Technical Paper 315

RELATIONSHIPS BETWEEN STUDENT ATTITUDES TOWARD COMPUTER-ASSISTED INSTRUCTION AND TRAINING PERFORMANCE

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The attitudes of 90 enlisted personnel toward Computer-Assisted Instruction (CAI) were measured before and after they received instruction presented by CAI. The attitude pretest and posttest were administered on line. The instructional material was divided into four lesson segments, each followed by a review (test) segment. Students who failed to reach the criterion score for any review segment repeated the corresponding lesson segment. A criterion test was administered at the end of the last segment. Measures of student performance used during the course of the instruction were (a) the total score on the criterion

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test (total score); (b) the number of errors made during the lesson and review segments (errors); (c) the percentage of responses made during the lesson and review segments that were incorrect (percent errors); (d) the time required to complete the lesson and review segments (time); and (e) the number of review segments failed (review failures). The attitude pretest did not correlate significantly with any of the performance measures. A significant correlation was obtained between attitude posttest and percent errors (r = -.22). Attitude change was correlated with total score (r = .28), errors (r = -.19), and percent errors (r = -.25). Attitude and attitude change were not related to student ability.

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FOREWORD

A portion of the Army Research Institute for the Behavioral and Social Sciences (ARI) program consists of research and development in areas of educational technology with applicability to military training. One research area of interest is the use of alternative training media for students of varying abilities and characteristics. Development and implementation of such systems can potentially increase the efficiency and effectiveness of the training process because the instruction can be adapted to the individual student to a greater extent than would otherwise be possible.

A prerequisite to the development of such systems is the identification of those student characteristics and abilities that are predictive of training success with specific media. Previous research had suggested that student attitudes toward the specific medium involved were potential predictors, and in addition had produced the necessary instruments to measure student attitudes toward one medium, Computer-Assisted Instruction (CAI). The purpose of this research was to investigate more extensively the relationships between student attitudes toward CAI and their performance while they were receiving instruction by CAI.

Whereas this effort is a basic research study, it initially evolved because of and in support of an operational evaluation. The impetus for this project was a request from the U.S. Army Ordnance Center and School (USAOC&S) for scales on which to measure student attitudes toward CAI to be used in an evaluation of the training effectiveness of the PLATO IV CAI system. To meet this request, basic research in this area was needed. A cooperative effort followed, with USAOC&S receiving the scales for their use, and ARI receiving personnel and student support for the first phase of the basic research project. This effort, which began during FY 75, was part of the Unit Training and Educational Technology Systems Technical Area work program. Following a reorganization, the effort continued in FY 76 as part of the Educational Technology and Training Simulation Technical Area, specifically the Educational Concepts and Evaluation Work Unit area. The entire research effort is responsive to FY 75 requirements of Project 2T161101A91B, "Independent Laboratory In-House Research."

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RELATIONSHIPS BETWEEN STUDENT ATTITUDES TOWARD COMPUTER-ASSISTED INSTRUCTION AND TRAINING PERFORMANCE

BRIEF

Requirement:

To investigate the relationships between military student attitudes toward Computer-Assisted Instruction (CAI) and performance while students were receiving instruction by CAI.

Procedure:

The attitudes of 90 military enlisted personnel toward CAI were measured before and after they received a 107-minute unit of instruction on human audition presented by CAI. Both the attitude pretest and the attitude posttest were administered by computer. The instructional material was divided into four lesson segments, each followed by a review (test) segment. Students who failed to reach a specified score on any review segment repeated the corresponding lesson segment. A final test, covering the material from all segments, was administered at the end of the last segment. Five measures of student performance during the course of the instruction were used: (a) the total score on the final test (total score); (b) the number of errors made during the lesson and review segments (errors); (c) the percentage of responses made during the lesson and review segments that were incorrect (percent errors); (d) the time required to complete the lesson and review segments (time); and (e) the number of review segments failed (review failures).

Findings:

Scores on the attitude pretest were not related to scores on any of the lesson performance criteria. A significant relationship was obtained between the attitude posttest percent errors, indicating that those students who made a lower percentage of errors during the lesson also had more positive end-of-lesson attitudes toward CAI. Change in attitude was related to total score, errors, and percent errors. Positive change in attitude was also related to "good" performance on these criterion measures. Scores on both attitude scales were independent of student ability, as measured by scores on the AFQT and the ACB.

