NAVAL PERSONNEL AND TRAINING RESEARCH LABORATORY

SAN DIEGO, CALIFORNIA 92152

RESEARCH REPORT SRR 73-21

JUNE 1973

COMPARISON OF PAIRED STUDENTS AND INDIVIDUAL STUDENTS TRAINED BY CAI

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NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER
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1. Enclosure (1) reports the results of research to investigate the possibility of using paired student instruction to increase the cost effectiveness of CAI training.

2. The summary appearing in the front matter of the report gives a brief overview of the research including problem statement, conclusions, and recommendations which should be of use to those not having the time or need to read the entire report.

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COMPARISON OF PAIRED STUDENTS AND INDIVIDUAL STUDENTS TRAINED BY CAI

by

Judith A. Hurlock
Richard E. Hurlock

June 1973

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Research Report SRR 73-21

Submitted by

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Approved by

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SUMMARY AND CONCLUSIONS

Problem

The purpose of the study was to investigate the possibility of using paired student instruction to increase cost effectiveness of CAI training.

Background

Previous research has demonstrated that CAI can reduce training time and often increase performance levels over conventional classroom instruction. CAI is also a relatively expensive mode of instruction. This assessment of CAI indicates a need for instructional methods which can improve the cost effectiveness of CAI without concomitant reductions in the teaching effectiveness. If an existing CAI program could be shown to train paired students as well as individuals without a significant loss in time savings, the cost per terminal hour of instruction would be immediately reduced by half.

Approach

Previously developed and operationally tested CAI Inductance and Capacitance Modules were employed as the training program. The curriculum covered basic theory and mathematics. Both modules were tutorial but also included problem solving, simulation and drill and practice. All course material was presented at student terminals directed by an IBM 1500 Instructional System. Seventy-five students from the Navy's Basic Electricity/Electronics School served as subjects in an Experiment Group (Pairs, N = 50) and Control Group (Individuals, N = 25). All assignments were random. Both groups followed the same training procedure. They received five and one-half hours of CAI training each day for approximately five days. The students were individually tested (paper and pencil) on two module tests during the course of instruction and on a final examination at the end of training; scores were used to evaluate achievement. Students also answered an attitude questionnaire before returning to the School.

Findings and Conclusions

The mean scores for students in the Control Group on the two module tests and the final examination were 89, 93, and 85; scores for students in the Paired Group were 86, 90, and 84, respectively. No significant differences were found between test scores at the .05 level. The mean training time for Individuals (14 hours) and for Pairs (15 hours) was not significantly different.

On the post training attitude questionnaire, paired students rated CAI 3.6 and individual students rated CAI 4.2 in comparison to other forms of instruction on a 5-point scale where 1 = poor, 3 = average, and 5 = outstanding. Pairs rated working with a partner 3.2 on a

similar scale. When asked their choice of working alone or with a partner, 26 paired students (52%) said "with a partner." The most frequently mentioned dislike was that their partner went either too fast or too slow. Students indicated that if they trained with a partner they would prefer to work with someone of equal ability.

In conclusion, it appears that paired student CAI training is effective and reduces the cost per terminal hour, where CAI course materials are basically linear and where students are paired on the basis of learning rate and aptitude. Additional research is recommended to investigate paired student training in a variety of CAI applications and in different training content areas.

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FOREWORD

The origin of this study was a research proposal by the senior author, a graduate student at California State University at San Diego, to the Computer Based Training and Simulation Research Department, Naval Personnel and Training Research Laboratory, San Diego. The proposed investigation showed promise of contributing information important to Navy CAI training, and a joint effort by the Laboratory and the University was undertaken.

A portion of the study was used by the senior author as a thesis for her Master of Arts Degree in Education at California State University at San Diego. This report presents the complete study with special emphasis on relating the results and findings to Navy training.

The senior author is now with the Santee School District, San Diego County, California.

JOHN D. FORD, JR.

COMPARISON OF PAIRED STUDENTS AND INDIVIDUAL STUDENTS TRAINED BY CAI

I. Introduction

Computer assisted instruction (CAI) has been shown to be an effective teaching method which can produce high levels of achievement along with significant time savings; it is also a relatively expensive mode of instruction (Seltzer, 1971). This assessment of CAI indicates a need for an instructional method which could improve the cost effectiveness of CAI without concomitant reductions in the teaching effectiveness. If it could be shown that an existing CAI program would train paired students as well as individuals without a significant loss in time savings, the cost per terminal hour of instruction would be immediately reduced by half. The purpose of this study was to investigate the feasibility of using CAI to train paired students, and it was expected that a comparison of the performance level of pairs and individuals would yield no significant differences ($p > .05$) in achievement or training time of the two groups.

The literature reports only three studies which investigate whether computer assisted instruction (CAI) can effectively teach pairs of students (Grubb, 1964; Karweit and Livingston, 1969; Love, 1969).

Grubb (1964) used an IBM 1440 Teletypewriter to teach a computer guided statistics course to college students. Four aptitude groups were used: High Pairs, Low Pairs, High Individuals, and Low Individuals. Subjects worked two hours a day, three days a week for an average of 12 hours and took individual examinations approximately two days after completing the course. He found no significant difference in training time or in final performance of the four groups.

A more recent study by Karweit and Livingston (1969) involved the use of a computer simulated economics game to compare individuals and groups on learning time and performance. Forty-four high ability 6th graders were divided into three computer trained groups (Individuals, 2-People, and 3-People) and an off-line control group. Subjects spent approximately one hour playing the game and were then individually tested on their ability to apply what they had learned. No differences were found between any of the groups in either learning time or performance.

The most extensive investigation of paired CAI (Love, 1969) used two classes of students in grades nine through twelve. A total of 18 pairs and 18 individuals were tested. Pairing within grade levels was random. Subjects took a CAI course in Boolean algebra presented on an IBM 1500 system. The course, an already modified CAI tutorial program, was further altered in order to conform to time restrictions, five periods of 50 minutes each, and the experimental objectives. After training, Ss took a paper and pencil examination. No significant differences were found in training time or final examination scores of the two groups.

