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ABSTRACT

Trainees from Navy Basic Electricity/Electronics School were assigned to receive either computer-assisted instruction (CAI) or conventional individualized instruction in a segment of a course requiring use of a multimeter to measure resistance and current flow. The (CAI) group used PLATO IV plasma-screen terminals; individualized instruction lessons utilized the actual multimeters. CAI trainees required a longer training period, but there was no significant difference in performance between CAI and individualized instruction on student performance. The CAI students studied more and had a positive attitude about their training. It was determined that dynamic simulations of equipment on an interactive computer terminal offer a feasible alternative to special training equipment. (CH)

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USE OF AN INTERACTIVE GENERAL-PURPOSE COMPUTER TERMINAL TO SIMULATE TRAINING EQUIPMENT OPERATION

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FOREWORD

The research described herein was performed under Technical Development Plan 43-03 (Education and Training Development), Work Unit Number 43-03.03A, (Experimental Evaluation of PLATO IV Technology). This effort is part of an Advanced Research Projects Agency/Joint Services Training Technology Program which has as a principal focus the development of computer-based training technology for DoD-wide application. The cooperation and assistance of personnel at the Basic Electricity/Electronics School, Service School Command, Naval Training Center (NTC), San Diego, California are gratefully acknowledged. The efforts of LT R. E. Renfro, STCM S. Grimm, IC1 C. Braswell, EM1 C. Edwards, ICC H. L. Flaberg, IC1 R. F. Getz, ICC W. L. Green, IC1 W. D. Shiram, and EMC D. Williams were particularly important to the success of this research.

Mr. R. Padilla assisted with coding for portions of the lessons, and Ms. Betty Whitehill assisted during the student runs. Their contributions are also gratefully acknowledged.

J. J. CLARKIN
Commanding Officer

SUMMARY

Problem

Research projects have demonstrated that computer-aided instruction is an effective alternative to classroom instruction (Ford, Slough, & Hurlock, 1972). However, the majority of investigations have centered around concept oriented, cognitive skills. Very little research has been directed at the question of developing operational skills by having the computer terminal "stand in" for operational equipment which may be very expensive to buy or maintain, or may be susceptible to damage in the hands of trainees. If it could be demonstrated that the general-purpose computer terminal can be used successfully to simulate operation of such equipments, training costs can be appreciably reduced in a great many areas.

Purpose

This research was conducted to explore the technical feasibility of computer-based simulation of operational equipment as a training method.

Background

Most investigations have concentrated on presentation of cognitive lesson materials, with little thought given to using the terminal to develop operational skills. Feurzeig and Lukas (1971) and Rigney, Morrison, Williams, and Towne (1973) have shown that general-purpose computer terminals can be used successfully to precondition skills requiring time-related responses to simulated operational situations, but there is no evidence of using such terminals to "stand in" for operational equipments in training on operational procedures. This study and another reported elsewhere by Stern (1975) investigated this possibility.

Approach

Trainees from one learning center of the Basic Electricity/Electronics (BE/E) School were randomly assigned to receive either CAI or conventional individualized instruction for a segment of their course using a multimeter to measure resistance and current flow. Experimental students received instruction from two lessons presented at PLATO IV terminals. The lessons taught the use of the Simpson 260-1 multimeter as an ohmmeter and as a DC ammeter using graphic simulations of the multimeter response. All instruction was self-paced, with the computer-aided instruction using learner control of lesson strategy as the instructional paradigm. Results on laboratory tests and module examinations were used to compare the performance of experimental and control groups.

Findings and Conclusions

There was no significant difference in performance between control and experimental students in their module exams or performance tests. Experimental students spent more time studying than control students and were enthusiastic about their training. It was assumed that the longer training time could be explained by the novelty of the situation, the greater opportunity for practice, and time taken for indoctrination to the system. It was concluded that dynamic simulations of equipment on an interactive general-purpose computer terminal such as the PLATO IV offer a feasible alternative to developing or providing special training equipments.