These findings indicate that student attitudes toward CAI are of little or no value in the selection of training media and methods for individual students, at least when the students have had limited prior exposure to CAI.

Utilization of Findings:

The on-line versions of the attitude scales are available for use by other organizations and will be used by ARI for future research.

RELATIONSHIPS BETWEEN STUDENT ATTITUDES TOWARD COMPUTER-ASSISTED INSTRUCTION AND TRAINING PERFORMANCE

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RELATIONSHIPS BETWEEN STUDENT ATTITUDES TOWARD COMPUTER-ASSISTED INSTRUCTION AND TRAINING PERFORMANCE

INTRODUCTION

A central theme in the field of educational technology has been the development and evaluation of methods that allow instruction to be individualized. Both training specialists and educational theorists recognize the importance of adapting training to the individual student if significant advances in training efficiency or effectiveness are to be made.

Training can be individualized in many ways. Self-pacing, either through Programed Instruction (PI) lessons or the self-pacing of entire courses, represents perhaps the simplest form of individualized training. Computer-Assisted Instruction (CAI) lessons that modify the amount and sequence of instructional material on the basis of student performance (or student choice) represent another way to individualize training. A more complex method is to assign each student to a particular training method or medium that is expected to be most effective for him or her. The "best" method may well differ for each student as a function of the type of instructional material presented. There are three minimal requirements for implementing individualized training of the last type: (a) multiple methods and media by which students can accomplish the same training objectives; (b) decision models for selecting the best training methods and media for individual students; and (c) mechanisms for implementing those decision models. Requirements (a) and (c) are well within the scope of today's technology. However, at present there is insufficient knowledge regarding the interactions among student characteristics, instructional treatments (methods and media), and training content to permit implementation of such an approach to individualized training.

Student attitudes toward training methods and media constitute one possible basis for media selection decisions. The relatively high importance of such attitudes, particularly toward CAI, PI, and Computer-Managed Instruction (CMI), as perceived by both Army trainers and researchers, made them a logical topic for further investigation. Army trainers typically assess student attitudes toward CAI or CMI systems as a part of the evaluations of those systems. The evaluations of the PLATO IV CAI system at the Army Ordnance Center and School and the Computerized Training Systems Project ABACUS at the Army Signal School are recent examples. High perceived importance by researchers is evidenced by the substantial number of studies that have collected student attitude data. King (1975), in a review of the research literature in this area, cited 44 such studies.

However, this importance has produced neither well-integrated nor consistent results, particularly with regard to relationships between student attitudes and student performance in the instructional situation. King (1975) noted two methodological problems which, it would appear, are at least partially responsible for this lack of integration and consistency. First, although student attitude data are frequently collected (as noted above), there has been no effort to investigate student attitudes in any integrated fashion. Only rarely are student attitudes the primary focus of the research. Investigators are justifiably more concerned with the effects of the independent variables on cognitive or psychomotor performance than with effects on student attitudes. Second, there is little agreement on an operational definition of student attitude. There have been some attempts to achieve consistency in the use of measuring instruments: five of the studies cited by King, and one additional study to be cited here (Gallagher, 1970), have used either a scale developed by Brown (1966) or modifications thereof. For the most part, however, the scales used are designed ad hoc with neither the items used nor the metric properties of the scales described. As King noted, "Most studies use experimenter-constructed tests which have unknown or unreported reliabilities (1975, p.7)."

Relatively few studies have attempted to investigate what, if any, relationships exist between attitudes toward PI, CAI, or CMI and performance in a course of instruction taught by one of those methods. Studies that have attempted to find relationships have produced mixed results. Doty and Doty (1964) found posttest attitude (attitude measured following the instruction) toward PI to be positively correlated with lesson achievement for female students but not for male students. Gallagher (1970) found no significant relationships between posttest attitude toward CMI and course performance. Mathis, Smith, and Hansen (1970) measured attitudes toward CAI both before and after the instruction was presented. Errors per question attempted during the course of the instruction correlated negatively with posttest attitude but not with pretest attitude. Reid, Palmer, Whitlock, and Jones (1973) measured attitudes toward CAI before and after the instruction was presented. Pretest attitude, posttest attitude, and attitude change were unrelated to lesson achievement and to the amount of time required to complete the lesson for the total sample. Although significant correlations between attitudes and performance were obtained for selected subgroups, it appears that no more than 5.2% of the correlations calculated were significant at the .05 level; thus these correlations could be attributed to chance alone.