Although each of these studies found no differences in the learning time and performance of pairs and individuals, they failed to answer

conclusively the question of whether CAI can effectively instruct paired students. Grubb (1964) used a teletypewriter system which possesses critical limitations not found in the newer IBM 1500 System. The teletypewriter requires more time to present stimulus material, produces distracting noises and delays feedback longer than a cathode ray tube display. Students are also able to look back over previous work and receive inadvertant prompting and review. The evaluation test was restricted to problem solving and did not include conceptual questions. The experimenter even stated that the test might not have been sensitive enough to detect differences between the two groups.

In the Karweit and Livingston study (1969), total training time was so short (one hour) that the reliability of the data is questionable. A computer stimulated game program was used for training and caution must be taken before making generalizations about the performance of paired students using a tutorial program. Training time was also short (five hours) in the Florida State study (Love, 1969), and the CAI program may not have taught effectively enough to yield valid data for evaluation. Although both groups demonstrated an increase in performance between daily quizzes and final examination, the final scores were very low. Neither group's mean score was over 54% correct. There is some indication that the increase shown on the final examination may have been due to outside study, since no increase in performance was found between the preview frames at the beginning of each day's training and the daily quizzes.

In summary, it is difficult to draw conclusions from these studies when the validity of the training courses and the reliability of the data is in question, although the hypothesis that pairs and individuals perform equally well under CAI conditions cannot be rejected.

The present study was therefore designed to continue the investigation of how pairs perform in comparison to individuals on both training time and achievement. It was anticipated that an operationally tested CAI course, an extended period of on-line training, and a tutorially adequate CAI system would yield data on the relative performance of pairs and individuals that could be used to make generalizations about other CAI training situations. Achievement and training time for pairs and individuals were not expected to differ.

II. Method

A. Subjects

All Ss were students attending the Navy's Basic Electricity and Electronics School (BE/E), Naval Training Center, San Diego, California. The BE/E School provided the fundamentals of electricity and electronics to future Interior Communications Technicians, Sonar Technicians, Electricians Mates, Oceanographics Technicians and Torpedomen. Upon completion of the basic six week curriculum at BE/E School, the graduate students proceed to their respective class "A" School where they study the specialties peculiar to their particular ratings.

The training program used at the BE/E School consisted of a pre-packaged, individualized, self-paced course of instruction known as Basic Electricity and Electronics Individualized Learning System (BEEINLES). Each new student received an identical packet of instructional materials which divided the curriculum into 14 modules. The modularized program allowed new trainees to start instruction as soon as they reported to the school. Students could work at their own speed, but they were expected to successfully complete a certain number of modules within a specified time limit.

Seventy-five students who had completed BEEINLES Modules 1-7 were used as Ss. As soon as a student finished the Module 7 Test, he was told to report to the CAI Laboratory and sign in on their roster.

As the Ss signed in, they were divided into groups of three which were treated as independent units. One S was selected at random and assigned to the Control Group; the other two Ss were paired and assigned to the Experimental Group.

B. CAI Lesson and Test Materials

The course of instruction consisted of two CAI Modules developed by the Navy Personnel and Training Research Laboratory (Hurlock, 1971a and 1971b) in cooperation with the Navy's BE/E School. The two modules covered the topics of Inductance and Capacitance and included all basic theory and mathematics taught in Modules 8, 9, and 11 at the BE/E School. An Introductory Lesson preceded the first CAI module and instructed the Ss on use of the keyboard, making corrections, sending answers to the computer and responding with the lightpen.

1. Inductance Module

The Inductance module was divided into seven training lessons with an on-line, multiple-choice test following each lesson. The lesson tests contained criterion questions on all lesson objectives.

The Module was basically linear with some student and/or lesson controlled remedial branching. All lessons were tutorial and the majority of the frames required constructed (keyboard) responses.

2. Capacitance Module

The Capacitance module was divided into nine training lessons and one review lesson. As in the Inductance module, an on-line test followed each training lesson.

The module was linear with some pretest and remedial branching and optional student review. The lessons were primarily tutorial but also included drill and practice, problem solving, and simulation. Most frames were objective (multiple-choice) and required lightpen responses.

3. Evaluation Tests

Three paper and pencil, multiple-choice tests (Inductance Test, Capacitance Test and Final Examination) were given during the course of training to evaluate student performance. The Inductance Test, comprised of 34 questions, was given at the end of the Inductance module. The Capacitance Test contained 35 questions and was given at the end of the Capacitance module. The Final Examination with 38 questions covering major objectives of both modules was administered last.

C. Supplementary Materials

1. Study Guides

The Study Guide (Hurlock, 1971a and 1971b) which accompanied each module outlined the major content of each lesson, provided review exercises, and eliminated the need for Ss to take notes. Occasionally the S was told to refer to the Guide during a lesson.

2. Instructions

The printed instructions issued at the start of each experimental period covered the testing procedure, rest breaks, review, and use of the Study Guides (see Appendix A and B). Instructions for the Experimental Group included additional information on sharing the carrel, working as a team on responses, and solving disagreements.

D. Attitude Questionnaire

Before returning to the BE/E School all students were asked to complete an attitude questionnaire. There was a separate form of the questionnaire for students trained individually (Appendix C) and students trained in pairs (Appendix D).

E. Apparatus

All course materials for the CAI training were presented at student terminals (see Figure 1) directed by an IBM 1500 Instructional System (IBM, 1967). Each terminal contained the following instructional devices: (a) An IBM 1510 Instructional Display with Keyboard and Lightpen used for output of textual material and graphic symbols via CRT and input of student keyboard and lightpen responses; (b) An IBM 1512 Image Projector used for displaying colored or black and white pictures and drawings; and (c) An IBM 1506 Audio Unit equipped with headphones.

The student terminals in the CAI Laboratory were partitioned into 5 x 6 ft. carrels (see Figure 2). The 5 ft. walls were high enough to block distractions from adjoining carrels.