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Although computer-based training is becoming more acceptable as a practical and useful educational medium, many questions related to the nature and extent of practical computer-based training programs must still be answered. Among these are questions about the kinds of materials appropriate for computer-assisted instruction and the degree of control to be exercised by students. These questions are currently being addressed by the Navy Personnel Research and Development Center (NAVPERSRANDCEN), San Diego, California as part of an Advanced Research Projects Agency/ Joint Services Training Technology Program which has as a principal focus the development of computer-based training technology for DoD-wide application. Of particular interest to the Navy is the possibility of using the computer during training as a substitute for expensive, easily damaged equipment which may be in short supply, or as an alternative device to equipment whose operation is hazardous for the trainee.

Purpose

This research was conducted to explore the technical feasibility of computer-based simulation of operational equipment as a training method.

Purchasing and maintaining special training devices and operational equipment for use in schools is an item of expense in the Navy's budget. Substitution of a programmable device like a computer terminal for even a small percentage of these training equipments could represent a large savings in operating costs. At the same time, it would make computer terminals available to schools for these functions and could accelerate the day when computer-based training plays a more important role in individualized naval training.

Background

Previous research projects have demonstrated that computer-aided instruction is an effective alternative to classroom instruction (Ford, Slough, & Hurlock, 1972). However the majority of investigations have centered around concept-oriented, cognitive skills. The need to expand the scope of CAI to techniques other than those utilized in training intellectual tasks has been pointed out by Feurzeig and Lukas (1971). Rigney, Bond, Mason, and Macaruso (1966) and Higget, Davis, and Rigney (1968) have mentioned the following advantages of using computer-based simulations for training:

1. The ability to illustrate processes that, if performed on real equipment, could cause damage.

2. The ability of the computer to automatically, and therefore more quickly, complete processes which would otherwise have to be done manually by the instructor.

3. The relative ease with which graphics may be developed and modified for computer simulations.

While the cost benefits and other advantages of such simulations are fairly obvious, the effectiveness of training performance-oriented skills in this manner, as opposed to hands-on experience with actual equipment, must be examined.

Recent studies have been positive with respect to transfer of training. For example, Feurzeig and Lukas (1971) used computer programs to train complex perceptual and motor tasks. Students were taught to "fly" a holding pattern in a simulated aircraft through instrument indicators. The programs simulated necessary displays and monitored and analyzed the student's learning difficulties while he was in the process of performing the task. Student responses were input through a teletype and/or "joy-stick" linked to the computer. The authors found positive transfer between the computer simulation and actual flight, and concluded that the feasibility of this kind of training had been demonstrated. In a second experiment, students were taught ship maneuvering and collision avoidance skills by simulating a PPI scope on the computer. These results were also positive.

In a novel implementation of computer graphics and concepts from cognitive and information processing psychology, Rigney, Morrison, Williams, and Towne (1973) developed an individual skills trainer designed around a programmable graphics terminal. This trainer gave radar intercept officers practice in procedures required during air intercepts. Experimental training results showed an improvement in performance of simulated air intercept procedures.

In 1974, Rigney, Towne, and King developed computer programs to evaluate the use of graphics in equipment simulations to serve as substitutes for physical devices and operations and to explicate invisible processes. The front panel topography and internal functional relationships of a piece of electronic equipment were simulated so that a student could study troubleshooting by investigating front panel symptoms and internal organization. Tests of the effectiveness of this approach to training are planned for the future.

Stern (1975) compared students trained on a computer-simulated oscilloscope to others that had undergone traditional training (individualized instruction plus hands-on experience with the equipment). Results of a performance test administered after training showed equivalent overall training for both groups. Although there were differences in subskills, these differences were not present in results of a second performance test given after lab practice with the oscilloscope. The author concluded that the computer-based simulation of the equipment had provided acceptable training, since performance after the integration of skills using the actual equipment was the same for both groups.

Research on student control of lesson strategies has proceeded by trial-and-error from a position where students had no control of lesson strategy to positions where they have almost complete control. Early research using linear programming was inefficient, since all students had to go through all training frames. Branching techniques, such as those reported by Slough, Ellis, and Lahey (1972), Hurlock (1972), and McCann, Lahey, and Hurlock (1973), provided adaptive programming and superior performance (usually) over straight linear programming. In much of this research, the student still had no choice of lesson strategy, but his performance controlled the extent and nature of the training he received.