The above studies were conducted using college or graduate students, and the attitude scales used were not felt to be appropriate for use with enlisted military personnel. Consequently, Knerr and Nawrocki (1978) developed two attitude-toward-CAI scales, a 13-item pretest and a 37-item posttest, for use with military personnel. When used in the evaluation of the PLATO IV CAI system at the U.S. Army Ordnance Center and School, neither the pretest nor the posttest was correlated with the time required to complete a series of four lessons presented by CAI, the only performance criterion available.

The purpose of this study was to continue the investigation of the relationships between military student attitudes toward CAI and student performance begun by Knerr and Nawrocki (1978), using a variety of measures of performance in the instructional situation.

METHOD

Subjects

Subjects were 90 enlisted military personnel receiving training at the U.S. Army Engineer School during the period September to November 1975. A description of salient student background information is provided in Table 1. Median values show that the typical student was male, was in pay grade E-2, was 19 years old, had been in the military for 3 months, had 12 years of formal education (all were at least high school graduates), and could not type.

Table 1

Student Background Information

Item	Median	Range
Pay grade	E-2	El - E5
Age	19	17 - 32
Months in service	3	2 - 53
Years education	12	12 - 16
Typing speed (words per minute)	0	0 - 100
	Male	Female
Sex	81	7

Note. N = 88. Background data on two students were destroyed by systems failure.

Attitude Scales

The two attitude scales, pretest and posttest, developed by Knerr and Nawrocki (1978) were used. The pretest consists of 13 five-alternative multiple choice items. When previously administered, it was found to have an internal consistency (Kuder-Richardson Formula 8; KR 8) of .91.[1] The posttest consists of 37 items and has an internal consistency of .89; it can be divided into two subtests. The first, the repeated subtest, consists of those 13 items in the pretest (rephrased in the past tense where necessary) and has an internal consistency of .85. The unique subtest consists of 24 additional items and has an internal consistency of .81. The pretest and posttest items are shown in appendixes A and B respectively.

The scales had previously been administered in paper and pencil format. Prior to this study they were modified for on-line administration and scoring by the PLATO IV CAI system.[2] The experimental procedure was such that the scales had to be administered on an individual basis. Computerized administration, then, offered a substantial time savings for the experimenter. It also provided the capability for automatic scoring and data reduction.

Figure 1 shows a sample item as it appeared initially to the student. The student responded by entering the letter of his or her choice (a through e) via the terminal keyboard. This choice was then marked by an asterisk, and the student was given an opportunity to change the answer before advancing to the next question, as shown in Figure 2. The student was required to answer each question in order to advance to the next.

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[1] This measure entails fewer assumptions than the more commonly used Kuder-Richardson formula 20 (KR 20). Specifically, KR 8 assumes that the intercorrelation matrix has a rank of one, that is, that the scale measures only one factor, while KR 20 assumes, in addition, that all item intercorrelations and standard deviations are equal. If these additional assumptions are met, KR 8 and KR 20 will produce identical reliability estimates. If they are not met, KR 8 will produce higher and more accurate reliability estimates than KR 20.

[2] Commercial designations are used only for precision of description. Their use does not constitute endorsement by the Army or the Army Research Institute.

```
Most courses could be taught more effectively by
a regular teacher than by computer.

          a.  Strongly agree
          b.  Agree
          c.  Undecided
          d.  Disagree
          e.  Strongly disagree
```

Figure 1. Pretest item 1, as it appears to the student before a response is selected.

```
Most courses could be taught more effectively by
a regular teacher than by computer.

          a.  Strongly agree
        * b.  Agree
          c.  Undecided
          d.  Disagree
          e.  Strongly disagree

Your answer is marked with an '*'.  You can change
it by pressing -BACK-, or continue with the next
question by pressing -NEXT-.
```

Figure 2. Pretest item 1, as it appears to the student after a response is selected.