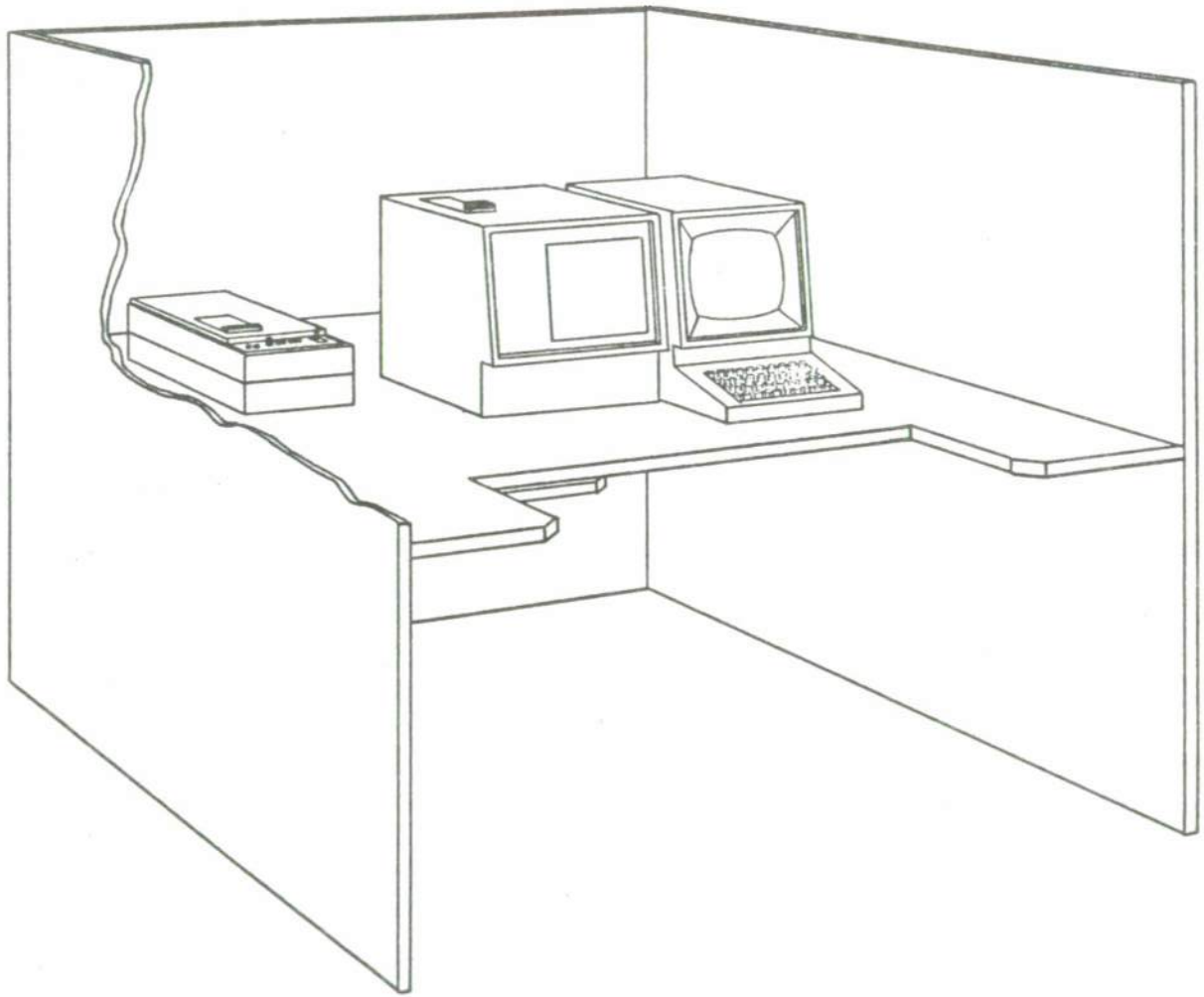

Figure 1. CAI student terminal and instructional devices.

