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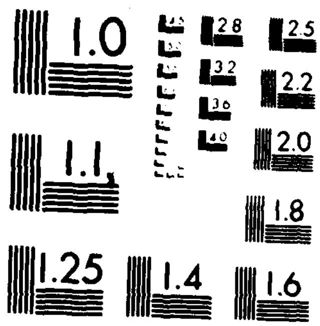

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TDI-TR-83-3

AN EVALUATION OF THE CAI SEGMENTS OF THE TOW FIELD TEST SET AND THE HAWK CW RADAR REPAIR COURSES

DEVELOPED BY:

LARRY D. FRANCIS, Ph.D.

LAWRENCE G. WELLING

GIRARD W. LEVY, Ph.D.

BATTELLE COLUMBUS LABORATORIES

29 JUNE 1983

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PREPARED FOR: US ARMY TRAINING AND DOCTRINE COMMAND
FORT MONROE, VA 23651

US ARMY MISSILE AND MUNITIONS SCHOOL
REDSTONE ARSENAL, AL 35897

NOTICES

This report has been reviewed and is approved.

FRANK E. GIUNTI
Chief, Instructional
Development Division

EDMUND J. GLABUS
Colonel, Infantry
Director, Training Developments
Institute

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THIS IS THE FINAL REPORT ON A PROJECT TO CONDUCT AN EVALUATION OF THE COMPUTER ASSISTED INSTRUCTION (CAI) SEGMENTS OF THE TOW FIELD TEST SET (TFTS) COURSE AND THE HAWK CONTINUOUS WAVE RADAR REPAIR COURSE CONDUCTED AT MMC&S. COMPUTER ASSISTED INSTRUCTION FOR BOTH COURSES WAS PROVIDED VIA THE PLATO CAI SYSTEM. PLATO WAS BROUGHT INTO THE TFTS COURSE BECAUSE IT WAS ANTICIPATED THAT VERY FEW TOW FIELD TEST SETS WOULD BE AVAILABLE AT THE SCHOOL FOR TRAINING.

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PLATO INSTRUCTIONAL SEGMENTS, WHICH COULD BE BETTER CHARACTERIZED AS "SIMULATION", WERE INTERSPERSED THROUGHOUT THE TFTS COURSE. ALL TFTS STUDENTS RECEIVED PLATO SEGMENTS AS AN INTEGRAL PART OF THEIR INSTRUCTION. THERE WAS NO "NON-PLATO" CONTROL GROUP AVAILABLE.

THE HAWK COURSE WAS NOT CONSTRAINED BY EQUIPMENT SHORTAGES IN THE WAY OF TFTS COURSE WAS. THE PLATO SEGMENTS OF THE HAWK COURSE WERE VERY SMALL IN COMPARISON TO THE LENGTH OF THE OVERALL COURSE. THEREFORE, WITH RESPECT TO THE HAWK COURSE EVALUATION, IT WAS POSSIBLE TO HAVE A CONTROL (NON-PLATO) GROUP AND AN EXPERIMENTAL (PLATO) GROUP FOR COMPARISON PURPOSES.

DATA ANALYSIS FOR BOTH THE TFTS AND THE HAWK EVALUATION WAS ORGANIZED AROUND THE QUESTIONS OF EFFECTIVENESS, EFFICIENCY, USER ACCEPTANCE, QUALITY OF IMPLEMENTATION, GENERALIZABILITY, SYSTEM RELIABILITY, AND COST EXTRAPOLATION.

THE RESULTS ARE THAT, FOR THE TFTS COURSE, THE PLATO SIMULATIONS WERE EFFECTIVE, EFFICIENT, ACCEPTED BY STUDENTS AND INSTRUCTORS, RELIABLE, AND POTENTIALLY COST EFFECTIVE. THE HAWK RESULTS ARE THAT THE PLATO SIMULATIONS ARE EQUALLY EFFECTIVE (TEST RESULTS) OR LESS EFFECTIVE (SUBJECTIVE RESULTS), OF QUESTIONABLE EFFICIENCY, UNACCEPTABLE TO STUDENTS AND INSTRUCTORS, RELIABLE, AND LESS LIKELY COST EFFECTIVE.

FINAL REPORT

on

AN EVALUATION OF THE CAI SEGMENTS OF THE TOW FIELD TEST SET AND THE HAWK CW RADAR REPAIR COURSES

to

U.S. ARMY TRAINING DEVELOPMENTS INSTITUTE

June 29, 1983

by

Larry D. Francis
Lawrence G. Welling
Girard W. Levy

The views, opinions, and/or findings contained in this report are those of the authors and should not be construed as an official Department of the Army position, policy, or decision unless so designated by other documentation.

BATTELLE
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

EXECUTIVE SUMMARY

The objective of this study was to conduct an evaluation of the computer assisted instruction (CAI) segments of the TOW Field Test Set (TFTS) Course and the HAWK Continuous Wave Radar Repair Course conducted at MMC&S. Computer Assisted Instruction for both courses was provided via the PLATO CAI system. PLATO was brought into the TFTS course because it was anticipated that very few TOW Field Test Sets would be available at the school for training. PLATO instructional segments, which could be better characterized as "simulation", were interspersed throughout the TFTS course. All TFTS students received PLATO segments as an integral part of their instruction. There was no "non-PLATO" control group available.

The HAWK course was not constrained by equipment shortages in the way the TFTS course was. The PLATO segments of the HAWK course were very small in comparison to the length of the overall course. Therefore, with respect to the HAWK course evaluation, it was possible to have a control (non-PLATO) group and an experimental (PLATO) group for comparison purposes.

Data analysis for both the TFTS and the HAWK evaluation was organized around the questions of effectiveness, efficiency, user acceptance, quality of implementation, generalizability, system reliability, and cost extrapolation.

The results are that, for the TFTS course, the PLATO simulations were effective, efficient, accepted by students and instructors, reliable, and potentially cost-effective. The HAWK results are that the PLATO simulations are equally effective (test results) or less effective (subjective results), of questionable efficiency, unacceptable to students and instructors, reliable, and less likely cost-effective.

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Columbus Laboratories

INTRODUCTION

The purpose of the study was to conduct an evaluation of the computer assisted instruction (CAI) segments of the TOW Field Test Set Course (hereafter referred to as the TFTS course) and the HAWK Continuous Wave Radar Repair Course (hereafter referred to as the HAWK Course). This evaluation was based on a previously developed test and evaluation plan*.

Implementation of the CAI Simulations

The courseware that was evaluated was implemented on the Control Data PLATO CAI system. This courseware was available in two forms: (1) a time-sharing supported system, and (2) a stand-alone, microcomputer system. Materials on both systems were very similar with only a few differences due to the advantages allowed by each method of delivery.

In both the TFTS and the HAWK course, the style of use and the style of courseware were atypical of the usual CAI implementation. For example, the CAI lessons were taken simultaneously by two students. One student read through the technical manual (TM) step-by-step while the other student performed the actions called for, by touching the screen or typing an answer.

The CAI lessons were unusual too, although they appeared to be very appropriate for their use. These CAI materials could more properly be called

* Francis, L. D., and Levy, G. W., A Test and Evaluation Plan for the CAI Segments of the TOW Field Test Set and the HAWK CW Radar Repair Courses, Battelle-Columbus, 1981.

CAI simulations than CAI lessons. That is, the simulations had no instructional objective, per se, other than the overall instructional objective of the module. The "objective" of each lesson was to reproduce as closely as possible the actions of the actual test or operating hardware, and to provide feedback (much like an instructor would) to the student actions. Because of the design objectives, enhanced achievement scores and retention were not expected. Some increase in student motivation/attitudes was anticipated.

A Brief Description of the PLATO System

The PLATO computer-based instruction system is a modern, sophisticated delivery system. As used for HAWK and TFTS training, the system consisted of a high-resolution (512 x 512 dot) monochrome CRT equipped with a 16 x 16 touch sensitive panel. The keyboard contained about a dozen extra keys that facilitated the instructional process and that were labeled for instructional uses (HELP, LAB, BACK, etc.). An internal microprocessor controlled the system. Some of the PLATO terminals at MMCS were connected to a large mainframe control computer by telephone lines. Other terminals (called micro-PLATO terminals) got their data only from connected floppy disks. Although centrally-connected terminals are needed to create courseware, once created, the courseware can be delivered more inexpensively via stand-alone, disk-based terminal systems. With proper attachments micro-PLATO terminals can use central PLATO services. This evaluation focused on the most efficient, minimum cost configuration that could be used for long-term courseware delivery and notes only briefly alternate configurations.

Lesson Topics

The lesson topics for the TFTS course were:

Controller DVM Alignment

Controller Counter A1 Alignment

Controller Timer A7 Alignment

Controller Timer A6 Alignment

Functional Analysis and Alignment of the Power Source Unit

Functional Analysis and Alignment of the Power Supply Modulator/Test Adapter

TOW Weapon System Verification Test (6 lessons)

2 new lessons on Troubleshooting written by MMCS course staff (not yet in general use)

The lesson topics for the HAWK course were:

Repair Antenna Positioning Circuits

Repair Horizontal Amplifier and Power Supply

The TFTS Simulations (15 - 17 hours) were placed throughout the three week course in essentially an even distribution. For nearly every exercise where a computer simulation could be predicted to offer a significant advantage, that simulation has been created.

The HAWK simulation (1 - 1-1/2 hours) was located past the half-way point in the course. It was a very saml1 part of a relatively long course (27 - 45 weeks).

Description of TFTS and HAWK Radar Equipment

The TOW Field Test Set consists of a group of about a dozen devices that are used to check the readiness of and troubleshoot problems for the TOW missile and its firing system. Most of the checks made are electronic, although there are some optical and mechanical tests as well. The test instruments are relatively large (compared to a simple test instrument like a multimeter) and rather complex in terms of the numbers of knobs, gauges, and jacks. The individual devices are packed in large trunks when moved.

The Improved HAWK Radar Set is a large piece of equipment mounted on a medium-sized rubber-tired trailer. A tower supports the revolving radar antenna and a side panel opens to become a control panel. Troubleshooting typically involves isolating a printed circuit board and then a circuit element on that board.

EVALUATION ISSUES

Overall Evaluation Questions

The evaluation attempted to look at the general questions, "Were the HAWK and TFTS CAI simulations implemented well enough to meet their intended objectives?" and "Can these results be generalized to other sites and situations?" This was to be done by examining specific issues about effectiveness, efficiency, cost, reliability, and user acceptance. The extent of generalizability is an important, but difficult question to answer with certainty. The results of any single study have low generalizability until they are combined with and compared to other studies with similar objectives and parameters. Even then, generalization is limited to other situations where the environment, objectives, and situation are similar to those studies from which the generalizations are made. Additionally, all evaluations have one further limitation: the quality of the implementation. If the quality of courseware and the associated instructor-led teaching is high, it is possible for participants (especially instructors or school administrators) to validly make subjective estimates about, for example, how widely applicable this CAI simulation technique is. However, if the quality of the implementation is low, it is very hard to believe that the measures of user acceptance, effectiveness, etc., would not be so low as to affect any estimate about how generally useful these simulations are. Note that a high quality implementation may still show that this technique could be applied successfully to only a few other courses. Thus, the generalizability of the results from this evaluation are limited by the quality of the implementation, and no attempt to draw conclusions and recommendations were to be made unless the implementation was first shown to have been satisfactory.

