPlus treatment. In fact, the LeanPlus subjects exercised greater learner control in the sense that they selected more options than FullMinus subjects bypassed. That is, LeanPlus subjects deviated from the default program more often than FullMinus subjects. Perhaps subjects "trusted" the default program to provide the necessary instruction: FullMinus subjects elected to bypass only 20% of options while LeanPlus subjects solicited only 32% of elective elements.

It was expected that learners in the FullMinus treatment, in using more options, would have taken longer to complete the program. This did not turn out to be the case; there was no overall time difference between any of the groups. FullMinus subjects did spend more than twice as much time on optional elements (nearly 10 minutes longer), yet this time was "made up" by LeanPlus subjects, who spent nearly 10 minutes longer on the common parts of the program. It would appear that the LeanPlus learners compensated for having less instruction by spending more time on the instruction they had. Another possible implication, given posttest scores, is that time spent on examples, practice, and review may be more beneficial to learners than additional time spent studying content screens, a suggestion consistent with findings by Sullivan, Baker, and Schutz (1967).

The fact that FullMinus subjects spent less time per screen suggests that they may have processed the instruction more efficiently. It seems likely that the ongoing use of examples, practice, and review may have fostered a stronger foundation of understanding that allowed these learners to progress more effectively through the program.

That LeanPlus subjects liked having the options more than FullMinus subjects suggests that LeanPlus subjects' less positive reaction to the program overall may have been due in part to performance difficulties. The fact that the LeanPlus Performance-Incentive group reported a negative attitude with respect to liking the program overall may have resulted from the group's relative lack of basic instruction in the subject matter coupled with the requirement to do well. Attitudinal results related to the instructional content showed a negative effect for LeanPlus subjects, who were less eager to further study statistics.

Overall, these findings support the suggestion that a FullMinus design may have advantages over a LeanPlus design. In this study, the FullMinus treatment produced better results than the LeanPlus treatment, with no greater investment of learner time.

Incentive

The finding that the type of incentive affected performance has implications for learner-control research as well as for instructional program development. Despite findings by Sullivan et al. (1967) and Sullivan, Schutz, and Baker (1971), as well as admonitions by Tennyson and Buttrey (1980), most learner-control studies have not taken into account the effect of incentive on learner performance.

The current results suggest that learners confronted with a performance criterion level may manifest greater achievement, at least within a single program. Since Performance-Incentive groups neither used more options nor spent more time on the program, their success apparently came from greater concentration on the program and/or a stronger desire to perform well. These findings support previous research (Sullivan et al., 1971, for example), which found that learners perform differentially on the same instruction depending on the incentive that is provided. The results also suggest that researchers of learner control should consider the use of performance-contingent incentives to maximize student achievement.

Contrary to expectations, there was no difference in reported effort between Task-Incentive and Performance-Incentive groups; all groups reported they had tried hard to learn. However, reported effort was significantly correlated with posttest performance for all groups. This supports Merrill's TICCIT research (1980), in which perceived effort was found to be the only variable associated with achievement.

Option Use

Typical option-use patterns extracted from the current data for university students were consistent with patterns suggested by Carrier et al., (1986) for elementary students. Some subjects used almost all options, some used almost no options, and some used options at the beginning of the program and then tapered off. This finding suggests that these three patterns of option use in CAI may be similar across varying subject matter and age levels.

The fact that some learners tend to use fewer options as they progress through an instructional program suggests that it may be advisable for instructional designers to include more mandatory instruction toward the end of a program. Like many instructional programs, the one used in the current study increased in difficulty as the lessons progressed, yet subjects used the fewest options during the most advanced lessons.

Implications for Instructional Design and Research

The results of this study have implications for instructional program development. The findings suggest that learners are sensitive to procedural cues embedded in an instructional program and tend to rely on default choices. Learners may tend not to deviate from what they perceive as a program's "normal" sequence.

Perhaps an effective strategy for designers is to offer the perception of control, or to allow learners to control instructionally benign aspects of the program, such as context of examples. Such a notion is in conformance with other findings which suggest that a small amount of learner control results in greater achievement than a high amount (Pollock & Sullivan, 1990), and that perception of control can improve performance (Kinzie et al., 1988).

Percentage of options used and reported effort were the variables that accounted for the most variance in posttest performance in this study. These factors should be considered in the design of learner-control studies and in the interpretation of their results. When comparing results from different studies, it may be especially important to consider the type of program (FullMinus or LeanPlus), the number of options used, and the incentive provided.

According to Merrill (1980), the ultimate learning environment is life itself, and here we should accept no substitute for learner control. Nevertheless, as this study suggests, within the microcosm of an instructional program our natural respect for individual freedom may be in conflict with achievement. The question of how to effectively offer learner control, already debated, may take on new dimensions as computer-based media provide greater instructional flexibility. There is an important and delicate balance between the goals of individual responsibility and instructional efficiency which designers and researchers should continue to explore. □

Samuel Hicken is with the Department of Training and Learning Technologies at the University of New Mexico, Albuquerque. Howard Sullivan and James Klein are with the Division of Psychology in Education at Arizona State University, Tempe.

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Requests for reprints should be addressed to: Samuel Hicken, University of New Mexico, Training and Learning Technologies, Albuquerque, NM 87131-1256, Bitnet: SAMUEL@UNMVMA

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