Lesson Material

The lesson material consisted of a four-section lesson entitled "The Elementary Physiology of Audition (or How Your Ear Works)." The sections dealt with sound waves, anatomy of the ear, balance, and ear damage and degeneration, respectively. Following each section, the students received a series of review questions covering the objectives of that section. Students who answered less than 85% of the review questions for any section correctly were required to repeat that section. After the fourth review was successfully completed, the student was administered a 68-item test covering the objectives of the entire lesson.

Performance Criteria

The following performance criteria were obtained for each student: (a) the amount of time required to complete the four lesson and review sections (time); (b) the total score on the final end-of-lesson test (total score); (c) the number of incorrect responses made during the lesson and review sections (errors); (d) the percentage of the total responses made during the lesson and review sections that were incorrect (percent errors); and (e) the number of reviews failed (review failures). Percent errors requires some additional explanation. It is the percentage of responses to which the student did not receive positive feedback (OK, correct, right, etc.). It is also similar to errors per question attempted, which Mathis et al. (1970) found to be correlated with posttest attitude.[3]

Experimental Procedure

Upon arrival at the experimental area, each student was given a short written explanation of the experimental procedures. After any questions were answered he or she was signed onto the PLATO IV system. The PLATO IV system controlled all student routing, lesson administration, and data collection. Unless a problem arose, the student did not interact with the experimenter again until the end of the session.

After being signed onto the system, each student received a short lesson on the use of the keyboard and terminal. This was followed by an on-line biographic questionnaire, the attitude pretest, the human audition lesson, the end-of-lesson test, and the attitude posttest.

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[3] It is not clear whether Mathis et al. (1970) used errors per attempt or errors per question as their performance measure. In CAI lessons, in general, a student may attempt questions more than once; the two measures, therefore, are not necessarily equal. Percent errors is equal to errors per attempt, and a monotonic (but nonlinear) function of errors per question.

Selection and Classification Test Scores

After the experiment had been completed, scores on the Armed Forces Qualification Test (AFQT) and the General Technical (GT) aptitude area of the Army Classification Battery were obtained for approximately one-half of the students. These scores permitted examination of the relationships between "ability" and attitude.

RESULTS

The results are organized around five separate issues. The first two are concerned with the characteristics of the attitude scales themselves: scale administration time and internal consistency. The second two deal with the relationships between the attitude scale scores and the performance criteria, and the relationships between attitude change and the performance criteria, respectively. The final issue is the relationships among student ability, student performance, and student attitude.

Attitude Scale Administration Time

Although the amount of time required for the students to complete the attitude scales is not directly related to the primary objective of this research, it does provide some information about the feasibility of on-line administration. Extremely long administration times would be indicative of student problems and would also suggest that administration in an operational setting is not feasible. Table 2 shows the administration time data for 87 students. (A systems error caused the loss of time data for the other three students.) Mean administration time for the pretest is 4.90 minutes, with 90% of the students completing it in 6.90 minutes or less. Mean administration time for the posttest is 9.17 minutes, with 90% completing it in 11.80 minutes or less.

Table 2

Attitude Scale Administration Time (in Minutes)

Time	Pretest	Posttest
Mean	4.90	9.17
Median	4.40	8.75
Standard deviation	1.81	2.32

Note. N = 87. Data on three students were lost.

Internal Consistency

The item stem, mean, standard deviation, and item-total correlation for each item are included in appendixes A (pretest) and B (posttest). Table 3 presents a comparison of the internal consistencies (KR 8) of the on-line versions of the pretest, total posttest, and unique and repeated subtests with the internal consistencies of the previously administered off-line (paper and pencil) versions. The internal consistencies for the on-line versions are .88 for the pretest, .93 for the repeated posttest, .87 for the unique posttest, and .93 for the total posttest. Each of these values was compared with the internal consistency of the same scale when administered in paper and pencil format. Differences were tested, using the z test for the significance of the difference between two correlations. Table 3 shows the results of these tests. Whereas it initially appeared that the on-line versions of the posttest had higher internal consistencies than did the off-line versions, this is supported only for the repeated posttest, for which the on-line version has an internal consistency of .93, and the off-line version, .85 ($z = -2.40$, $p < .01$).