Specific Evaluation Issues

In order to collect the data to answer the relevant issues, seven types of questions were asked.

1. Effectiveness. Normally this question would be "Do the materials teach?", but because of the objectives of these simulations, two appropriate questions for both courses were considered to be: "Was the simulation fidelity high?" and "Did transfer occur?"; for the TOW course, "Was equipment damage reduced?"; and, for the HAWK course, "Was there a significant difference in scores and grades when portions of the course are taught via simulation?"

2. Efficiency. This question had two meanings in the context of these courses. First, "When engaged with the CAI system, was the student's time well used?"; second, "When CAI systems were introduced for practical exercises, was efficient

use made of the student's available time?"

3. User Acceptance. This issue was raised among two groups: students and instructors.

   In various formats, the essential question was, "If you had a choice, would you try to use CAI simulations again?"

4. Reliability. This information was gathered separately for each type of delivery system. It was to be measured in a quantitative, objective way by calculating hardware reliability factors such as mean time between failure and also by subjective estimates of the comparative reliability. Courseware reliability was considered as an integral part of the implementation quality issue (see above).

5. Cost. Cost extrapolation was to answer the question, "How much would it cost if these CAI simulations were permanently installed as an on-going part of these courses?"

The issues of generalizability and quality of implementation were treated equally with the five issues above, but have been discussed previously. The latter issue was measured both by questioning users and by analysis of logged data about student problems.

Overall Evaluation Summary

Looking at evaluation only from an "issues" point of view tends to obscure the reasons and objectives for the original decision to implement the PLATO system in the courses chosen. Therefore, these objectives are reviewed here.

TOW Field Test Set Course

PLATO was brought into the TFTS course because it was anticipated that very few TOW Field Test Sets (TFTSs) would be available at the school for training. The reasons for the addition of PLATO-simulated test components were many:

- During practical exercise (PE) time, four students are typically paired with one instructor. It is possible for only two students to work at a piece of equipment under the instructor's supervision. The other half of the time a student must be occupied with self-study. In such a case, the student's time in PE (particularly PE1, hands-on training) is not efficiently used. Taking advantage of this time for PLATO simulations would keep the student stimulated and motivated and would provide nearly double the "hands-on time" (if the simulations were effective).

- Furthermore, it sometimes happens that the course starts before all the TFTS equipment has arrived and been readied. In that case, a PLATO simulation could provide the only experience a student gets before having to work in the field with a piece of equipment.

- Also because of equipment shortages, the availability of spare parts or replacement items was expected to be low. Therefore, equipment damage caused by students who misconnect or improperly control the test equipment could have a major, long-term effect on the ability of the school to teach the course. The threat was very real in that there are several excellent opportunities for misadjusted controls to damage very expensive equipment. The PLATO simulations were programmed to catch these cases and provide unforgetable feedback about the consequences of such actions on the actual TFTS.

- Although not their direct responsibility, school officials looking at an overall Army need for training realized that, for those portions of the course with PLATO simulations, it might be possible to have training exportable to anyone who has a TFTS and access to a PLATO terminal and the TFTS courseware.

The TFTS course had no comparison group for a CAI vs. non-CAI study. Overall, therefore, its evaluation asked, "What does having PLATO simulations available add to this course?"

HAWK Continuous Wave Radar Repair Course

The HAWK course had a comparison group (CAI vs. non-CAI) available, but was not constrained by equipment shortages in the way the TFTS course was. Therefore, the questions asked were: "What is the effect of replacing some hands-on equipment experience (which has little feedback) with some computer simulated experience (with feedback)?" "Does the CAI help bridge the gap between theory classes and PE or does it enhance motivation (since this is a relatively long course)?"

EVALUATION DESIGN

This section of the report presents the evaluation design for the TFTS and HAWK courses. These designs were based on discussions at MMCS and a thorough exploration of alternatives. They appeared to be the most feasible from a technical, cost and schedule viewpoint.

TFTS Evaluation

The TFTS evaluation was severely constrained by the absence of any control group. There was no comparable group of students that was taught the TOW Field Test Set course without the use of PLATO. The evaluation of effectiveness, therefore, focused on whether an acceptable level of performance was achieved by an acceptable percentage of students. The evaluation of efficiency focused on two questions: whether students were acceptably trained using fewer equipment end items per student than in traditional courses (i.e., four students per equipment end item), and whether better use was made of the students' time during P.E.s.

In general, the evaluation consisted of subjective comparisons (by students and instructors) of the effectiveness, efficiency, acceptance, and generalizability of PLATO simulations compared with the use of real equipment.

HAWK Evaluation

The HAWK effectiveness evaluation was based on test scores for the lesson using PLATO, comparing those students who used PLATO with those who did not. In the evaluation design, classes would be randomly assigned to PLATO and non-PLATO conditions until the required number of students was obtained.

Another part of the evaluation consisted of subjective comparisons (by students and instructors in PLATO classes) of the effectiveness, efficiency, acceptance, and generalizability of PLATO simulations compared with the use of real equipment.

Since the amount of PLATO use could vary widely in the HAWK classes, a question on amount of use was given to students, for possible use as a control variable in the statistical analyses.

Sample Size

Minimum sample size for a study were determined based on three statistical considerations: (1) the desired precision of estimation or the desired amount of difference that is to be reliably detected, (2) the desired confidence level for the study, and (3) the population variance. Desired levels for the first two items were established. The third item, the population variance, was estimated from previous experience. Nonstatistical considerations, such as cost of additional sampling units or difficulty in obtaining additional units, also figured into the determination of sample size. Samples larger than the minimum were requested to counteract any attrition due to dropouts, missing data, etc.

Sample Size - TFTS

The minimum sample size required for the TFTS evaluation was based on the desired precision of estimation for the student subjective judgments (since there was no control group). As most of the questions are based on a 5-point rating scale, this type of scale was used as the basis for calculating the required sample size. It was first assumed that the desired precision of estimation is just under one-half of a scale step (i.e., .49 units). That is, if the mean judgment for a particular question is 2.5, it would be desirable to have a large enough sample, so that we could state that the population mean is greater than 2.0 and is less than 3.0 with a specified level of confidence. The usual level of confidence selected is 95 percent. That is, we would make an error only 5 times in 100 replications of the study. Other levels of confidence, such as 90 percent or 99 percent, are sometimes used.

The required minimum sample size (N) was calculated from:

$$N = 4\sigma^2 \, (Z_{1-\alpha/2})^2 / w^2$$

where:

N = minimum sample size

σ^2 = population variance

α = 1-the confidence level (α = 1-.95 = .05)

$Z_{1-\alpha/2}$ = abcissa of the unit normal curve corresponding to $1-\alpha/2$ ($Z_{.975}$ = 1.96)

w = width of the confidence interval (w = ± .49 = .98)

Previous experience with 5-point scales has shown that the sample variance (used as an estimate of the population variance) is likely to lie between 1.00 and 1.96. (This latter number is only coincidently the same as the value for $Z_{.975}$). If σ^2 = 1.96, then the required minimum sample size was approximately 31 students. Actual sample size attained in the study was 34 students.

The same considerations apply to the number of instructors and school staff required to provide reasonably precise estimates of their judgments. Since it is unlikely that there would be as many as 31 different TFTS instructors, we simply had to accept as many as we could get. (Because of differences in PLATO implementation in the TFTS and HAWK courses, and the different experiences of the instructors, the data from TFTS and HAWK instructors were not combined.)

Sample Size - HAWK

The minimum sample size required for the HAWK evaluation was based on the amount of difference in mean test lesson scores between PLATO and non-PLATO classes that is to be reliably detected. It was assumed that a difference of 10 percentage points or more between the means was important to detect. Further, it was assumed that a difference this large or larger should be detected 90 percent of the time (90 out of 100 replications of the study). Finally, the level of confidence was set at 95 percent.

The required minimum size for each group was calculated from:

$$N = 2\sigma^2 \, (Z_{\alpha/2} + Z_{\beta})^2 / d^2$$

where:

- N = minimum sample size in one group
- σ^2 = estimated population variance
- α = 1-the confidence level, or the probability of rejecting the null hypothesis when it is true (α = 1-.95 = .05)
- β = the probability of accepting the null hypothesis when it is false (β = 1-.90 = .10)
- Z = abcissa of the unit normal curve corresponding to the subscripted area
- d = difference between independent means (10 percent)

It is estimated that the sample variance is likely to be 100 percenage points. If σ^2 = 100, α = .05, β = .10, and d = 10, then the required minimum sample size in each group was approximately 21 students. Actual sample size attained in this study was 35 students in the experimental group and 25 students in the control group.

Evaluation Variables

The evaluation variables (i.e., effectiveness, efficiency, user acceptance, quality of implementation, generalizability, reliability, and cost) are presented in Appendix A, Tables 1 through 9, together with their metrics, rationale for use, and data sources.

DATA COLLECTION AND ANALYSIS

Data Collection

Data was collected on the TFTS and HAWK courses in accordance with the data collection plan.

1. For each course, the school designated a person who was responsible for gathering, making minor checks upon, and storage of the course data during the evaluation period.
2. HAWK course instructors chose five test items that clearly and primarily reflected knowledge gained during the portion of the block that was taught via PLATO.
3. Instructors who used PLATO were briefed on:
   - Usage logs
   - Administration of questionnaires
   - Problem logs
   - Recording of unusual incidents - weekly
4. Copies of problem and usage logs were reproduced.
5. Lists of terminal number, terminal type, and terminal location were prepared.
6. HAWK student data (common subjects scores, and scores on the relevant test items) for both PLATO and non-PLATO classes were obtained.
7. The evaluators screened end-of-course evaluations for PLATO-related comments.
8. At the end of the PLATO instruction, the instructor or someone designated by the school:
   - Verified the accuracy and completeness of the usage and problem logs and checked that back-in-service time/data were recorded.
   - Recorded any anecdotes about class events that were related to the CAI lessons.
   - Transcribed common subjects course scores to student data form (HAWK only).
   - Distributed and collected the PLATO end-of-course evaluation.
9. Battelle evaluators:
   - Gathered PLATO cost data from the CDC sales representative and reviewed budget completeness.

- Gathered TFTS acquisition and repair costs *from the school.*

The only staff questionnaires received for both the TFTS and HAWK courses were from the course instructors. Other school administrative personnel did not complete these forms.