A significant input to the question of student control of lesson strategy was provided when Evans, Glaser, and Homme (1960) questioned the proper order for presenting materials within a particular training objective. In other words, whether the student should be given the rules, followed by example(s), or example(s) followed by the rule. Neither their research nor that of others has been able to resolve this question, suggesting that perhaps there is no one "best way."

Mager (1961), Mager and McCann (1961), and Mager and Clark (1963), in an imaginative set of experiments, discovered that when students are given complete control of their learning situation, they not only learn, but learn faster than students given instruction according to parameters developed by "experts." This research, plus that of Evans, et al. (1960), suggests that lesson strategy may safely be put in the hands of the learner. The TICCIT System, developed by researchers at the Mitre Corporation and at Brigham Young University, takes advantage of this construct. The system hardware and software is designed to give students substantive control of lesson strategy. The major premises and propositions underlying the learner control strategem used are presented by Merrill (1973).

Research at NAVPERSRANDCEN (Slough et al., 1972; Hurlock, 1972; McCann, et al., 1973; and Lahey, Hurlock, and McCann, 1973) has determined that learner control of lesson strategy has a desirable effect on attitude and does not degrade performance. Follow-on investigation of learner control is now underway. One effort has developed a paradigm for use on the PLATO IV system which gives the learner freedom of choice in his selection of training objectives, content (i.e., rule, example, or practice), and level of difficulty (i.e., easy, medium, or hard). A description of the paradigm was used as a basis for preparing the lesson materials used in this study, which is reported by Lahey, Crawford, and Hurlock (1975, in press).

METHOD

Subjects

The subjects were trainees assigned to Learning Center C, Basic Electricity/Electronics (BE/E) School, Naval Training Center, San Diego. A total of 116 participated, 74 in the experimental group and 42 in a control group which studied the same lesson materials via the individualized course materials used by the BE/E School. Students going through Learning Center C were selected randomly for the CAI training as they reached the appropriate lesson space. Data for 32 of these students had to be rejected due to irregularities in the selection process, because of failure of the data system, and because of PLATO IV operational failures, leaving a total of 42 for this group. Data for an equal number of controls was obtained by random selection out of the pool of students not selected for the experimental group who went through Learning Center C during the same period.

Apparatus

The CAI lesson materials were presented via PLATO IV plasma-screen terminals located in individual carrels (Figure 1) at the BE/E School. The terminals were connected via multiplexers and leased phone lines to a Control Data Corporation CDC 6500 central processing unit located on the University of Illinois campus in Urbana, Illinois. Twelve terminals were available to two shifts of students from 0600 to 1145 and 1200 to 1730 daily during the experimental period, 7 October to 22 November 1974.

CAI Training Materials

The CAI training materials consisted of two lessons on the use of the Simpson Model 260-1 multimeter. The lessons taught the use of the multimeter as an ohmmeter and a DC ammeter, and were equivalent in content to Lesson IV, Module 3 and Lesson I, Module 4 of the materials (NAVPERS 94558-3 and 94558-4a) used by the BE&E School.

All lesson materials were presented via the plasma-screen, using graphics to simulate the multimeter. Major emphasis was placed on preparing the CAI materials so that meter functions were symbolically represented. For example, needle deflections reliably reflected specified meter readings, and the student could change range and function switch settings and specify how to connect the meter to a schematic of simple circuits. A photo of the simulated multimeter as presented on the PLATO screen is shown in Figure 2.