Table 3

A Comparison of the Internal Consistencies (KR 8) of the On-Line and Off-Line Versions of the Attitude Scales

Tests	Off line	On line[a]	$z_{difference}$
Pretest	.91[b]	.88	1.20
Repeated posttest	.85[c]	.93	-2.40*
Unique posttest	.81[c]	.87	-1.20
Total posttest	.89[c]	.93	-1.44

[a] N = 90.

[b] N = 228.

[c] N = 64.

*$p < .01$.

Attitude-Performance Relationships

The matrix of intercorrelations among the attitude scale scores and the lesson performance criteria is shown in Table 4. The left side of the table indicates that the performance criteria are highly correlated, with the absolute value of the correlations ranging from .57 to .90. High values of total score reflect good performance, whereas high values of the other performance criteria reflect poor performance. Thus the correlations between total score and the other performance criteria are negative.

The lower right corner of the intercorrelation matrix shows the intercorrelations among the various attitude scales. Correlations of the pretest with the repeated, unique, and total posttests are .78, .59, and .71, respectively. The correlation between the unique and repeated posttests is .78.

The attitude pretest appears to have no predictive validity. Correlations of the pretest with the performance criteria range from -.02 to .09. None of these correlations is significant at the .05 level.

Two of the performance criteria show significant relationships with the postlesson attitude scales. Total score is correlated with the unique posttest ($r = .21$, $p < .05$). Percent errors is correlated with the unique posttest ($r = -.22$, $p < .05$) and the total posttest ($r = -.22$, $p < .05$). The square of these correlations indicates that between 4.41% and 4.84% of the variance in posttest attitude is accounted for by the performance criteria.

Attitude Change and Performance

The relationships between attitude change and performance criteria were also determined. The measure of attitude change used was residual change, that is, the portion of the posttest score that is independent of the pretest score. Use of residual change in this situation has two advantages over the use of a raw gain score (posttest minus pretest): (a) it is not correlated with pretest score, while raw gain is negatively correlated with pretest score; and (b) it does not require that the pretest and posttest scores have the same metric (Manning & DuBois, 1962). Correlations between the performance criteria and residual change were calculated by using the part correlation (McNemar, 1962). Thus the correlation calculated is that between a performance criterion and a posttest score with the effects of the pretest removed from the posttest score. Three different residual changes calculated were the following: pretest-unique posttest, pretest-repeated posttest, and pretest-total posttest.

Table 4

Correlations Between the Attitude Scales and the Lesson Performance Criteria

	Total score	Errors	Percent errors	Time	Review failures	Pretest	Repeated posttest	Unique posttest	Total posttest
Total score	1.00	-.62**	-.59**	-.64**	-.63**	-.02	.12	.21*	.18
Errors		1.00	.90**	.65**	.79**	-.00	-.12	-.17	-.15
Percent errors			1.00	.57**	.66**	-.06	-.19	-.22*	-.22*
Time				1.00	.76**	-.02	-.06	-.12	-.10
Review failures					1.00	.09	-.02	-.13	-.08
Pretest						1.00	.78**	.59**	.71**
Repeated posttest							1.00	.78**	.94**
Unique posttest								1.00	.95**
Total posttest									1.00
Maximum N	90	87	87	90	89	90	90	90	90
Mean	79.31	51.84	20.72	106.79	1.53	45.91	47.42	91.86	139.28
Standard deviation	9.44	51.19	9.65	34.57	1.74	8.34	10.25	11.86	20.86

*$p < .05$.
**$p < .01$.

The resulting correlations are presented in Table 5. Time and review failures are not correlated significantly with any of the residuals. Total score and percent errors are correlated with each of the residuals. Errors are correlated only with the pretotal residual. The absolute value of these significant correlations ranges from .21 (errors and the pretotal residual) to .28 (total score and the pretotal and preunique residuals). Thus the proportion of variance in attitude change accounted for by the performance criteria, when significant, varies between 4.41% and 7.84%.

Table 5

Correlations Between Residual Attitude Change and the Lesson Performance Criteria

Performance criteria	N	Type of residual		
		Pretotal	Prerepeated	Preunique
Total score	90	.28**	.22*	.28**
Errors	87	-.21*	-.18	-.20
Percent errors	87	-.25*	-.22*	-.23*
Time	90	-.12	-.08	-.13
Review failures	89	-.03	.07	-.09

*$p < .05$.
**$p < .01$.