Data Analysis

Data analysis for both TFTS and HAWK evaluations was organized around the questions of effectiveness, efficiency, user acceptance, quality of implementation, generalizability, system reliability, and cost extrapolations. Reliability and cost data from the TFTS and HAWK courses were pooled. The other data were analyzed separately for the TFTS and HAWK course evaluations.

Analysis of the subjective questions involved obtaining frequency distributions for each question. Differences between students and instructors, and between TFTS and HAWK courses were examined.

The HAWK effectiveness evaluation involved a comparison of the means on the test lesson for the PLATO and non-PLATO classes. Scores on the common course subjects portion of the course and the estimated time spent were used to interpret the effectiveness results.

RESULTS

This section reports the results for the TFTS and HAWK course evaluations with respect to effectiveness, efficiency, user acceptance, quality of implementation, generalizability, reliability, and cost.

Mode of Discussion for Likert-Type Rating and Evaluation Items

The evaluation will be discussed issue by issue, treating all evaluation items for one issue before beginning a new issue. The tables found at the end of each issue discussion will direct the reader to the specific questions asked on each questionnaire. The questionnaires will be found in Appendices B-E; the frequency of each response has been entered onto the questionnaire form. The discussion of the issues will generally note only trends or consensuses, leaving the details of the response profile to be found in the appendices.

Effectiveness

HAWK Effectiveness

The HAWK effectiveness evaluation was based on derived 5-item subtest scores related to the PLATO lessons, comparing those students who used PLATO with those who did not. The observed mean for the experimental (PLATO) group on this test was 93% (N=35), which was slightly worse than the control (non-PLATO) group mean of 97% (N=25). With respect to the common subjects portion of the course and the time required for completion of the HAWK course, the experimental group took less time but did not perform as well when compared to the control group. While the evaluation plan considered the use of covariance analysis to compare the experimental and control group on the five item effectiveness measure, this was not done because the distribution of scores on the five item test did not lend itself to covariance analysis. As is obvious from the means achieved (i.e., 97% vs. 93%), the scores on the effectiveness measure were consistently high across both the control and the experimental groups. It is difficult, therefore, to establish any important or practical difference between the two groups in terms of the five item test. Go/No-Go data from criterion referenced tests were also examined but found to be essentially all "go" in both groups.

TFTS Effectiveness

TFTS students received course grades based on 2 PE and 2 written test scores. The class that began in March 1983 was told that their PLATO test scores would also be included in the average. As a result, students treated PLATO exercises even more seriously. Interestingly, their PLATO scores remained the same, but written and PE scores increased considerably (see below). Since this change in procedures (announcing that PLATO scores would be averaged into the grades) was not part of the original experimental design, Battelle captured only the following averaged data from the last three classes in the evaluation period.

Class Information			Overall Grade		PLATO-Only Grade	
Class #	Started	N	Avg.	Range	Avg.	Range
105	Dec. 82	9	84.9	79-88	86.2	83-89
001	Jan. 83	7	86.6	82-94	86.0	82-89
002	Mar. 83	6	94.3	94-95	86.2	85-88

The sample sizes are too small to draw firm conclusions, but anecdotal information from the instructors indicates a significant improvement of an already excellent situation after the announcement was made. All of the above scores should be viewed as very commendable: the criterion level for passing the course is 70.

Subjective Effectiveness Data

Training effectiveness was also measured via ratings by students and instructors. TFTS students comparing PLATO to the real equipment felt they learned equally from each and felt they could learn "a great deal" if they had learned only from PLATO. HAWK students felt they learned less from PLATO and could have learned "a little" using only PLATO. TFTS instructors found PLATO greatly increased student learning and greatly increased learning about the relationships among system components and tests. HAWK instructors saw little or no change in either of these categories.

Speed of learning for TFTS students was self-rated as faster on PLATO, but HAWK students felt they learned slower on PLATO.

Simulation fidelity or realism is an important dimension of training effectiveness in cases where a training simulation is used. Most (22) TFTS students stated they were never confused by differences between real and simulation equipment and several (12) said they occassionally were confused. None reported being confused often. These students were divided between the two highest ratings for the fidelity and adequacy of PLATO for training. HAWK students were divided fairly evenly between those who were never confused by differences between real and simulated equipment and those who occassionally were. Four students reported being confused often. Opinions on the adequacy of simulation fidelity for training spanned the range of alternatives. Overall the ratings were slightly positive.

Students answered one rating question about the relevancy or applicability of PLATO learning to the actual job. TFTS students gave PLATO very high marks here, HAWK students were neutral to slightly negative. Instructors had a similar question: TFTS instruction got positive responses; HAWK instruction got mostly neutral and one negative response.

Student confidence could be expected to increase as a result of using the simulators. TFTS responses were all positive or neutral, with half the students reporting PLATO "increased my confidence". HAWK students were almost exactly neutral. A similar question to TFTS instructors produced all positive comments; HAWK instructors comments mirrored in reverse the TFTS results: they were all negative. If the simulator can boost a student's confidence, it's also possible the simulator could lead to overconfidence. However, TFTS instructors found student overconfidence decreased (a positive finding). Three of the four HAWK instructors agreed, but one reported increased overconfidence.

Because students don't always use tech manuals (TMs) as frequently as they ought, one goal of the PLATO simulations was to increase this use. TFTS instructors reported a considerable increase in TM use (both in a rating item and in open-end comments), but HAWK instructors saw no change (3 of 4) or a great decrease (1).

One of the most consistent findings about why computer-based training improves performance is that student attention is enhanced. Most TFTS students checked the highest category for their interest level while using PLATO; all three instructors also recorded greatly increased attention. HAWK students reported a rather high interest level, only slightly lower than TFTS students. HAWK instructors, however, noted no change or even a decrease in attention.

The student questionnaire contained one item (number 3) that was an overall rating of effectiveness and acceptance. On a 1 to 10 scale (10 being highest) students rated the usefulness of PLATO simulation. TFTS student's ratings were all positive (i.e., the lowest rating was 6), the mode was 10, and the mean was 8.9. HAWK student's ratings spanned the range from 1 to 10, the mode was 10, and the mean was only 5.7.

TABLE O. INDEX OF QUESTIONNAIRE ITEMS AND SUBJECTIVE TRAINING EFFECTIVENESS VARIABLES

Subjective Training Effectiveness Variables (Keyed to Tables 1 and 2a in Appendix A)	Student End-Of-Course Evaluation	Instructor End-Of-Course Evaluation
1.2 Perceived amount of learning	Questions 5 & 12	Questions 6 & 17
1.3 Perceived speed of learning	Question 6	--
1.4 Perceived fidelity of simulation	Questions 4 & 11	--
1.5 Perceived application of training to job performance	Question 10	Question 12
1.6 Perceived extent of student confidence	Question 8	Question 9
1.7 Perceived extent of student overconfidence	--	Question 14
1.8 Perceived use of TM's	--	Question 10
1.9 Perceived holding of student attendion	Question 9	Question 8

Training Efficiency

Training efficiency questions as defined in this study address two issues. The first is, "Was the available practical exercises (PE) time well used?" Instructors in TFTS found a lower workload and more time for helping students when they had PLATO available, but HAWK instructors had essentially an opposite view. TFTS students felt their time was used better or perhaps much better with PLATO whereas HAWK students perceived no difference. Instructor opinions matched those of their students.

The second efficiency question is, "Was the simulation itself efficient?" To measure this, the evaluation plan made two assumptions: the simulated tasks should not take longer than the actual tasks, and greater individualization (because of feedback, help, etc.) should make the ratio between fastest and slowest student larger for an efficient simulation than for the real task. Only TFTS had a subject for which the above comparisons could be reasonably made, and only two instructors had enough experience to accurately estimate the time needed to perform the tasks. The first hypothesis was upheld: simulated operation was as fast or faster than actual operation. However, the second hypothesis, that PLATO feedback would increase the disparity between fast and slow students, was not observed. In fact, the students who were slowest on the real equipment apparently received the greatest "speed-up" when using PLATO: instructors estimated that for the slowest, simulated operation took 1.0 hours whereas on actual equipment the operation took 1.5 hours.

TABLE 1. INDEX OF QUESTIONNAIRE ITEMS AND SUBJECTIVE TRAINING EFFICIENCY VARIABLES

	Subjective Efficiency Variables (Table 3, Appendix A)	Student End-Of-Course Evaluation	Instructor End-Of-Course Evaluation
1.2	Use of instructor's time during P.E.	--	Questions 11 & 16
1.3	Use of student's time during P.E.	Question 7	Question 15
1.4	Estimated time to complete tasks	--	Questions 25 - 28

Salvaged Time

Another measure of efficiency is "salvaged time". Since typically only half the students could work with the real TFTS equipment at once, the time of the other students was being underutilized before PLATO simulations were added to the course. Based on comments from course personnel, it seems fair to count as "salvaged time" all the student time spent using the TFTS simulations; the average time for TFTS students, 12.3 hours/person, is therefore regarded as the amount of extra instruction each student received because of the PLATO simulations, but without extending the length of the course. TFTS instructors also indicated via oral comments that PLATO totally eliminated student complaints regarding underutilized time that occurred earlier. HAWK instructors felt because real equipment was available, PLATO took away from experience using it. As a result no "salvaged time" would be gained.

Reduction of the Need for Hardware

One possible purpose for PLATO-type simulations is the replacement of real hardware with simulated hardware. To measure this possibility the evaluation plan proposed to calculate the number of students per set of real hardware before and after PLATO. In actual practice, the number of students was more a function of class frequency and class size than of hardware availability. For that reason and because there is no value against which to compare the ratio obtained, this issue was examined by informal interviews of course staff. The clear consensus in the TFTS course was that even as valuable as the PLATO simulations were, some minimum time with the real equipment was necessary and that for the TFTS course, for example, a further "dilution" of hardware among students would be detrimental to the training program. They pointed out that it was not infrequent that one of the three TFTS systems was broken. Whereas the remaining operable equipment could temporarily accommodate a 50% increase (from one-third of the load to one-half of the load), if there were only two TFTS units when one failed, the remaining unit could not be expected to handle a 100% load increase (from one-half to the full load).

User Acceptance

User acceptance was broken into two parts: student acceptance and instructor acceptance. The responses from TFTS and HAWK students were sufficiently different that they were analyzed separately.

Analysis of TFTS Student Comments from Open-End Questionnaire Items

Two questions on the end-of-course student evaluation asked TFTS students what they liked and what they disliked about the PLATO part of the course. In addition, several students added comments of a similar nature to other questions and to the end-of-week evaluation sheet. All these comments were divided into roughly a dozen positive and a dozen negative categories. The total number of comments exceeds the number of students because most students made multiple comments.