Within the lessons, the student could decide both what and how much he wanted to see of the lesson materials. Following a presentation scheme developed by M. David Merrill and others of Brigham Young University, the total lesson content was segmented by (1) training objective, (2) type of content (i.e., rules, examples, and practice problems) and (3) level of difficulty (i.e., easy, medium, and hard). In this way, the

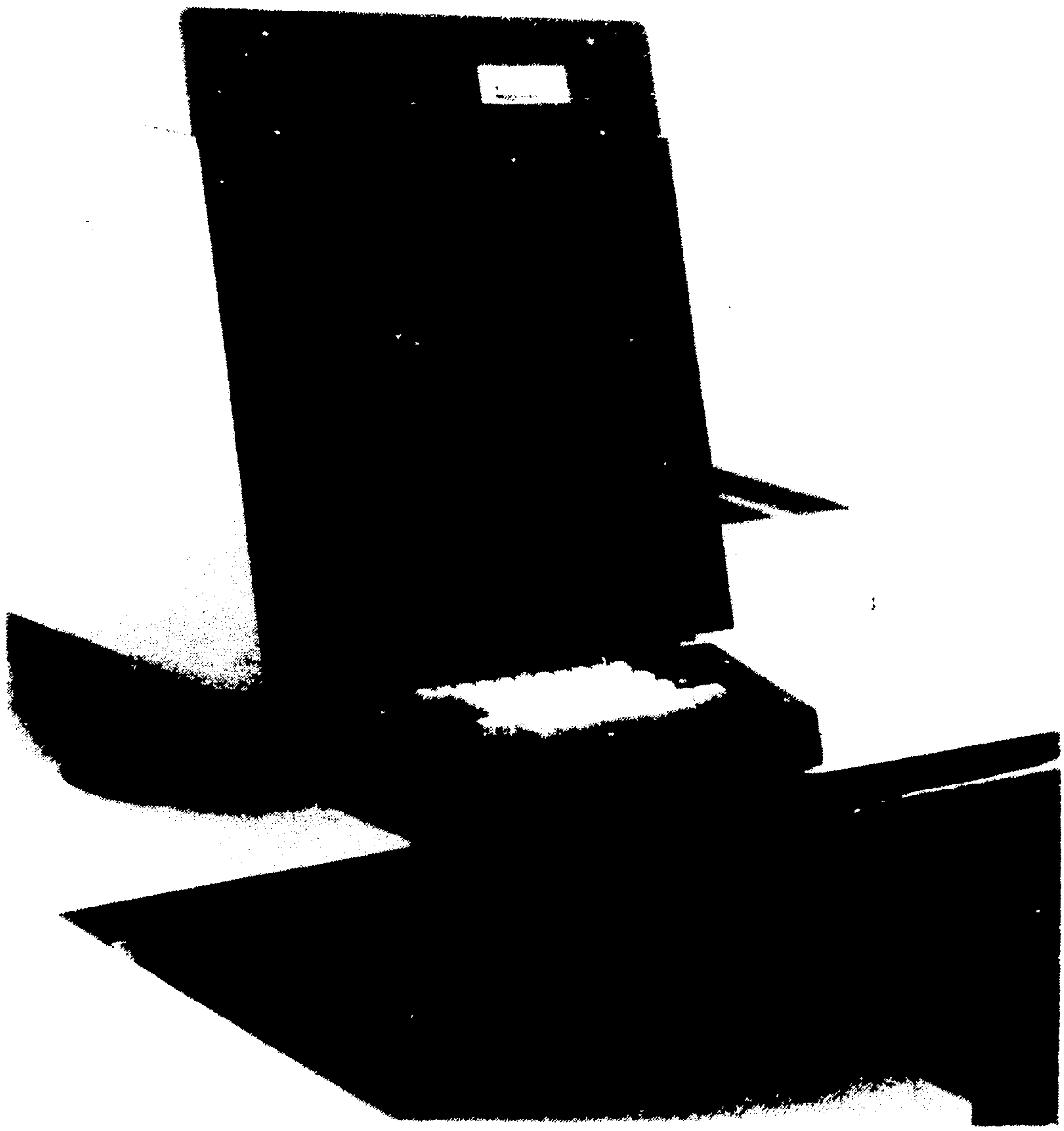


Figure 1. Student terminal. PLATO IV system.