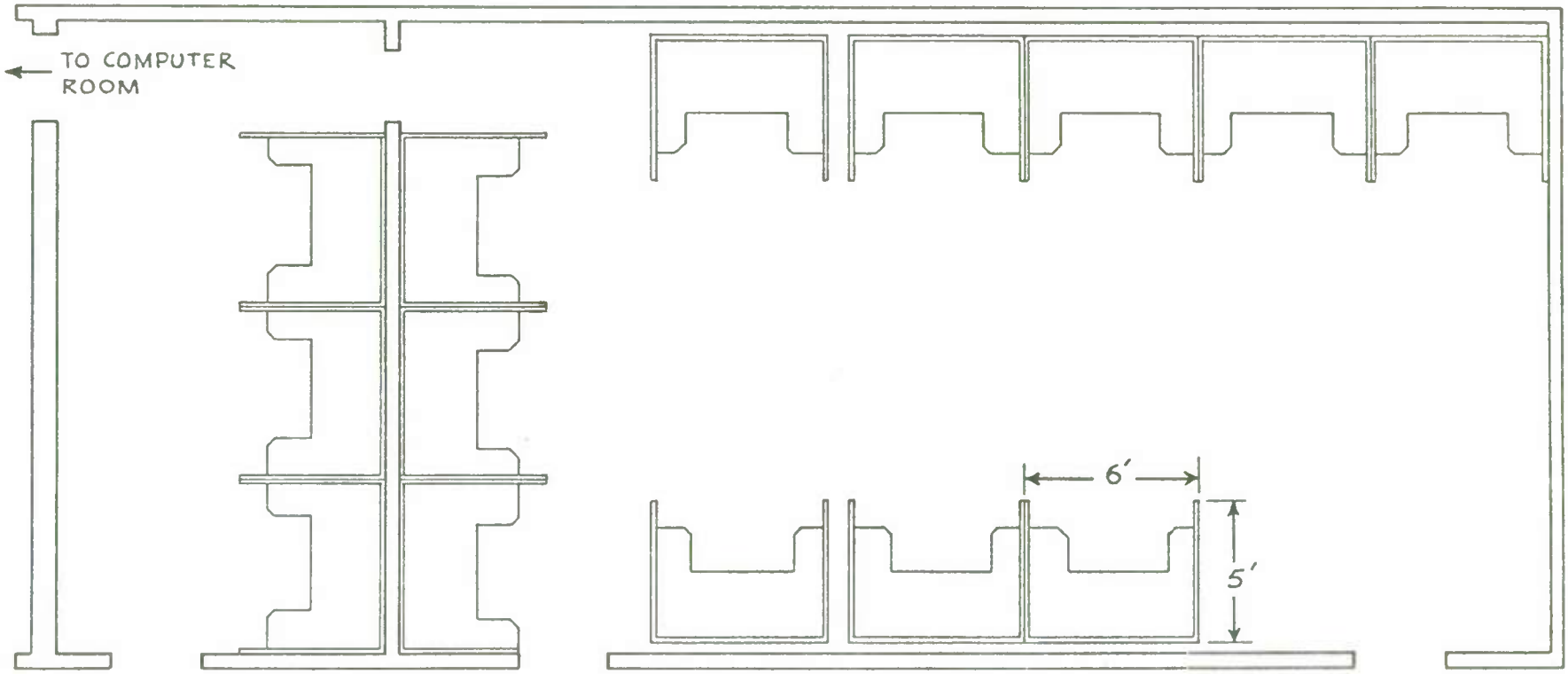

Figure 2. Carrel floorplan in CAI laboratory.

F. Design and Procedures

There were two experimental periods, each covering five consecutive days of instruction with two training sessions per day. One Experimental Group and one Control Group were run each week. During Week 1, the Experimental Group (12 pairs) attended the morning sessions, and the Control Group (12 individuals) attended the afternoon sessions. The sessions were counterbalanced during Week 2 with 13 individuals in the morning sessions and 13 pairs in the afternoon sessions. Table 1 presents the design used in the study.

Each week the CAI training procedure was the same for both pairs and individuals. Subjects reported to the CAI Laboratory each day at the assigned time until their training was completed.

TABLE 1

Experimental Design for the Assignment of Subjects to Counterbalanced Sessions

		Training Sessions	
		Mornings 0645-1145	Afternoons 1145-1645
Experimental Period	Week 1	12 Pairs N = 24	Individuals N = 12
	Week 2	Individuals N = 13	13 Pairs N = 26

Day 1: both experimental groups (Pairs). Subjects reported to the CAI Laboratory and were divided into pairs predetermined by their position on the roster. Each pair was issued Study Guides, a standardized set of instructions, and assigned to a student terminal.

At the terminal Ss read the instructions and began the CAI Introductory Lesson on how to use the terminal devices. When Ss completed this lesson, they started Lesson 1 of the Inductance module and continued to work until the terminals were signed off.

Day 1: both control groups (Individuals). Individuals worked alone, otherwise they followed the same procedure that was used for pairs.

Days 2-5: all groups. Subjects returned to the CAI Laboratory and resumed the previous day's instruction. At the end of Inductance Lesson Test (about Day 3), they reported to the proctor for the Inductance Module Test. Subjects were told to spend no more than 30 minutes reviewing their Study Guide before taking the test.

When an S was ready, he was given the test, sent to a separate classroom, and told to report back when finished. At that time the proctor scored the test, discussed incorrect answers, and suggested the S spend a few minutes looking over his mistakes before beginning the next module.

Then Ss took a 5-10 minute break and began Lesson 1 of the Capacitance Module. When Training Lessons 1-9 and the Review Lesson were completed (about Day 4), they reported to the proctor for the Capacitance Module Test. Review, testing, and follow-up procedure were the same as for the Inductance Test.

After Ss completed the Capacitance Module Test, they were told to spend no more than one hour reviewing for the Final Examination (about Day 5). When the Examination was scored and incorrect items discussed, the proctor asked the S to complete a questionnaire (attitude questionnaire) and report back to the BE/E School.

III. Results

Data used in the analysis were obtained from three sources: (a) Computer stored performance listings (time records); (b) Test records (criterion test scores); and (c) BE/E School records (background scores).

The time records reported both the S's total module time from when he signed on and signed off the system each day (Total Module Time) and the time required to complete lessons and lesson tests (Training Time). The criterion test scores included a S's performance on both module tests (Inductance and Capacitance) and the final examination (Final Examination). The number of days needed to complete BEEINLES Modules 1-7 (Previous Training Time); the average test score on BEEINLES Modules 1-7 (Previous Test Average); and three aptitude scores which included the General Classification Test (GCT), Electronic Technicians Selection Test (ETST), and Arithmetic Test (ARI) comprised the S's background scores. All data for each S were punched on IBM cards for processing.

A. Analysis Procedures

A one-way analysis of variance with a Bartlett's test for homogeneity was run on all data. The program reported sample size, mean, standard deviation, variance, sum of squares, and a one-way ANOVA table for each analysis. Separately, a test of power was run on all criterion scores and time measures (Dixon and Massey, 1957). The power of the analysis of variance was tested against the alternate hypotheses that Individuals would perform 5% better than Pairs on measures of achievement and that Pairs would take 10% longer than Individuals on Training Time.

1. Background Measures

Table 2 compares the two groups' performance on the background measures and shows the mean, standard deviation, and resulting F values. There were no significant differences ($p > .05$) between Pairs and

Individuals on any of the measures. The assumption of homogeneity was rejected on the ETST (B = 7.96; df = 1; p < .004), but the ANOVA has been shown to be a robust test which is not necessarily sensitive to violations of homogeneity (Lindquist, 1953).

TABLE 2

An Analysis of the Background Scores
for Pairs and Individuals

Background Measure	Individuals	Pairs	F Ratio[a]
GCT	N = 25 M = 63.08 SD = 4.80	N = 50 M = 61.78 SD = 5.97	.895
ARI	N = 25 M = 45.48 SD = 12.65	N = 50 M = 41.34 SD = 13.05	1.6937
ETST	N = 25 M = 64.84 SD = 3.69	N = 49[b] M = 62.73 SD = 6.35	2.332[c]
Previous Test Average	N = 25 M = 92.73 SD = 2.85	N = 50 M = 92.24 SD = 3.37	.3919
Previous Training Time	N = 25 M = 9.27 SD = 2.85	N = 50 M = 9.82 SD = 3.37	.1616

[a] $F(1,74) = 3.97$ for $\alpha = .05$

[b] One S's score was not available

[c] Bartlett's test showed groups to differ significantly on variability ($\beta = 7.96$, df = 1, $p < .004$)

2. Performance Scores

The data reported in Table 3 indicated no significant difference between groups on any of the three criterion tests. The only scores approaching significance were on the Inductance Test (F = 3.06; df = 1; p < .06), although the means differed by only 3.12 points.