Likes. The aspect of PLATO that most student comments noted (17) was the extra simulated practice with the equipment. A large number (10) also felt that use of the computer added "interest" and "fun" to the course. Equal numbers of comments (6) were received for: practice with the TMs using a computer, and general positive (but non-specific) comments. Five comments showed appreciation of the graphics, three comments each dealt with the feedback received and the testing aspects of the computer. Two comments mentioned interaction and one each noted the touch input and the reduced possibility of equipment damage. Thus, in general, the objectives for which PLATO training was designed were noted by the students. The comments were really quite positive (i.e., no sarcastic remarks) and no unexpected or unusual comments appeared.

Dislikes. The most popular negative comment was, in fact, a positive comment. Fifteen comments of "none" or "nothing" were listed as dislikes about the PLATO part of the course. The second most frequent comments regarding dislikes may have related to an apparent problem with differing tolerances between the PLATO and the TM requirements. Some students said merely that right answers were sometimes marked wrong; other students went on to explain about the tolerances problem. Discussion with course personnel indicated that the tolerance difference was a deliberate design decision to try to get better results through tighter tolerances. Four people commented about touch input problems. This could be a result of overly restrictive judging by the software (failing to account for parallax and sloppy finger placement) or a result of hardware problems. The number of problems noted is predictable for touch input. Three people made what is probably another example of positive comment in a negative category: they felt there was not enough time to use PLATO. Three comments were noted regarding difficulties in moving from PLATO simulator to the real equipment. Two comments each were received that PLATO feedback was confusing and that the computer instruction was too simplistic. Four comments were made only once: a better introduction to using the computer was needed, touch input combined with typing was confusing, the student should be able to insert errors into the simulated equipment, and a student felt as if he were just playing a game with the computer.

TFTS Summary. Total comments about likes totaled 60; those about dislikes totaled 42. Considering that all of the likes were positive comments and 18 of the dislikes were positive comments; this gives a ratio of 78 to 24 negative.

Overall these comments paint a picture of a very satisfied student user group. It might be noted that although some minor courseware rewrites might be needed to reduce even further the number of problems noted in the comments, no problems were apparently severe enough to warrant writing them down in the problem log.

Analysis of HAWK Student Comments from Open-End Questionnaire Items

The HAWK students who used PLATO answered the questions about likes and dislikes rather differently than the TFTS students.

Likes. The most common reason for liking PLATO (9 responses) was that "it broke the routine/was fun/a good toy". Six people found it faster to use and five enjoyed working with PLATO as a computer. A few (4) felt "it makes you think/it helps to understand the circuitry" and two liked it because it was easy to use. One comment each was received that a student liked the PLATO simulation because: it saved the training equipment, it was good and more of the subject should be on PLATO, that it was NOT good for teaching, and that it was good if integrated with the rest of the course.

Dislikes. Two types of comments tied for the most common dislikes: six students each noted "not enough realism/no feeling of learning" and "doesn't give enough information/does too much automatically". Several comments (4) were made about the brevity of the PLATO experience being too short to be useful. Three students found nothing to dislike and three said PLATO simulations were only good if there was an equipment shortage [there isn't a shortage currently in the HAWK course]. One comment each was received that PLATO was "boring", "not detailed enough" and "mixed up".

HAWK Summary. Total positive comments were 30 and negative were 25. Moving negative comments under "likes" to "dislikes" and vice-versa, one finds there were 32 positive and 23 negative comments. Despite their numerical majority, the positive comments were often weak (e.g., the most popular comment), and the negative comments were strong. Overall it's clear the HAWK students felt PLATO's advantages were those of an interesting diversion from learning; few comments suggested that it had an important role in training. The HAWK student's experience with PLATO was much different and much less positive than that for TFTS.

Ranked Acceptance Items: Students

Two end-of-course items rated student acceptance on a 5-point scale. TFTS students voted overwhelmingly that they would like to use PLATO for other hands-on training; most also said they would recommend to a friend that a PLATO course be selected over a non-PLATO course if convenient and many said they would advise the friend to "fight tooth and nail to get into the PLATO course". These are both very strong recommendations. Most HAWK students, in contrast, felt they would prefer not to take more PLATO in other training or were undecided (there was not a strong consensus). Similarly, they were neutral to slightly negative about advising a friend with respect to other PLATO-containing courses.

TABLE 2. INDEX OF QUESTIONNAIRE ITEMS AND STUDENT ACCEPTANCE VARIABLES

	Student Acceptance Variables (Table 4, Appendix A)	Student End-Of-Course Evaluation
1.1	Likes and dislikes about PLATO training	Questions 1 & 2
1.2	Willingness to use PLATO in other P.E. lessons	Question 14
1.3	Willingness to take other courses involving PLATO	Questions 15

Acceptance Items: TFTS Instructors

Instructor acceptance attitudes matched student attitudes fairly closely. TFTS instructors each listed multiple advantages: student self-confidence, lack of equipment damage, saved instructor time, individual feedback to students, increased attention, etc. Two instructors found no disadvantages and a third noted that use of PLATO meant less time on actual equipment (but qualified his comment saying the advantages outweighed the disadvantages). An open-end question about role changes caused by a wider PLATO implementation produced two similar positive comments of "more time to give individual attention" and one comment predicting little role change. A rating question measuring existing role changes was very positive. An open-end question about training practices elicited explanations of implementation procedures and reiterations of advantages.

TFTS instructors had consensus at the highest positive level regarding more PLATO simulations for their course and for other courses at the school. Regarding their seeking a position as instructor in a PLATO-based course, their responses were strung evenly between a neutral and very positive.

Acceptance Items: HAWK Instructors

HAWK instructors responding to advantage/disadvantage questions found no PLATO advantages (3) and use possibly for remediation (1). Disadvantages were plentiful: six disadvantages were cited by four instructors. They all dealt with the extra time and manpower needed to implement PLATO. Considering the amount of terminal familiarization time compared to the student learning time, the instructor's comments are certainly understandable. An open-end question about role changes caused by a wide implementation of PLATO in the course resulted in responses nearly identical in substance to the "disadvantages" question. A rating question measuring existing role change was neutral to negative.

Instructor's comments to an open-end question about changes in training practices resulting from PLATO had only negative comments: time lost from real equipment, students lax in procedures after using PLATO (2), and students less safety conscious (touching on PLATO was theorized to induce students to touch actual components).

HAWK instructors were mostly undecided about advocating PLATO simulation for other courses at the school, but definitely did not want them in the HAWK course. Of the four instructors, two would avoid if possible teaching a course using PLATO simulation and two would neither request nor avoid such a course.

TABLE 3. INDEX OF QUESTIONNAIRE ITEMS AND INSTRUCTOR ACCEPTANCE VARIABLES

	Instructor and School Staff Acceptance Variables (Table 5, Appendix A)	Instructor/Staff End-Of-Course Evaluation
1.1	Advantages and disadvantages with using PLATO	Questions 2 & 3
1.2	Willingness to expand PLATO lessons in current course	Question 18
1.3	Willingness to teach other courses using PLATO	Questions 19 & 23
1.4	Perceived changes in role of instructor/staff	Questions 5 & 7
1.5	Perceived changes in conduct of training	Question 4

Quality of Implementation

An adequate summative evaluation requires that some attention be given to the quality of implementation of the courseware. Unless the implementation is carried out in accordance with the project plans, and is of high quality, conclusions cannot be made about the impact of the courseware.

Quality of implementation was assessed by means of seven questions that recorded the frequency of typical problems experienced with incompletely-tested courseware. All these items were listed on what was labeled the "end-of-week evaluation". In both courses a single end-of-week evaluation was used, even if the PLATO simulations were used over several weeks. Also, two slightly different forms of this evaluation were used. One course used an earlier draft form and the other used a finalized version. TFTS students had three response options for describing the frequency of occurrence of each problem: never, once, more than once. HAWK students had the same questions, but were just given a yes/no item, "did this problem ever occur", followed by "if yes, how often: once, two or three times, four or more times".

A subjective reading of the TFTS results, based on Battelle's experience and based upon analysis of student's open-end comments as explanations of the above implementation data, suggests that most of the "bugs" had been removed prior to student testing and that efforts toward further polishing of the courseware would probably not have influenced the results. The only cases in which a majority of students had a problem more than once seemed to be caused by non-responsive touch panels and needing an instructor for further information. Considering the number of hours on PLATO, the predictability of responses (question 4), the indexing of content (question 6), and the simulation fidelity (question 8) all received very high tallies in the "never a problem" category.

HAWK student data are difficult to compare directly to TFTS data since the duration of the PLATO experience was so different. However, the pattern of responses for HAWK is basically similar, with fewer problems noted because of fewer hours of operation. Two exceptions to the pattern were that HAWK students recorded more touch panel problems (possibly a hardware or programming problem) and simulation fidelity problems. The higher rate of problems recorded for HAWK could have contributed to the lower acceptance of PLATO by students in that course, particularly since, for example, 10 of the 34 students reported problems with simulation fidelity that occurred two or more times during their short usage. An alternate explanation is that the high number of problems noted was a symptom of dissatisfaction arising from some other cause rather than a contributory factor to the cause.

An instructor questionnaire item (number 24) measuring the quality of implementation in terms of instructor assistance required produced positive results for TFTS and negative results (more assistance needed) for HAWK.

Generalizability

There are two questions that might be termed "generalizability"; first, "Are the results valid, and thus generalizable to other students and courses?" and second, "Based on the knowledge and experience of the instructors and school staff, are there other training situations that would benefit from application of this technology?" Although both questions are related, the first question is not a measurable quantity, but is based on the quality of the implementation and the quality of the research design, whereas the second question was hoped to be measurable to some extent using subjective ratings.

Two rating items attempted to measure the instructor's impressions of the generalizability of the PLATO simulation approach within their own course (question 21) and to other courses (question 22). TFTS staff found PLATO applicable to all other P.E. lessons in TFTS and "almost all" similar situations in other courses with limited equipment for training. (Note: the HAWK course does not suffer from equipment shortages as does the TFTS course.) The HAWK instructors (3 of 4) said PLATO was not applicable to other PE lessons and some (2 of 4) said PLATO shouldn't have been used where it was. Their opinion about applicability to other courses was also negative: 3 of 4 found only a limited number of courses that might benefit and one instructor found no use at all for PLATO simulation. Clearly instructor experience strongly colors opinion, even about applications outside their own course. The total lack of instructor consensus demonstrates that inadequate data are available with which to form a conclusion on generalizability, and that instructor data alone are probably not adequate to settle this issue.

Reliability

Failure Rates

Because of the excellent performance of the hardware and software, many of the reliability measurements have little meaning or cannot be calculated. As stated in the test plan, the software problems encountered during the very first class should not be included in the calculation of mean time between problems (MTBP). Since no problems were logged after the first week, this value cannot be calculated. The only software errors logged were four noted during the first TFTS class.

As a result of the above, the three metrics: mean time between failures (MTBF), mean time between problems (MTBP) and mean time to repair (MTTR) as well as the malfunction profile are not calculable or reported here. The only terminal hardware failure was a touch panel that took exactly one week to repair.