Student Ability, Attitude, and Performance

GT and AFQT scores were available for 42 students. These scores were correlated with the performance criteria and the attitude scale scores, with the results shown in Table 6. Because the GT and AFQT scores are highly correlated (r (41) = .88, $p < .01$), they show similar correlations with the other variables. Both are correlated significantly with each of the lesson performance criteria. In all cases, students with higher AFQT and GT scores obtained better scores on the performance criteria.

Table 6

Correlations of GT and AFQT Scores With the Attitude Scale Scores and the Lesson Performance Criteria

Measure	GT	AFQT
Total score	.66*	.67*
Errors	-.51*	-.54*
Percent errors	-.40*	-.42*
Time	-.77*	-.79*
Review failures	-.65*	-.66*
Pretest	-.20	-.06
Repeated posttest	-.16	-.02
Unique posttest	.04	.16
Total posttest	-.06	.08
N = 42		
Mean	111.79	66.14
Standard deviation	12.60	18.20

$^{*}p < .01$.

In contrast, GT and AFQT scores are not correlated with any of the attitude scale scores. Also, as shown in Table 7, GT and AFQT scores are not correlated with attitude change. In summary, total score, errors, and percent errors are related to attitude change; GT and AFQT scores are related to total score, errors, and percent errors; but GT and AFQT scores are not related to attitude change. A possible explanation for this is that the relationships between attitude change and performance are too small to contribute to relationships between "ability" and attitude change.

Table 7

Correlations Between Residual Attitude Change and GT and AFQT Scores

Test	Pretotal	Prerepeated	Preunique
GT	.10	-.02	.17
AFQT	.17	+.04	.23
N = 42			

DISCUSSION

Based on the results of this study, it appears feasible to measure student attitudes toward CAI through the use of on-line attitude scales. Certainly there are many questions that could be raised about such an approach. One such question is whether the method of administration (on-line versus paper and pencil) produces differential student responses. A related question is whether the method of administration has any effect on the metric properties of the scales. There was one significant difference between the internal consistencies of the on-line versions and those of Knerr and Nawrocki's (1978) paper-and-pencil versions; however, the background characteristics of the students in the two studies were not exactly equivalent and, more importantly, the amount of exposure that the students had to CAI, both before the administration of the pretest and between the administration of the pretest and the posttest, differed for the two groups. Thus the difference obtained may be a result of factors other than the method of administration.

Despite these uncertainties, on-line administration appears to have certain advantages. The first advantage is the reduction of personnel time required for administration and scoring; a second is that the scales can be integrated into the computer system's management function, thus insuring that each student is administered the proper scale at the proper time; finally, the method of presentation eliminates certain types of student errors, such as answering a question in the wrong space on an answer sheet, or failing to answer a question.

The internal consistencies of .88 for the pretest and .93 for the total posttest compare favorably with those of previously developed scales.[4] Few other scales that could be used as pretests have reported reliabilities. Gallagher (1970) reported an internal consistency of .937 (Hoyt method) for the Michigan State University Learning Service "Attitude Toward Learning Inventory." This scale is suitable for use as a pretest, but it is not designed specifically to measure attitudes toward CAI. Mathis et al. (1970) developed a 30-item pretest but reported no internal consistency for it.

Internal consistencies (KR 20 or equivalent) for other scales used as posttests are .89 for Brown's (1966) 40-item scale and .82 for the 27-item scale developed by Mathis et al. (1970). Many scales, such as those used by Doty and Doty (1964) and Reid et al. (1973), have no reported internal consistencies.

Evidence is mounting that preinstructional attitude toward CAI does not affect subsequent performance in the instructional situation, at least when relatively naive students are involved. Knerr and Nawrocki, (1978), using time as the criterion, found this to be the case. Mathis et al. (1970) obtained similar results, using errors per question attempted as the criterion. In the present study, no predictive relationships were found, although a variety of lesson performance criteria were used.

These results may not be generalizable to students who have had extensive previous experience with CAI. Mathis et al. (1970) and Knerr and Nawrocki (1978) used as subjects students who had no previous experience with CAI. In the current study, the experience of the students prior to the administration of the pretest was limited to the time required to complete the terminal familiarization lesson and the biographic information questionnaire--less than 30 minutes. Thus CAI was still a novel and somewhat unfamiliar situation for the students. It is not known whether similar results would have been obtained if the students had previously received instruction by CAI.