TABLE 3

An Analysis of the Performance of Pairs and Individuals on Criterion Scores

Criterion Score	Individuals	Pairs	F^a Ratio	$1-\beta$ ($\alpha = .05$)
Inductance	N = 25 M = 89.08 SD = 5.87	N = 50 M = 85.96 SD = 7.10	3.60	.87
Capacitance	N = 25 M = 92.60 SD = 6.28	N = 50 M = 90.44 SD = 6.57	1.87	.90
Final Examination	N = 25 M = 84.80 SD = 6.80	N = 50 M = 83.90 SD = 8.06	.2097	.75

[a] $F_{(1,74)} = 3.97$ for $\alpha = .05$

3. Time Scores

Table 4 shows that the two groups did not differ significantly ($p > .05$) in the amount of time required to complete the lessons and lesson tests (Training Time). The groups, however, did differ significantly in Module Time ($F = 5.58$; $df = 1, 49$; $p < .001$).

4. Tests of Power

The power function ($1-\beta$) for each performance measure is reported in Tables 3 and 4. Table 3 includes the power level for each of the achievement measures when the analysis was tested against the alternate hypothesis that Individuals would score 5% better than Pairs (Inductance = .87, Capacitance = .90, Final Examination = .75). Table 4 includes the test for power run against the alternate hypothesis that Pairs would take 10% longer than Individuals on Training Time (.64).

TABLE 4

An Analysis of the Performance of Pairs and Individuals on Time Measures

Time Measure	Individuals	Pairs	F Ratio[a]	1-β (α = .05)
Training Time	N = 25 M = 819.68 SD = 154.59	N = 25 M = 869.44 SD = 129.34	1.5237	.64
Time Other Activities	N = 25 M = 75.40 SD = 51.76	N = 25 M = 141.72 SD = 58.33	18.02[b]	
Total Module Time	N = 25 M = 898.28 SD = 177.89	N = 25 M = 1011.16 SD = 159.45	5.58[c]	

[a] $F_{(1,74)} = 4.04$ for $\alpha = .05$

[b] $p < .001$

[c] $p < .001$

5. Attitude Questionnaire

Ten questions were identical for Control and Paired students. Of the first eight questions, the ones of interest to the study asked students to rate CAI in comparison to their regular course of instruction on a 5-point scale, to describe their attitude toward CAI by indicating the proportion of their training they would like to receive via CAI, and to select their preferred training method. The last of these questions asked students to indicate their preferences toward working with a partner.

Students who trained with a partner tended to rate CAI lower ($\bar{x} = 3.6$) than students who trained alone ($\bar{x} = 4.2$). A χ^2 analysis of this difference across the 5-point rating scale, using the control group data as the expected frequencies, was significant ($\chi^2 = 11.3$, df = 4, $p < .01$). The difference between groups is even more evident when comparing the percentage of students who rated CAI "above average" or "outstanding" (Table 5).

TABLE 5

Rating of CAI

	Percentage of Students	
Scale (points)	Individuals (N = 24)	Pairs (N = 50)
poor (1)	0	0
below average (2)	8	10
average (3)	8	38
above average (4)	42	36
outstanding (5)	42	16

When students were asked if they would prefer to use CAI all the time, part of the time, or none of the time, the percentage of students answering "all" or "part" was similar for the Control (92%) and Paired (94%) group (Table 6). A χ^2 analysis by category was not significant, although Pairs did not respond as positively as individuals to "all the time," 28% versus 40%, respectively.

TABLE 6

Proportion of CAI Training

	Percentage of Students	
CAI Proportion Preferred	Individuals (N = 25)	Pairs (N = 50)
all the time	40%	28%
part of the time	52%	66%
none of the time	8%	6%

A significant difference between groups was also found when students responded to the training method they preferred ($\chi^2 = 11.6$, df = 3, $p < .01$). Only 54% of the students trained with a partner selected CAI or other methods combined with CAI versus 73% of the students who trained alone (see Table 7 for breakdown).

TABLE 7

Preferred Training Method

	Percentage of Students	
Method	Individuals (N = 22)	Pairs (N = 50)
Classroom	4%	8%
BEEINLES	23%	38%
CAI	41%	30%
Combi + CAI	32%	24%

Only the last 13 students who trained alone were asked to answer questions about their preferences for training with a partner. All 50 Paired students responded to these questions. One question asked, "if you had a choice, you would prefer: a. working with a partner b. working alone." Only one (8%) out of the 13 students who trained alone selected "with a partner" versus 25 (50%) of the Paired students. Analysis of Paired student agreement between partner on this question revealed the following breakdown (see Table 8). Partners generally disagreed about whether they would choose to work in pairs (64%), one member of the pair indicating "with a partner" while the other selected "without a partner." In only five pairs (20%) did both members state they would prefer to work with a partner. In four pairs (16%) both partners agreed that they would prefer to work alone.

TABLE 8

How Partners Agreed on Working with a Partner

Agreement Between Partners		No. Pairs	Percentage
disagreed:	one "with," one "without"	16	64%
agreed:	both "with"	5	20%
agreed:	both "without"	4	16%

The second question asked students to indicate the type of partner they would select if they had to train in pairs. As shown in Table 9, students that had trained alone, with no experience working with a partner, responded quite differently than students who had trained in pairs. Students who experienced training in pairs wanted a partner of equal ability.

TABLE 9

Choice of Partner

	Percentage of Students	
Choice	Individuals (N = 16)	Pairs (N = 60)
a friend	19%	8%
more ability	31%	10%
equal ability	19%	52%
less ability	0%	2%
accept recommendation	31%	28%

Students who trained with a partner were given additional questions. The ones of importance asked the students to rate working with a partner on CAI and to indicate the biggest disadvantages of working in pairs.