Perceived Reliability

In addition to various measures of reliability it is also instructive and important to measure perceived reliability since a few failures at critical moments may disproportionately affect user's perceptions of reliability. TFTS students rated PLATO reliability (question 13) as much better than other training equipment. HAWK student's ratings were positive to neutral, although no reliability problems were logged in that course. The three TFTS instructors (question 20) saw PLATO reliability as much better than other training equipment; HAWK instructors saw it as "much better" or about the same (1).

PLATO System Availability

Availability is the percentage of time the system is available to deliver training. Availability will be reported separately for each type of terminal, but the values will mean slightly different things in an operational sense. If one had 90% availability on 10 micro-PLATO systems, one could expect on the average that one system would be inoperable. About 1% of the time, two systems might be inoperable. Very, very rarely would they all be inoperable at once. If one had central PLATO, all failures were central system problems (no inoperable terminals) and 90% reliability, one would have no terminals operable 10% of the time. Hence 90% availability may describe both systems accurately, yet have very different implications operationally.

The HAWK terminal's usage was combined with TFTS usage for all analyses. Availability was calculated according to the following formula:

$$\text{Avail.} = \left[1 - \left(\frac{\sum_{1}^{\#\text{Failures}} \#\text{ Hrs. down (8 hrs./day)} \times \#\text{Terminals affected}}{\sum_{1}^{\#\text{Working days}} 8 \times \#\text{Terminals available}} \right) \right] \times 100\%$$

For micro-PLATO system, central PLATO system downtime is ignored. For that system of five terminals, availability was calculated to be 99.17%. For central PLATO based systems, both local hardware problems and central PLATO system problems are included. For a system of seven terminals, two of which were connected to central PLATO, availability was 99.20%.

Amount of Use

The amount the terminals were used may have had a bearing on how much maintenance was required and how frequently intermittent problems (including central system downtime) were noticed. Two kinds of usage were discernible from logs of usage: student use and author use. For HAWK there was no usage of the terminals by authors. Student usage from 11 May through 18 October on one terminal totaled 20.25 hours.

Usage as defined by:

$$\text{Usage} = \frac{\sum_{1}^{\#\text{Uses}} \text{Duration in hours}}{\#\text{Weeks} \times \#\text{Terminals available}} \quad \text{(In units of hours/terminal/week)}$$

for HAWK was 0.84 hours/week/terminal. For TFTS, two terminals were connected to central PLATO for authoring purposes and were not to be used by students unless necessary because of equipment failure. No such failure occurred and logged usage indicated:

Terminal #	#Hours Student Usage	#Hours Author/Demo Use
1	80:40	0
2	39:10	274:00
3	0	900:55
4	0	23:20
5	32:35	0
6	87:45	1:50
Total	240:10	1200:05

The four TFTS student terminals compiled usage of 10 hours/week or 2.50 hours/week/terminal. The four TFTS terminals used for authoring or demonstrations had an average usage of 12.5 hours/week/terminal, with terminal #3 in "fulltime" use 37.5 hours per week.

With a higher percentage of terminal time in use, it might be expected that breakdowns would increase and system availability would decrease.

A further analysis of the usage logged revealed the following: The log was apparently maintained very carefully. Very few data were lost due to incomplete records, etc. Session length varied by usage type. HAWK students use varied from 1 hour to 2-3/4 hours with the two modes at 1 hour to 2-3/4 hours. TFTS students typically had brief sessions: 5-15 minutes was not uncommonly short and 20-40 minutes typical. Only a few students spent long blocks of time (2-6 hours) at the terminal. Author usage tended to be at least an hour in length, but 6-8 hours was not uncommon. Off-hours use was most typically author usage. Since so few failures were recorded, off-hours use was not separately analyzed.

Cost Extrapolation and Analysis

For TFTS and HAWK, the costs were figured similarly. Most cost items were based on quotes from current GSA rates combined with estimates about the time and resources needed for software maintenance to keep training materials up-to-date. For each course, the minimum configuration possible was costed. Thus, such items as on-line PLATO services (connection to a large time-sharing system), printers, etc., were eliminated. Originally for TFTS, it was estimated that six (6) stand-alone micro-PLATO terminals would be needed for a class of 12 students. During implementation it was found that four (4) terminals were sufficient. The HAWK course has used a single terminal throughout the test period. Costs were calculated based on 1982 constant dollars; that is, 1982 costs were extended for the estimated

10 years of life of hardware and software with the assumption that maintenance costs would rise at the same rate as inflation. Thus no inflation rate nor time-value of dollars have been explicitly included in the calculation. The one cost that could not be determined exactly is the 1982 cost of a micro-PLATO terminal on a GSA schedule. The manufacturer has a different model than used in this test (equivalent, but newer) on the GSA schedule at $6,780. The manufacturer has the exact model used in this test available, only at retail, for $7,450. In our calculations, the $6,780 figure was used. For TFTS the calculation for minimum cost is:

First Year	
Four (4) Terminals x $6,780	$ 27,120
Maintenance for four (4) Terminals at $81/Terminal/Month (3 months free maintenance with purchase) 4 x 9 x $81	2,916
20 Hours Software Maintenance x $31.50/hr.	630
Disk space rental $4/Month/Space x 12 x 70 spaces	3,360
Remastering Disks and Copying	136
Total	$ 34,162

Second through Tenth Year	
Maintenance for four (4) Terminals at $81/Terminal/Month	$ 3,888
20 Hours Software Maintenance x $31.50/hr.	630
Disk Space Rental $4/Month/Space x 12 x 70	3,360
Remastering Disks and Copying	136
Total	$ 8,014
x Nine (9) Years	72,124
10 Year Grand Total	$106,288

The costs for a terminal for the HAWK course are one-fourth those for TFTS, or $26,572. The incremental cost for additional terminals (should, for example, the student flow rate in the TFTS course increase so much that more computer terminals were needed) is $16,597 per terminal over the 10 years for either HAWK or TFTS.

Developmental costs were not addressed by the test and evaluation plan, but some data gathered as part of the evaluation paint a broad picture of these costs. The vendor, CDC, was paid $93,845 to develop the purchase of HAWK and TFTS materials. Not included in that amount were hardware and computer time used by CDC and MMCS staff in development. No estimates of the staff time or other resources used at the MMCS were made.

Important cost questions which cannot be explicitly answered are, "Can a PLATO microcomputer that costs under $10,000 each replace, for training purposes, TFTS components which cost over $100,000 each," and, "Can use of

PLATO simulation reduce equipment damage?" Although these questions cannot be answered, information addressing these issues was gathered as part of this evaluation. For training a class of 12 students, three TFTS units are needed. Purchase price for these three units is estimated at $345,000 - $400,000. Procurement of these units is slow and difficult compared to procurement of PLATO microcomputers. Because spare parts for the TFTS units are difficult to obtain, downtimes tend to be long (especially compared to that of PLATO simulators). During the time Battelle visited MMCS to collect data, one TFTS unit was down.

One of the instructor questions asked if damage to equipment changed as a result to PLATO simulation usage. The analysis showed that the two TFTS instructors who responded both felt that PLATO simulations greatly decreased damage whereas 3 of 4 HAWK instructors noted little or no difference and one felt damage had increased.

Interviews revealed no indications that significant changes had occurred to the number of safety violations nor was any equipment apparently damaged via student error. Lack of equipment damage is a positive finding, but not conclusive since there was no control group and equipment damage is not a frequent event.

CONCLUSIONS AND FINDINGS

The conclusions and findings differ sharply between the two courses in which PLATO simulations were implemented. Considering that the training materials for both courses were developed by the same team of people, the difference is even more dramatic. It is dangerous to make statements that are broad, based on data collected from so few instructors (3 TFTS, 4 HAWK), but a few observations seem warranted based on the high degree of consensus found within each of the two sets of instructor data. Without exception, the instructor and student data within a course supported each other. With few exceptions, the data from one course contradicted the data from the other course. In general, the instructor data (admittedly few in number) tended to represent a more extreme view than did student data. It would be too strong to say that this showed students were mirroring instructor attitudes; on the other hand, some research studies have indicated that students are strongly cued by instructor attitudes.

The basis for the instructor and student attitudes, whatever their source, seems rooted in two factors: (a) the original purpose for introducing PLATO simulators and (b) size of the implementation. In the TFTS, there was a considerable need for some technique or technology to solve the problem of a shortfall of equipment. Other alternatives than PLATO may have been as welcome and effective if they addressed this problem. For the TFTS course a considerable number of hours of PLATO instruction are available (about 12). Therefore the time "invested" to figure out how to run this new device could be "amortized" over a considerable "payback" period.

For the HAWK course the above two factors were reversed. The HAWK course was working fine as it stood. Plenty of equipment was available. Instead of implementing PLATO as part of a new course (as in TFTS), implementing PLATO in the HAWK course meant discarding some existing training so that PLATO could be substituted. The best PLATO could do in the HAWK course was a little better since the current instruction was at least adequate. If PLATO did nothing at all or functioned in the mediocre way that the first draft of instruction materials often do, it would be worse than the previous situation. In TFTS, the best PLATO could do would be to "save the day" with respect to delivering the course while suffering an equipment shortage. If it did nothing, it wouldn't be much more than a blind alley to be abandoned in a search for an equipment shortage solution.

With those constraints understood, the TFTS results are that the PLATO simulations were effective, efficient, accepted by students and instructors, reliable, and potentially cost-effective. The HAWK results are that the PLATO simulations are equally effective (test results) or less effective (subjective results), of questionable efficiency, unacceptable to students and instructors, reliable, and less likely cost-effective. The lower potential for cost-effectiveness is because the large number of terminals needed to quickly serve a class would sit unused for long periods.