Certain aspects of student performance in the instructional situation are related to posttest attitude (total score and percent errors) and to attitude change during the course of instruction (total score, errors, and percent errors). These effects, however, were not large. None of the

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[4] Other internal consistencies reported have been calculated using formula KR 20 or an algebraic equivalent. For the scales used in this study, KR 20 internal consistencies were .87 for the pretest and .92 for the posttest. The KR 20 values are less accurate than the KR 8 values, but they provide a fairer comparison with other scales.

performance criteria accounted for more than 5% of the variance in posttest attitude or more than 8% of the variance in attitude change.

Student ability, as measured by AFQT and GT scores, was related to neither attitude scale scores nor attitude change. This result provides some evidence for the construct validity of the attitude scales. At a minimum, it shows that the attitude scales measure something other than student ability. This is a necessary requirement for the establishment of construct validity, but it is not a sufficient one. According to the APA Standards for Educational and Psychological Tests,

> Evidence of construct validity is not found in a single study; rather, judgments of construct validity are based upon an accumulation of research results (1974, p. 30).

Future research examining the relationships between the attitude scale scores and other variables would be required to establish the construct validity of the scales.

CONCLUSIONS

In view of the lack of predictive relationships between the attitude pretest and subsequent performance, measuring pretest attitude for naive students would seem to be of little value unless one is interested in studying attitude change, per se. Student attitudes do not appear to be useful for deciding whether a particular student should receive instruction by CAI or by some other medium. This may not be the case for students who have had extensive previous experience with CAI, however.

Preparation of CAI lesson materials that produce low student error rates during the course of instruction and on the postlesson test may be beneficial in terms of maintaining or producing positive student attitudes toward CAI. It has been demonstrated that certain aspects of student performance are related to subsequent student attitudes; nevertheless, a causal relationship has yet to be established.

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APPENDIX A
PRETEST ITEM SUMMARY

This appendix includes a list of all pretest items, with the mean, standard deviation (s.d.), and item-total correlation (r_{it}) for each. All odd-numbered items are negatively worded, that is, a "strongly agree," "all of it," "all the time," or "quite often" response is the one least favorable toward CAI. All even-numbered items are positively worded.

Response alternatives are coded as follows:

A - a. Strongly agree
    b. Agree
    c. Undecided
    d. Disagree
    e. Strongly disagree

P - a. All of it
    b. 75%
    c. 50%
    d. 25%
    e. None of it

T - a. All the time
    b. Most of the time
    c. Some of the time
    d. Only occasionally
    e. Never

F - a. Quite often
    b. Often
    c. Occasionally
    d. Seldom
    e. Very seldom

All data are based on a sample size of 90.

Item no.	Item stem	Mean	s.d.	r_{it}
1.	Most courses could be taught more effectively by a regular teacher than by computer. (A)	2.96	0.92	.47
2.	I would like to take a lesson taught by CAI. (A)	4.21	0.91	.60
3.	Taking a lesson taught by CAI would make me nervous. (A)	3.89	0.98	.37
4.	Taking a course taught by computer would be more interesting than taking the same course taught in some other way. (A)	3.60	1.14	.66
5.	People should be taught by other people, not by machines. (A)	3.13	1.05	.62
6.	I would prefer to have most courses taught by computer rather than by other teaching methods. (A)	2.97	1.09	.74
7.	I think I would feel isolated and alone while taking a course taught by computer. (A)	3.51	1.13	.67
8.	I think I would feel challenged to do my best work while taking a course taught by computer. (T)	3.81	1.04	.62
9.	It would be boring to take a course taught by computer. (A)	3.53	1.10	.64
10.	I think it would be easy to understand the material in a course taught by computer. (A)	3.49	0.81	.54
11.	Students are being treated more and more like IBM cards. (A)	2.99	1.34	.61
12.	How much of this lesson do you think you would like to have taught by computer? (P)	4.28	1.08	.62
13.	Taking a lesson taught by computer would be too mechanical. (A)	3.54	1.06	.77

APPENDIX B
POSTTEST ITEM SUMMARY

This appendix includes a list of all posttest items, with the mean, standard deviation (s.d.), and item-total correlation (r_{it}) for each. All odd-numbered items are negatively worded, that is, a "strongly agree," "all of it," "all the time," or "quite often" response is the one least favorable toward CAI. All even-numbered items are positively worded.