Table 10 shows how Paired students rated working with a partner on CAI. Ratings on a 5-point scale resulted in a mean of 3.23. Rating agreement between partners yielded an $\underline{r} = -.02$. A strong positive correlation was found between how a student rated CAI and how he rated working with a partner ($\underline{r} = .44$).

TABLE 10

Rate Working with a Partner

Scale (points)	No. Students	Percentage
poor (1)	6	12%
below average (2)	11	22%
average (3)	7	14%
above average (4)	15	30%
outstanding (5)	11	22%

Student data on the disadvantages of working with a partner are summarized in Table 11. The most frequently mentioned category of complaint was partner's speed, either too fast (21%) or too slow (25%). Twenty-one students (38% of total comments) felt that there were no disadvantages to Paired student training.

TABLE 11

Disadvantages of Training with a Partner

Disadvantage	Frequency Listed	Percentage
partner too slow	12	21%
partner too fast	14	25%
decreased test scores	0	0
prevented concentration	9	16%
none	21	38%
	56	100%

IV. Discussion and Conclusions

The purpose of the study was to investigate how effectively CAI could train paired students. Students were measured on achievement and training time variances; data were collected on attitudes; the results, conclusions and recommendations for future research are discussed below.

A. Achievement

The achievement of each S was measured by three criterion tests, and the scores of Ss trained in pairs and the scores of Ss trained alone were not significantly different. Analysis of variance of the scores made on the Inductance Test (Individuals $\bar{x}$ = 89.08; Pairs $\bar{x}$ = 85.96) taken immediately after inductance training failed to reject the null hypothesis ($p > .05$) that performance of paired students was equal to that of students trained alone. Analysis of scores for the two groups on the Capacitance Test (Individuals $\bar{x}$ = 92.6; Pairs $\bar{x}$ = 90.44) that immediately followed capacitance training and of the scores on the Final Examination (Individuals $\bar{x}$ = 84.8; Pairs $\bar{x}$ = 81.9) taken within an hour after the Capacitance Test also failed to reject the null hypothesis at the .05 level of confidence. In summary, three separate criterion tests failed to yield achievement scores which were statistically different for Individuals and Paired students. The possibility that there were no differences in achievement is further supported by: (a) a previous item analysis showing that a total of more than 90% of all course training objectives were tested by the three criterion tests (Hurlock, 1971b), and (b) the power of the analysis which was run against the alternate hypothesis that Individuals would perform 5% better than Pairs on achievement tests (Inductance Test = .87, Capacitance Test = .90, and Final Examination = .75).

The data of this study are similar to the findings of previous studies, but there is reason to believe that it more strongly supports the null hypothesis. Grubb (1964) used an operationally proven program, but the content validity of his one criterion test was questionable. The test was limited to only problem solving and contained no conceptual questions. Grubb stated that the test might not have been sensitive enough to detect differences between the two groups. The Florida State study (Love, 1969) used an instructional program which may not have taught effectively enough to yield valid data for evaluation. The one criterion test supposedly included all of the major objectives, but low performance levels (Individuals $\bar{x}$ = 54%; Pairs $\bar{x}$ = 51%) and low correlations between daily quiz scores and final examination scores (Individuals r = -.10; Pairs r = -.15) makes the results doubtful. Neither Grubb nor Love reported power levels for their analyses.

B. Training Time

The Training Time reported in the present study included time spent on each lesson from the first frame to the last and time spent taking each lesson test. At the end of training, the lesson and lesson test times for both the Inductance and Capacitance Modules were totaled and recorded as Training Time. A one-way ANOVA showed no significant difference ($p > .05$) in the Training Time of the groups (Pairs $\bar{x}$ = 869 min.; Individuals $\bar{x}$ = 820 min.). The power of the analysis run against the alternate hypothesis that Pairs would take 10% longer than Individuals for Training Time was greater than .65. Earlier studies by Grubb (1964) and Love (1969) obtained similar results, no difference in training time at the .05 level.

C. Time Other Activities

Another important time variable which was not included in earlier studies concerned the time spent in test review and rest breaks (Time Other Activities). Total Module Time (time from sign-on to sign-off each day) minus Training Time gives Time Other Activities. Review was supposed to precede each lesson test (see Student Instructions, Appendix A and B), but it was not mandatory. Students were observed to generally take their tests immediately after completing each lesson. This means that test review probably accounted for very little of the time spent on other activities and that rest breaks were the major contributor. Rest breaks in the present study should have totaled approximately 150 minutes since training sessions ran five hours each day and Ss were instructed to take a 10 minute rest break at the end of each lesson test. The 150 minutes were for rest breaks alone, test review should have consumed additional time. The data for Time Other Activities which included both break and review time showed the mean time of Individuals (79 min.) and Pairs (142 min.) to be highly significant. The difference appeared to be due to the length of the rest breaks, but lack of additional data makes it impossible to determine whether Pairs took more time or Individuals took less time than they should have. It is interesting to note that although paired students spent almost twice as much time as individuals on Time Other Activities, both groups still spent less than the

150 minutes allotted for rest breaks alone. Since these times were well within the 150 minutes of rest breaks the S were instructed to take and allotted in the training schedule, the differences in rest break times are not interpreted as important to the present thesis. It is difficult to say why the Ss in this study spent less time than might be expected, since previous research (Hurlock 1971b) on the same modules showed Ss spent an average of 172 minutes on Time Other Activities. The finding does point out the need for further research into the interaction of rest breaks and CAI training. For instance, there are no data available on the optimal ratio for rest breaks and training time, nor is there any information on the possible relationship between rest breaks and achievement. During CAI training the computer could easily control rest breaks by: (a) inserting a "Pause" at the end of the lesson test so Ss could not continue before a specified lapse of time; (b) inserting a "Time Out" to warn Ss who have taken longer than the allotted time limit; and (c) notifying the proctor when an S continued to ignore the "Time Out" warnings.