APPENDIX A

DESCRIPTION OF EVALUATION VARIABLES

TABLES 1 THROUGH 9

TABLE 1. TRAINING EFFECTIVENESS VARIABLES - TOW COURSE

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Skill level at end of training	2.1 Course grade	3.1 PLATO should support an overall "acceptable" level of achievement	4.1 Course Records
1.2 Perceived amount of learning using PLATO versus using actual equipment	2.2 Subjective question on amount of learning, 5-point scale	3.2 Amount of learning using PLATO should be as great as using real equipment, instructional objective	4.2 Student End-Of-Course Evaluation Instructor End-Of-Course Evaluation
1.3 Perceived speed of learning using PLATO versus using actual equipment	2.3 Subjective question on speed of learning, 5-point scale	3.3 Learning using PLATO should be as fast as using real equipment, instructional objective	4.3 Student End-Of-Course Evaluation
1.4 Perceived fidelity of simulation	2.4 Subjective question on simulation fidelity and confusion, 5-point scale	3.4 Departures from perfect fidelity should not confuse the student	4.4 Student End-Of-Course Evaluation
1.5 Perceived application of training to job performance using PLATO versus using actual equipment	2.5 Subjective question on application of training to job performance, 5-point scale	3.5 Learning using PLATO should be as applicable to job as using real equipment, instructional objective	4.5 Student End-Of-Course Evaluation Instructor End-Of-Course Evaluation

TABLE 1. TRAINING EFFECTIVENESS VARIABLES - TOW COURSE (Continued)

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.6 Perceived extent of student confidence using PLATO versus using actual equipment	2.6 Subjective question on student confidence, 5-point scale	3.6 PLATO simulation should enhance student confidence with real equipment, instructional objective	4.6 Student End-Of-Course Evaluation Instructor End-Of-Course Evaluation
1.7 Perceived extent of student overconfidence using PLATO versus using actual equipment	2.7 Subjective question on student overconfidence, 5-point scale	3.7 PLATO simulation should not result in overconfidence with respect to real equipment, instructional objective	4.7 Instructor End-Of-Course Evaluation
1.8 Perceived use of TM's with PLATO versus with actual equipment	2.8 Subjective question on use of TM's, 5-point scale	3.8 PLATO simulation should encourage use of TM's, instructional objective	4.8 Instructor End-Of-Course Evaluation
1.9 Perceived holding of student attention using PLATO versus using actual equipment	2.9 Subjective question on holding student attention, 5-point scale	3.9 PLATO simulation should hold student attention as well as actual equipment, instructional objective	4.9 Student End-Of-Course Evaluation Instructor End-Of-Course Evaluation

TABLE 2a. TRAINING EFFECTIVENESS VARIABLES - HAWK COURSE

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Skill level on test lesson	2.1 P.E. test, and written test subscore on test lesson	3.1 Measures level of achievement on test lesson	4.1 Derived from course records
1.2 Perceived amount of learning using PLATO versus using actual equipment	2.2 Subjective question on amount of learning, 5-point scale	3.2 Amount of learning using PLATO should be as great as using real equipment, instructional objective	4.2 Student End-Of-Course Evaluation Instructor End-Of-Course Evaluation
1.3 Perceived speed of learning using PLATO versus using actual equipment	2.3 Subjective question on speed of learning, 5 point scale	3.3 Learning using PLATO should be as fast as using real equipment, instructional objective	4.3 Student End-Of-Course Evaluation
1.4 Perceived fidelity of simulation	2.4 Subjective question on simulation fidelity and confusion, 5-point scale	3.4 Departures from perfect fidelity should not confuse the student	4.4 Student End-Of-Course Evaluation
1.5 Perceived application of training to job performance using PLATO versus using actual equipment	2.5 Subjective question on application of training to job performance, 5-point scale	3.5 Learning using PLATO should be as applicable to job as using real equipment, instructional objective	4.5 Student End-Of-Course Evaluation Instructor End-Of-Course Evaluation

TABLE 2a. TRAINING EFFECTIVENESS VARIABLES - HAWK COURSE (Continued)

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.6 Perceived extent of student confidence using PLATO versus using actual equipment	2.6 Subjective question on student confidence, 5-point scale	3.6 PLATO simulation should enhance student confidence with real equipment, instructional objective	4.6 Instructor End-Of-Course Evaluation
1.7 Perceived extent of student overconfidence using PLATO versus using actual equipment	2.7 Subjective question on student overconfidence, 5-point scale	3.7 PLATO simulation should not result in overconfidence with respect to real equipment, instructional objective	4.7 Instructor End-Of-Course Evaluation
1.8 Perceived encouragement for use of TM's with PLATO versus with actual equipment	2.8 Subjective question on encouraging use of TM's, 5-point scale	3.8 PLATO simulation use of TM's, instructional objective	4.8 Instructor End-Of-Course Evaluation
1.9 Perceived holding of student attention using PLATO versus using actual equipment	2.9 Subjective question on holding student attention, 5-point scale	3.9 PLATO simulation should hold student attention as well as actual equipment, instructional objective	4.9 Instructor End-Of-Course Evaluation

TABLE 2b. CONTROL VARIABLES - HAWK COURSE

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Skill level before test lesson	2.1 Written test score on common subjects portion of course	3.1 Provides reliable, current measure of aptitude	4.1 Course Records
1.2 Speed of learning	2.2 Hours spent on common subjects portion of course	3.2 Provides reliable, current measure of aptitude	4.2 Course Records
1.3 Amount of PLATO use	2.3 Hours spent on PLATO Subjective question on amount of time spent (above average, average, below average) compared with other students in class	3.3 Amount of PLATO usage could vary in HAWK test lesson, and could affect achievement and subjective judgments	4.3 PLATO Use Log Student End-Of-Course Evaluation

TABLE 3. TRAINING EFFICIENCY VARIABLES - TOW AND HAWK COURSES

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Number trained per hardware item	2.1 Number of graduates divided by the number of end items in laboratory	3.1 PLATO simulation is intended to reduce the number of equipment end items needed for training (TOW) or supplement use of actual equipment (HAWK)	4.1 Course Records
1.2 Use of instructor's time during P.E.	2.2 Subjective question on availability of time to assist students, 5-point scale	3.2 PLATO should reduce time spent setting-up and monitoring use of equipment	4.2 Instructor End-Of-Course Evaluation
1.3 Use of student's time during P.E.	2.3 Subjective question on use of time during P.E., 5-point scale	3.3 PLATO should reduce time spent waiting for other students to finish or for down equipment	4.3 Student End-Of-Course Evaluation Instructor End-Of-Course Evaluation
1.4 Estimated time to complete tasks using PLATO versus using actual equipment	2.4 Difference between the ratios of fastest student time to slowest student time using PLATO and using real equipment	3.4 Performance of tasks using PLATO simulation should not be slower than performance using actual hardware	4.4 Instructor End-Of-Course Evaluation

TABLE 3. TRAINING EFFICIENCY VARIABLES - TOW AND HAWK COURSES (Continued)

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.5 Salvaged time	2.5 Number of hours of extra training provided per student due to use of PLATO	3.5 Semi-productive time should be upgraded due to availability of PLATO	4.5 PLATO Use Log and Course Records

TABLE 4. STUDENT ACCEPTANCE VARIABLES - TOW AND HAWK COURSES

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Likes and dislikes about PLATO training	2.1 Open-ended question	3.1 Allows unanticipated attitudes and problems to be expressed	4.1 Student End-Of-Course Evaluation
1.2 Willingness to use PLATO in other P.E. lessons	2.2 Subjective question, 5-point scale	3.2 If PLATO training is accepted, students should be willing to use it in other P.E. lessons	4.2 Student End-Of-Course Evaluation
1.3 Willingness to take other similar courses involving PLATO	2.3 Subjective question, 5 alternatives	3.3 If PLATO training is accepted, students should be willing to take other courses involving PLATO	4.3 Student End-Of-Course Evaluation

TABLE 5. INSTRUCTOR AND SCHOOL STAFF ACCEPTANCE VARIABLES - TOW AND HAWK COURSES

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Advantages and disadvantages with PLATO training	2.1 Open-ended question	3.1 Allows unanticipated attitudes and problems to be expressed	4.1 Instructor End-Of-Course Evaluation
1.2 Willingness to expand PLATO lessons in current course	2.2 Subjective question, 5-point scale	3.2 If PLATO training is accepted, instructors should be willing to use it in other P.E. lessons	4.2 Instructor End-Of-Course Evaluation
1.3 Willingness to teach other courses using PLATO simulation	2.3 Subjective question, 5-point scale	3.3 If PLATO training is accepted, instructors should be willing to teach other courses involving PLATO	4.3 Instructor End-Of-Course Evaluation
1.4 Perceived changes in role of instructor	2.4 Open-ended question	3.4 Allows unanticipated attitudes and problems to be expressed	4.4 Instructor End-Of-Course Evaluation
1.5 Perceived changes in conduct of training	2.5 Open-ended question	3.5 Allows unanticipated attitudes and problems to be expressed	4.5 Instructor End-Of-Course Evaluation

TABLE 6. QUALITY OF IMPLEMENTATION VARIABLES - TOW AND HAWK COURSES

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Occurrence of implementation problems	2.1 Frequency of seven generic implementation problems, 4 alternatives	3.1 Quality of simulation is a necessary prerequisite to other evaluations. Frequency of generic problems is indicative of implementation quality	4.1 Questionnaire given to students at end of each module involving PLATO
1.2 Ability of students to work without instructor involvement	2.2 Subjective question on amount of instructor assistance required, 5-point scale	3.2 Frequent instructor involvement is indicative of poor quality	4.2 Instructor End-Of-Course Evaluation

TABLE 7. GENERALIZABILITY VARIABLES - TOW AND HAWK COURSES

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Generalization to other P.E. lessons	2.1 Subjective question on generalizability to other P.E. lessons, 5-point scale	3.1 PLATO simulation should be generalizable to other lessons	4.1 Instructor End-Of-Course Evaluation
1.2 Generalization to other equipment	2.2 Subjective question on generalizability to other equipment, 4 alternatives	3.2 PLATO simulation should be generalizable to other equipment	4.2 Instructor End-Of-Course Evaluation

TABLE 8. SYSTEM RELIABILITY VARIABLES - TOW AND HAWK COURSES

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Frequency and type of malfunction	2.1 Mean time between failure, Mean time between problem, Malfunction profile	3.1 Logged data will allow failures versus problems and types of malfunctions to be sorted. These are commonly quoted measures	4.1 Problem And Maintenance Log
1.2 Time to repair	3.1 Mean time to repair	3.2 A useful measure for estimating the impact of a failure	4.2 Problem And Maintenance Log
1.3 PLATO system availability	2.3 Percent of training time system is available	3.3 A measure needed to estimate number of terminals needed	3.4 Derived From Problem and Maintenance Log
1.4 Amount of use	2.4 Weekly use per terminal	3.4 Amount of maintenance and occasions to log problems are proportion to use	4.4 PLATO Use Log
1.5 Purpose of use	2.5 Use profile	3.5 Type of use affects types of problems noticed	4.5 PLATO Use Log
1.6 Perceived reliability	2.6 Subjective question on reliability of PLATO versus other media, 5-point scale	3.6 Reflects confidence in reliability of PLATO versus other media	4.6 Student End-Of-Course Evaluation Instructor End-Of-Course Evaluation

TABLE 9. COST EXTRAPOLATION VARIABLES - TOW AND HAWK COURSES

1.0 Variable	2.0 Metric	3.0 Rationale	4.0 Data Source
1.1 Minimum configuration cost	2.1 1981 dollars per year for a 10-year life	3.1/3.2 To provide cost data in a format which allows maximum flexibility in interpretation, a minimum configuration for each course and an incremental cost for expansion will be costed	4.1 CDC Sales Representative
1.2 Incremental cost	2.2 1981 dollars per year for a 10-year life		4.2 CDC Sales Representative
1.3 Perceived equipment damage	2.3 Subjective question on extent of damage to actual equipment when using PLATO simulation, 5-point scale	3.3 Use of PLATO should reduce damage to actual equipment	4.3 Instructor End-Of-Course Evaluation
1.4 Cost comparison of real and simulated equipment	2.4 Acquisition time and cost	3.4 To show advantages as an equipment extender, PLATO should be much faster and cheaper	4.4 School Staff

APPENDIX B

TFTS STUDENT EVALUATION FORMS AND RAW DATA

END-OF-WEEK EVALUATION

END-OF-COURSE EVALUATION

STUDENT
END-OF-WEEK EVALUATION

You have just completed course modules using PLATO. Please fill in this form as best you can, so that we can improve the modules. Your answers should only apply to this week's study.