Response alternatives are coded as follows:

A - a. Strongly agree
    b. Agree
    c. Undecided
    d. Disagree
    e. Strongly disagree

P - a. All of it
    b. 75%
    c. 50%
    d. 25%
    e. None of it

T - a. All the time
    b. Most of the time
    c. Some of the time
    d. Only occasionally
    e. Never

F - a. Quite often
    b. Often
    c. Occasionally
    d. Seldom
    e. Very seldom

All data are based on a sample size of 90.

Item no.	Item stem	Mean	s.d.	r_{it}
1.	The way the material was presented to me made me feel that no one really cared whether I learned or not. (A)	3.67	1.17	.55
2.	Based on my experience with this lesson, I prefer CAI to other methods of instruction. (A)	3.21	1.14	.66
3.	The method by which I was told whether I had given a right or wrong answer became boring. (A)	3.50	1.21	.66
4.	I felt as if someone were engaged in conversation with me. (T)	2.91	1.25	.51
5.	I was concerned that I might not be understanding the material. (T)	3.53	0.93	.25
6.	The responses to my answers were appropriate. (T)	4.11	0.81	.35
7.	I felt uncertain as to my performance compared to the performance of others. (T)	3.34	1.28	.27
8.	I knew whether my answers were correct or not before I was told. (F)	3.50	1.26	-.01
9.	I found myself just trying to get through the lesson rather than trying to learn. (T)	3.62	1.04	.63
10.	I was encouraged by the responses given to my answers. (T)	3.61	1.01	.63
11.	I guessed at the answers to questions. (F)	4.39	0.83	.35
12.	I was able to work at my own pace. (T)	4.80	0.62	.23
13.	In view of the time allowed, I felt too much material was presented. (T)	4.19	1.10	.39

14.	I felt as if I had a private instructor. (T)	3.77	1.40	.53
15.	I was more involved in running the machine than in understanding the material. (T)	4.11	0.95	.52
16.	I was aware of efforts to suit the material specifically to me. (F)	3.24	1.33	.49
17.	I found it difficult to concentrate on the course material because of the machine. (T)	4.24	0.95	.50
18.	Computer-assisted instruction made it possible for me to learn quickly. (A)	3.92	1.05	.64
19.	Questions were asked which were not relevant to the material presented. (T)	4.67	0.67	.11
20.	The responses to my answers seemed to take into account the difficulty of the question. (T)	3.04	1.23	.28
21.	In order to get more information from the machine, I gave answers which I knew were wrong. (F)	4.51	0.92	.29
22.	In view of the effort I put into it, I was satisfied with what I learned while taking CAI. (A)	4.34	0.85	.65
23.	I was given answers but still did not understand the questions. (F)	4.17	0.96	.60
24.	In view of the amount I learned, I would say that CAI is superior to other teaching methods. (A)	3.44	1.06	.64
25.	Most courses could be taught more effectively by a regular teacher than by computer. (A)	3.12	1.22	.67
26.	I would like to take another lesson which uses CAI. (A)	4.13	1.10	.73
27.	Taking a lesson taught by CAI made me nervous. (A)	4.10	1.08	.34

28. The material taught by computer was more interesting than taking similar material taught in some other way. (A)	3.64	1.21	.62
29. People should be taught by other people, not by machines. (A)	3.29	1.14	.71
30. I would prefer to have most courses taught by computer rather than by other teaching methods. (A)	3.19	1.16	.72
31. I felt isolated and alone while working with the computer. (A)	3.47	1.22	.58
32. I felt challenged to do my best work while being taught by computer. (T)	4.03	1.00	.68
33. It was boring to learn material taught by computer. (A)	3.74	1.21	.72
34. It was easy to understand the material taught by computer. (A)	3.92	0.89	.59
35. Students are being treated more and more like IBM cards. (A)	3.21	1.28	.58
36. How much of the lesson you just completed do you think should be taught by computer? (P)	3.90	1.26	.71
37. The lessons taught by computer were too mechanical. (A)	3.67	1.13	.75

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