D. Total Module Time

It was not unexpected to find a significant difference ($p < .02$) in the Total Module Time for the two groups (Individuals $\bar{x}$ = 898 min.; Pairs $\bar{x}$ = 1011 min.), because it was confounded by the highly significant difference which occurred in Time Other Activities.

E. Attitude

The Paired training condition appears to have produced a negative attitude toward CAI. Students who trained alone were significantly more positive in their attitudes toward CAI than students who trained with a partner. Only 52% of the Paired students rated CAI above average compared to 84% of the Control students (Table 5); and 54% of the Paired students' selections included CAI as a preferred training method versus 73% of the Control students (Table 7).

Previous training experience using CAI apparently influenced the student's feelings toward future CAI training. Twelve out of 13 Control students (92%) said they would like to train alone if given a choice; 50% of the Paired students said they would prefer to work with a partner.

Paired student teams showed considerable disagreement between partners about whether or not they liked working in pairs (Table 8). The data showed that 16 teams (64%) had opposing opinions. In only five pairs (20%) did both partners agree that they would like to train with a partner.

Paired students rated working with a partner only "average," mean of 3.2 (Table 10). A total of 17 students (34%) rated working with a partner below average. Rating agreement between partners was near zero ($r = -.02$).

How a student rated working with a partner (Table 10) was strongly related to how he rated CAI (Table 5). The correlation of these data yielded an r of .44. If a student gave a low rating to working with a partner, he probably rated CAI low as a training method.

The Paired student data on the disadvantages of working with a partner revealed a common problem which could have contributed to their attitudes toward training with a partner as well as their attitudes toward CAI as a training method. The dislike most frequently mentioned was that their partner went either too fast or too slow (Table 11). Paired students confirmed this view when asked to indicate the characteristics of the partner they would select if they had to train in pairs; 52% said they would choose someone of equal ability (Table 9).

The data shown in Table 9 indicate that students, who have not had the experience of training with a partner, may not be the best judge when selecting a training companion in a free choice situation. Students who had trained alone on CAI most frequently indicated that they would choose someone of more ability (Table 9).

Generalizations about paired student attitudes are limited by the scope of the present research. The data do point out potential problem areas, especially with regard to the methods of assigning partners. There is a need for further investigation concerning how student attitudes toward paired instruction affects CAI. Some students may be more responsive to CAI training if they are working with a partner while others may prefer working alone. Additional research may show random pairing of students to be less efficient than matching students on the basis of ability or rate of responding. Random assignment, as employed in the present study, and the less than positive attitudes paired students apparently did not affect overall achievement or taining time. Whether attitudes were related to the lengthened rest breaks is questionable.

F. Summary

1. No achievement score differences were found between students that trained with a partner and students that trained alone.

2. No training time difference was found between paired and control students.

3. Paired students took longer rest breaks than control students, but the total rest break time was not greater than that recommended by their instructions.

4. The paired training condition appears to have produced attitudes toward CAI that were significantly less positive than those produced in the control condition.

5. The major complaint reported by paired students was that their partner went either too fast or too slow.

6. There is need for additional research to investigate optimal methods for assigning partners and controlling attitudes for paired student training by CAI.

7. In conclusion, the results of this research indicate that paired student training is a feasible method to reduce the cost per terminal hour of CAI, where CAI course materials are basically linear and where students are paired on the basis of learning rate and aptitude.

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Appendix A

CAI Training Instructions for Individuals

Appendix A

CAI Training Instructions for Individuals

You have been selected to participate in a training program using computer assisted instruction (CAI). The purpose of the program is to see if CAI can help meet Navy training needs.

The CAI material is divided into two modules, Inductance and Capacitance. These modules cover all of the information taught in BEEINLES Modules 8, 9, and 11. You will receive Module 10 after returning to BE/E P School.

Tests

Each module is organized into lessons, and there is a short test at the end of each lesson. These lesson tests will let you know how well you have learned the lesson. They will not count on your grade.

At the end of each module there is a paper and pencil module examination. At the end of all CAI training there is a paper and pencil comprehensive examination. These three examination scores will be your BE/E P School grade.

Questionnaire

After you have finished the comprehensive examination you will be asked to answer a questionnaire on your reaction to CAI training.

Study Guide

You have each been issued Study Guides that contain outlines of the modules, lists of lesson objectives, overviews of each lesson, and some practice exercises.

Do not take notes. Everything you need for review is in your Study Guides. Unless otherwise instructed, do not use your guide during a lesson. Do NOT use it during any test.

Breaks

You should schedule a rest break at the end of every lesson test or about every 45 minutes. Limit your break to 5 or 10 minutes.

Review

You should review for your lesson test. Do not spend more than 5 or 10 minutes reading over the Study Guide.

Operational Procedure

Do not intentionally make mistakes. All of your responses are being recorded.

You are ready to begin CAI. All further information you need will appear on the screen. Read and follow instructions closely. If you have any questions contact the proctor.

GOOD LUCK!

Appendix B

CAI Training Instructions for Pairs

Appendix B

CAI Training Instructions for Pairs

You have been selected to participate in a training program using computer assisted instruction (CAI). The purpose of the program is to see if CAI can help meet Navy needs.

The CAI material is divided into two modules, Inductance and Capacitance. These modules cover all of the information taught in BEEINLES Modules 8, 9, and 11. You will receive Module 10 after returning to BE/E P School.

You have been assigned a partner and you will be working together during all CAI training. You may not change partners.

Test

Each module is organized into lessons and there is a short test at the end of each lesson. You will work together on all lessons and lesson tests. These lesson tests will let you know how well you have learned the lesson. These test scores will not count on your grade.

At the end of the module you will take a paper and pencil module examination. At the end of your training you will take a paper and pencil comprehensive examination. You will take all three examinations alone, although you may review for each exam alone or as a team. These three individual test scores will be your BE/E P School grade.

Questionnaire

After you have finished the comprehensive examination you will be asked to answer a questionnaire on your reaction to CAI training.

Study Guide

You have each been issued Study Guides that contain outlines of the modules, lists of lesson objectives, overviews of each lesson, and some practice exercises.

Do not take notes. Everything you need for review is in your Study Guides. Unless otherwise instructed, do not use your guide during a lesson. Do NOT use it during any test.