Course Name: TFTS

Today's Date: ______ day ______ month ______ year

1. Which week of this course have you just completed? ______

Please answer the questions below. If you found any of the problems, show how often the problem came up in your use of PLATO during the week. Remember, your answers should only be for the week you have just completed.

2. Were you ever unsure of what to do next on PLATO (for example, touch the screen, hit a key, or wait for PLATO)? No 24 Yes 11

   If yes, how often did this happen?

   Once 5 Two or three times 3 Four or more times 4

3. Were you ever sure you gave the right answer, but PLATO said you were wrong? No 24 Yes 10

   If yes, how often did this happen?

   Once 5 Two or three times 5 Four or more times 5

4. Did PLATO ever do something that surprised you (for example, you hit BACK, but PLATO went forward)? No 28 Yes 7

   If yes, how often did this happen?

   Once 1 Two or three times 3 Four or more times 1

5. Did you ever hit a key or touch the panel, and nothing happened? No 18 Yes 17

   If yes, how often did this happen?

   Once 3 Two or three times 12 Four or more times ___

6. Was it ever hard to study or practice a test on PLATO because you couldn't get to it, or because you had to go through too many other steps to get to the part you wanted? No 30 Yes 4

If yes, how often did this happen?

Once 1 Two or three times___ Four or more times___

7. Did you ever have to ask your instructor for help because PLATO was not correct or was incomplete? No 22 Yes 13

If yes, how often did this happen?

Once 3 Two or three times 5 Four or more times 1

8. Were you ever confused because the drawings on PLATO looked or worked different from the real equipment? No___ Yes___

If yes, how often did this happen?

Once 2 Two or three times 6 Four or more times 4

STUDENT
END-OF-COURSE EVALUATION

Please complete this form to the best of your ability so that this course can be fully and fairly evaluated.

Course Name: TFTS ______________________________

Today's Date: __________ day __________ month __________ year

1. What did you like about the PLATO part of the course? ______________________________

____

____

____

____

2. What did you dislike about the PLATO part of the course? ______________________________

____

____

____

____

3. On a scale of 1 to 10 (with 10 being the highest score), how useful do you think the PLATO simulations were?

   Circle a number: 1 2 3 4 5 6[2] 7[1] 8[11] 9[7] 10[13]

4. Did the training on PLATO ever confuse you because the real equipment looked or worked differently than the PLATO simulations?

   __22__ 1) No, it never did

   __12__ 2) Yes, occassionally

   _____ 3) Yes, often

5. When you used PLATO, how much do you think you learned compared with using the real equipment?

____2 1) Learned much more using PLATO

____8 2) Learned more using PLATO

____16 3) Learned about the same amount using PLATO

____7 4) Learned less using PLATO

____1 5) Learned much less using PLATO

6. When you used PLATO, how fast do you think you learned compared with using the real equipment?

____5 1) Learned much faster using PLATO

____17 2) Learned faster using PLATO

____7 3) Learned in about the same time using PLATO

____4 4) Learned slower using PLATO

____ 5) Learned much slower using PLATO

7. When you used PLATO, how did it affect the use of your time during P.E.'s?

____10 1) Made much better use of my time

____19 2) Made better use of my time

____4 3) Made little or no difference in use of my time

____1 4) Made worse use of my time

____ 5) Made much worse use of my time

8. How did use of PLATO influence your confidence about operating the real equipment?

____10 1) Greatly increased my confidence

____13 2) Increased my confidence

____5 3) Did not change my confidence

____ 4) Decreased my confidence

____ 5) Greatly decreased my confidence

9. How interested were you in going through the PLATO lessons?

____19 1) Very interested while using PLATO

____13 2) Interested while using PLATO

____ 3) Not interested while using PLATO

____2 4) Bored while using PLATO

____ 5) Very bored while using PLATO

10. How much of what you learned using PLATO could be applied on the job?

- 17 1) Almost all of what I learned
- 12 2) Most of what I learned
- 5 3) Some of what I learned
- ___ 4) Little of what I learned
- ___ 5) None of what I learned

11. For training purposes, how adequately did the PLATO simulations work like the real equipment?

- 14 1) Very Adequate for training
- 14 2) Reasonably adequate for training
- 5 3) Borderline for training
- 1 4) Somewhat inadequate for training
- ___ 5) Very inadequate for training

12. How much do you think you could have learned about the operation of the real equipment using only PLATO?

- 6 1) Almost everytning
- 18 2) A great deal
- 9 3) Some
- 1 4) A little
- ___ 5) Almost nothing at all

13. Compared with other training equipment you have used (slide projector, video cassettes, Beseler Cue/See), PLATO's reliability was:

- 22 1) Much better than other training equipment
- 12 2) Better than other training equipment
- ___ 3) About the same as other training equipment
- ___ 4) Worse than other training equipment
- ___ 5) Much worse than other training equipment

14. Would you like to use PLATO for other hands-on training?

- 24 1) Would very much like to use PLATO
- 3 2) Would like to use PLATO
- 5 3) Undecided
- 1 4) Would not like to use PLATO
- ___ 5) Would very much not like to use PLATO

15. How would you advise a friend who had a choice between taking a course where there was a great deal of PLATO simulations or another course that covered the same material but without PLATO?

__15__ 1) Fight tooth and nail to get into the PLATO course

__17__ 2) Request PLATO course, if convenient

__2__ 3) Neither request nor avoid course

__1__ 4) Avoid PLATO course, if possible

_____ 5) Avoid PLATO course like the plague

16. How much time did you spend on PLATO compared with other students in your class?

__4__ 1) More time on PLATO than others

__28__ 2) About the same amount of time on PLATO as others

__2__ 3) Less time on PLATO than others

APPENDIX C

TFTS INSTRUCTOR EVALUATION FORMS AND RAW DATA

PLATO INSTRUCTOR/STAFF QUESTIONNAIRE

Please complete this form to the best of your ability so that this course can be fully and fairly evaluated.

Course Name: TFTS ____________________

Today's Date: ________ day ________ month ________ year

1. Please check the item which best describes your role in this course.
   - _3_ 1) Regular instructor (Answer all questions.)
   - ___ 2) School staff (Stop after Question 5.)
     Specify position: ____________________

2. What do you feel are the instructional advantages of using PLATO in this particular course? ____________________

3. What do you feel are the instructional disadvantages of using PLATO in this particular course? ____________________

4. What changes in training practices occurred in this particular course because of the use of PLATO? ____________________

5. If the use of PLATO became more widespread (more lessons in this course and/or more courses), how would your role be changed? ____________

____

____

____

____

In Questions 6 through 17, compare practical exercises using PLATO with practical exercises using only real equipment. For each question, please check the one box which best describes your opinion about the impact of PLATO simulations in this course.

	How did use of PLATO in practical exercises affect:	Greatly Increased	Increased	Little or No Change	Decreased	Greatly Decreased
6.	Student learning during P.E.	2	1			
7.	Instructor's confidence and feeling of usefulness during P.E.	2	1			
8.	Student attention during P.E.	3				
9.	Student confidence when dealing with real equipment.	1	2			
10.	Use of TM's.	2	1			
11.	Instructor's workload during P.E.			1	2	
12.	Application of learning to job performance. ...	1	2			
13.	Damage to equipment items used for training....					2
14.	Student overconfidence when dealing with real equipment.				2	1
15.	Efficient use of student's time during P.E. ...	1	2			

How did use of PLATO in practical exercises affect: (Continued)	Greatly Increased	Increased	Little or No Change	Decreased	Greatly Decreased
16. Instructor availability to assist students during P.E.	1	2			
17. Learning of relationships among system components and tests.	3				

Please check the one response which best describes your opinion.

18. I would like to see PLATO simulations used in other P.E. lessons in this course.

__3__ 1) Strongly agree

_____ 2) Agree

_____ 3) Undecided

_____ 4) Disagree

_____ 5) Strongly disagree

19. I would like to see PLATO simulations used in other courses at the school.

__3__ 1) Strongly agree

_____ 2) Agree

_____ 3) Undecided

_____ 4) Disagree

_____ 5) Strongly disagree

20. Compared with other training equipment I have used (35-mm projectors, video cassettes, Beseler Cue/See), PLATO's reliability is:

__3__ 1) Much better than other training equipment

_____ 2) Better than other training equipment

_____ 3) About the same as other training equipment

_____ 4) Worse than other training equipment

_____ 5) Much worse than other training equipment

21. In your opinion, how widespread is the applicability of PLATO simulations for use in other P.E. lessons in this course?

___3___ 1) PLATO is applicable to all other P.E. lessons

______ 2) PLATO is applicable to most other P.E. lessons

______ 3) PLATO is applicable to a limited number of other P.E. lessons

______ 4) PLATO is not applicable to any other P.E. lessons

______ 5) PLATO should not have been used in the P.E. lessons where it was used

22. In some courses there is limited availability of equipment for training purposes. In your opinion, how widespread is the applicability of PLATO simulations for teaching the operation or maintenance of equipment like that taught at MMCS?

___2___ 1) The teaching of almost all equipment items would benefit by being supplemented by PLATO simulations

______ 2) The teaching of most equipment items would benefit by being supplemented by PLATO simulations

______ 3) A limited number of equipment items would benefit by being supplemented by PLATO simulations, but most would not benefit

______ 4) Current computer simulation technology is too limited to be of practical benefit for equipment training purposes

23. If I had the choice of teaching another course where there was major use of PLATO simulations like those written for this course, I would:

___1___ 1) Fight tooth and nail to be assigned as the instructor

___1___ 2) Request assignment, if convenient

___1___ 3) Neither request nor avoid assignment

______ 4) Avoid assignment, if possible

______ 5) Avoid assignment like the plague

24. Once students became familiar with PLATO, how much instructional assistance did a typical student require when learning a new task using PLATO compared with using real equipment?

______ 1) Much more assistance needed when using PLATO

______ 2) More assistance needed when using PLATO

______ 3) About the same amount of assistance needed using PLATO or using real equipment

___2___ 4) Less assistance needed when using PLATO

___1___ 5) Much less assistance needed when using PLATO

In Questions 25 through 28, consider the Controller DVM alignment test on the TFTS, which can be trained using real equipment or a PLATO simulation.