Breaks

You should schedule yourselves a rest break at the end of every lesson test or about every 45 minutes. Limit your breaks to 5 or 10 minutes.

Both members must leave the terminal during breaks. You must not go through lessons without your partner.

Review

You should review for your lesson tests. Do not spend more than 5 or 10 minutes discussing the lesson and reading over the Study Guide.

Operational Procedure

Although there can be only one response, both of you should work together on every question. This ensures the best learning. When you and your partner fail to agree on an answer, discuss the problem and solve it as a team.

To ensure equal time at the console you will switch positions at the end of each lesson test. Decide among yourselves who will be first.

Whenever earphones are used, the message will automatically repeat. Switch earphones with your partner.

Do not intentionally make mistakes; a record is being kept of all responses.

You are ready to begin CAI. All further information you need will appear on the screen. Read and follow instructions closely. If you have any questions, contact the proctor.

GOOD LUCK!

Appendix C

Attitude Questionnaire
for Individually Trained Students

Appendix C

Attitude Questionnaire
for Individually Trained Students

Computer Assisted Instruction Questionnaire

Your answers will be kept confidential. Please give us your frank opinions so we can properly evaluate the course.

1. Please circle the highest year of education completed:

   7 8 9 10 11 12 13 14 15 16

2. For each course below, circle the total years of training you have had in high school, trade school, and college.

   a. general science/physics 0 ½ 1½ 2 2½ 3 3½ 4 4½ 5
   b. mathematics 0 ½ 1½ 2 2½ 3 3½ 4 4½ 5
   c. electricity/electronics 0 ½ 1½ 2 2½ 3 3½ 4 4½ 5

3. How would you rate CAI in comparison to your regular course (BEEINLES) in electronics training?

___very poor/ ___below average/ ___average/ ___above average/ ___outstanding

4. Which of the following best describes your attitude toward CAI?

   a. I would prefer using CAI all of the time.
   b. I would prefer using CAI part of the time.
   c. I would prefer to never use CAI.
   d. Other (specify percent of time). _____

   _____

5. Choose your preferred training method.

   a. Regular classroom with text book.
   b. Individualized program (BEEINLES).
   c. CAI.
   d. Other (please specify). _____

   _____

6. Which of the following did you like best about CAI? You may circle more than one.

   a. I could go at my own speed.
   b. I was always being asked questions.
   c. It told me immediately when I was wrong and gave me a review.
   d. It presented material in a clear and interesting way.
   e. Other (please specify). _____

   _____

   _____

7. Which of the following did you like least about CAI? You may circle more than one.

   a. I couldn't ask questions.
   b. I couldn't back up.
   c. It was too much work.
   d. It was too impersonal.
   e. Other (please specify). _____

   _____

   _____

8. Are there any other comments you would like to make? _____

   _____

   _____

   _____

   _____

9. If you had a choice, you would prefer:

   a. working with a partner.
   b. working alone.

10. If you had to choose a partner for CAI training which of the following would you choose. (You may choose more than one.)

    a. Choose a friend.
    b. Choose someone with more ability.
    c. Choose someone with equal ability.
    d. Choose someone with less ability.
    e. Would accept a partner that (I was told) would result in the best learning.

Appendix D

Attitude Questionnaire
for Students Trained in Pairs

Appendix D

Attitude Questionnaire
for Students Trained in Pairs

Computer Assisted Instruction Questionnaire

Your answers will be kept confidential. Please give us your frank opinions so we can properly evaluate the course.

1-8. (Same as for individually trained students, Appendix C.)

9. How would you rate working with a partner on CAI?

___poor/ ___fair/ ___average/ ___above average/ ___outstanding

10. If you had a choice, you would prefer:

a. working with a partner.

b. working alone.

11. If you had to choose a partner for CAI training which of the following would you choose. (You may choose more than one.)

a. Choose a friend.

b. Choose someone with more ability.

c. Choose someone with equal ability.

d. Choose someone with less ability.

e. Would accept a partner that (I was told) would result in the best learning.

12. Which of the following was the biggest advantage of working in pairs? (You may choose more than one.)

a. We could discuss the problems.

b. I made fewer mistakes than I would have made working alone.

c. I learned more working in a team.

d. I didn't have to work as hard.

e. Other (please specify). _____

_____

_____

13. What one thing did you like most about working on CAI with a partner?

_____

_____

_____

14. While working as a team:

a. Your partner did most of the work.

b. You did most of the work.

c. You both did an equal share of the work.

15. Which of the following best describes your team?

a. We agree on everything.

b. We agree on most things.

c. We only agreed about half the time.

d. We never seemed to agree on anything.

16. Which of the following was the biggest <u>disadvantage</u> of paired instruction? (You may choose more than one.)

a. My partner slowed me down.

b. My partner went too fast.

c. My partner's mistakes lowered my lesson test scores.

d. With a partner, I could not concentrate (learn) and I think it lowered my examination scores.

e. Other (please specify). _____

_____

17. What <u>one</u> thing did you <u>dislike</u> most about having to work on CAI with a partner? _____

_____

_____

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13. ABSTRACT

The feasibility of reducing cost per terminal hour of computer assisted instruction (CAI) was investigated by training Ss in pairs on two modules of an operationally tested tutorial CAI course in the Navy's basic electronics curriculum. Navy electronics students, randomly assigned to groups, received all training on an IBM 1500 Instructional System. No differences were found between Ss trained in pairs (N = 50) and Ss trained alone (N = 25) in performance on two major tests and a comprehensive examination or in training time. The paired training condition appears to have produced attitudes toward CAI that were significantly less positive than those produced in the control condition. The major complaint reported by paired students was that their partner went either too fast or too slow. There is need for additional research to investigate optimal methods for assigning partners and controlling attitudes for paired student training by CAI. In conclusion, the results of this research indicate that paired student training is a feasible method to reduce the cost per terminal hour of CAI, where CAI course materials are basically linear and where students are paired on the basis of learning rate and aptitude.

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computer-assisted instruction						
CAI						
computer-based training						
CBT						
computer controlled learning						
CAI training technique