25. How fast could your fastest student perform this task on the real equipment? *0.5 and 0.6* hours

26. How fast could your slowest student perform this task on the real equipment? *1.5 and 1.5* hours

27. How fast could your fastest student perform this task on PLATO? *0.5 and 0.5* hours

28. How fast could your slowest student perform this task on PLATO? *1.0 and 1.0* hours

APPENDIX D

HAWK STUDENT EVALUATION FORMS AND RAW DATA

END-OF-WEEK EVALUATION

END-OF-COURSE EVALUATION

Please tell us how often you had any of the problems listed below. Check one box opposite each item to show how often the problem came up in your use of PLATO during the week. Remember, your answers should only be for the week you have just completed.

	Never	Once	More Than Once
2. How often were you unsure of what to do next (for example, touch the screen, hit a key, or wait for PLATO)?	4	14	14
3. How often were you sure you gave the right answer, but PLATO said you were wrong?	7	5	20
4. How often did PLATO do something that surprised you (for example, you hit BACK, but went forward)?	25	6	0
5. How often did you hit a key or touch the panel, and nothing happened?	14	3	15
6. How often was it hard to study or practice a particular subject because you couldn't get to it, or because you had to go through too many other steps to get to the part you wanted?	24	6	2
7. How often did you have to ask your instructor for help because PLATO was not correct or was incomplete?	8	9	15
8. How often were you confused because PLATO looked or worked different from the real equipment?	23	4	5

STUDENT
END-OF-COURSE EVALUATION

Please complete this form to the best of your ability so that this course can be fully and fairly evaluated.

Course Name: HAWK CW RADAR

Today's Date: ________ day ________ month ________ year

1. What did you like about the PLATO part of the course? ________

2. What did you dislike about the PLATO part of the course? ________

3. On a scale of 1 to 10 (with 10 being the highest score), how useful do you think the PLATO simulations were?

   Circle a number: 1 [2] 2 3 [5] 4 [2] 5 [5] 6 [6] 7 [1] 8 [2] 9 [5] 10 [1]

4. Did the training on PLATO ever confuse you because the real equipment looked or worked differently than the PLATO simulations?

   12 1) No, it never did

   13 2) Yes, occassionally

   4 3) Yes, often

5. When you used PLATO, how much do you think you learned compared with using the real equipment?

_____ 1) Learned <u>much</u> <u>more</u> using PLATO

__4__ 2) Learned <u>more</u> using PLATO

__4__ 3) Learned <u>about</u> <u>the</u> <u>same</u> <u>amount</u> using PLATO

__17__ 4) Learned <u>less</u> using PLATO

__5__ 5) Learned <u>much</u> <u>less</u> using PLATO

6. When you used PLATO, how fast do you think you learned compared with using the real equipment?

_____ 1) Learned <u>much</u> <u>faster</u> using PLATO

__5__ 2) Learned <u>faster</u> using PLATO

__8__ 3) Learned in <u>about</u> <u>the</u> <u>same</u> <u>time</u> using PLATO

__9__ 4) Learned <u>slower</u> using PLATO

__8__ 5) Learned <u>much</u> <u>slower</u> using PLATO

7. When you used PLATO, how did it affect the use of your time during P.E.'s?

__2__ 1) Made <u>much</u> <u>better</u> use of my time

__6__ 2) Made <u>better</u> use of my time

__16__ 3) Made <u>little</u> <u>or</u> <u>no</u> <u>difference</u> in use of my time

__5__ 4) Made <u>worse</u> use of my time

__1__ 5) Made <u>much</u> <u>worse</u> use of my time

8. How did use of PLATO influence your confidence about operating the real equipment?

_____ 1) <u>Greatly</u> <u>increased</u> my confidence

__5__ 2) <u>Increased</u> my confidence

__19__ 3) <u>Did</u> <u>not</u> <u>change</u> my confidence

__7__ 4) <u>Decreased</u> my confidence

_____ 5) <u>Greatly</u> <u>decreased</u> my confidence

9. How interested were you in going through the PLATO lessons?

__10__ 1) <u>Very</u> <u>interested</u> while using PLATO

__15__ 2) <u>Interested</u> while using PLATO

__4__ 3) <u>Not</u> <u>interested</u> while using PLATO

__1__ 4) <u>Bored</u> while using PLATO

_____ 5) <u>Very</u> <u>bored</u> while using PLATO

10. How much of what you learned using PLATO could be applied on the job?

_____ 1) Almost all of what I learned

__4__ 2) Most of what I learned

__15__ 3) Some of what I learned

__5__ 4) Little of what I learned

__5__ 5) None of what I learned

11. For training purposes, how adequately did the PLATO simulations work like the real equipment?

__1__ 1) Very Adequate for training

__12__ 2) Reasonably adequate for training

__8__ 3) Borderline for training

__6__ 4) Somewhat inadequate for training

__3__ 5) Very inadequate for training

12. How much do you think you could have learned about the operation of the real equipment using only PLATO?

__2__ 1) Almost everything

__5__ 2) A great deal

__5__ 3) Some

__15__ 4) A little

__3__ 5) Almost nothing at all

13. Compared with other training equipment you have used (slide projector, video cassettes, Beseler Cue/See), PLATO's reliability was:

__7__ 1) Much better than other training equipment

__10__ 2) Better than other training equipment

__12__ 3) About the same as other training equipment

__1__ 4) Worse than other training equipment

_____ 5) Much worse than other training equipment

14. Would you like to use PLATO for other hands-on training?

__4__ 1) Would very much like to use PLATO

__6__ 2) Would like to use PLATO

__8__ 3) Undecided

__10__ 4) Would not like to use PLATO

__2__ 5) Would very much not like to use PLATO

15. How would you advise a friend who had a choice between taking a course where there was a great deal of PLATO simulations or another course that covered the same material but without PLATO?

 1 1) Fight tooth and nail to get into the PLATO course

 8 2) Request PLATO course, if convenient

 11 3) Neither request nor avoid course

 10 4) Avoid PLATO course, if possible

 1 5) Avoid PLATO course like the plague

16. How much time did you spend on PLATO compared with other students in your class?

 1 1) More time on PLATO than others

 25 2) About the same amount of time on PLATO as others

 4 3) Less time on PLATO than others

APPENDIX E

HAWK INSTRUCTOR EVALUATION FORMS AND RAW DATA

PLATO INSTRUCTOR/STAFF QUESTIONNAIRE

Please complete this form to the best of your ability so that this course can be fully and fairly evaluated.

Course Name: HAWK

Today's Date: ______ day ______ month ______ year

1. Please check the item which best describes your role in this course.

   __✓__ 1) Regular instructor (Answer all questions.)

   _____ 2) School staff (Stop after Question 5.)

   Specify position: ______________________

2. What do you feel are the instructional <u>advantages</u> of using PLATO in this particular course? ______________________

3. What do you feel are the instructional <u>disadvantages</u> of using PLATO in this particular course? ______________________

4. What changes in training practices occurred in this particular course because of the use of PLATO? ______________________

5. If the use of PLATO became more widespread (more lessons in this course and/or more courses), how would your role be changed? ______________

____

____

____

____

In Questions 6 through 17, compare practical exercises using PLATO with practical exercises using only real equipment. For each question, please check the one box which best describes your opinion about the impact of PLATO simulations in this course.

How did use of PLATO in practical exercises affect:	Greatly Increased	Increased	Little or No Change	Decreased	Greatly Decreased
6. Student learning during P.E.			4		
7. Instructor's confidence and feeling of usefulness during P.E.			2	2	
8. Student attention during P.E.			3	1	
9. Student confidence when dealing with real equipment.				3	1
10. Use of TM's.			3		1
11. Instructor's workload during P.E.		4			
12. Application of learning to job performance. ...			3	1	
13. Damage to equipment items used for training....		1	3		
14. Student overconfidence when dealing with real equipment.		1		3	
15. Efficient use of student's time during P.E. ...				3	1

How did use of PLATO in practical exercises affect: (Continued)	Greatly Increased	Increased	Little or No Change	Decreased	Greatly Decreased
16. Instructor availability to assist students during P.E.		1		3	
17. Learning of relationships among system components and tests.			3		1

Please check the one response which best describes your opinion.

18. I would like to see PLATO simulations used in other P.E. lessons in this course.

    ____ 1) Strongly agree

    ____ 2) Agree

    ____ 3) Undecided

    __3__ 4) Disagree

    __1__ 5) Strongly disagree

19. I would like to see PLATO simulations used in other courses at the school.

    ____ 1) Strongly agree

    ____ 2) Agree

    __3__ 3) Undecided

    ____ 4) Disagree

    __1__ 5) Strongly disagree

20. Compared with other training equipment I have used (35-mm projectors, video cassettes, Beseler Cue/See), PLATO's reliability is:

    ____ 1) Much better than other training equipment

    __3__ 2) Better than other training equipment

    __1__ 3) About the same as other training equipment

    ____ 4) Worse than other training equipment

    ____ 5) Much worse than other training equipment

21. In your opinion, how widespread is the applicability of PLATO simulations for use in other P.E. lessons in this course?

_____ 1) PLATO is applicable to all other P.E. lessons

_____ 2) PLATO is applicable to most other P.E. lessons

_____ 3) PLATO is applicable to a limited number of other P.E. lessons

__3__ 4) PLATO is not applicable to any other P.E. lessons

__2__ 5) PLATO should not have been used in the P.E. lessons where it was used

22. In some courses there is limited availability of equipment for training purposes. In your opinion, how widespread is the applicability of PLATO simulations for teaching the operation or maintenance of equipment like that taught at MMCS?

_____ 1) The teaching of almost all equipment items would benefit by being supplemented by PLATO simulations

_____ 2) The teaching of most equipment items would benefit by being supplemented by PLATO simulations

__3__ 3) A limited number of equipment items would benefit by being supplemented by PLATO simulations, but most would not benefit

__1__ 4) Current computer simulation technology is too limited to be of practical benefit for equipment training purposes

23. If I had the choice of teaching another course where there was major use of PLATO simulations like those written for this course, I would:

_____ 1) Fight tooth and nail to be assigned as the instructor

_____ 2) Request assignment, if convenient

__2__ 3) Neither request nor avoid assignment

__2__ 4) Avoid assignment, if possible

_____ 5) Avoid assignment like the plague

24. Once students became familiar with PLATO, how much instructional assistance did a typical student require when learning a new task using PLATO compared with using real equipment?

_____ 1) Much more assistance needed when using PLATO

__3__ 2) More assistance needed when using PLATO

__1__ 3) About the same amount of assistance needed using PLATO or using real equipment

_____ 4) Less assistance needed when using PLATO

_____ 5) Much less assistance needed when using PLATO

In Questions 25 through 28, consider the Controller DVM alignment test on the TFTS, which can be trained using real equipment or a PLATO simulation.

25. How fast could your fastest student perform this task on the real equipment? ____N/A____ hours

26. How fast could your slowest student perform this task on the real equipment? ____N/A____ hours

27. How fast could your fastest student perform this task on PLATO? ____N/A____ hours

28. How fast could your slowest student perform this task on PLATO? ____N/A____ hours

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