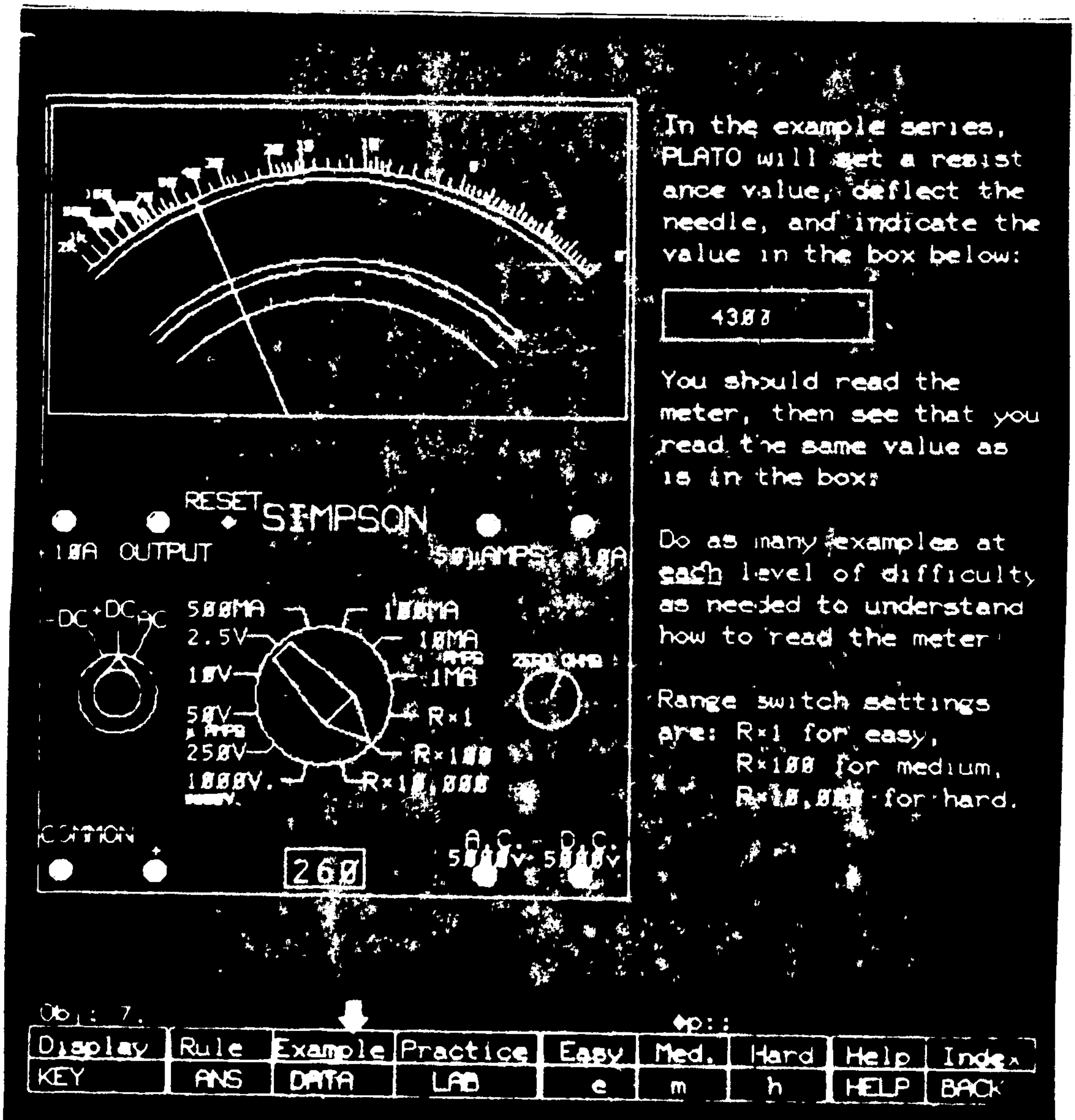


Figure 2. Graphic simulation of multimeter function.

student could study as much or as little of the materials that he felt he needed to understand the individual training objectives. The function table used to select content and level of difficulty categories is shown at the bottom of Figure 2. The various categories of learning objectives available to the student are depicted in Figure 3. A "typical" sequence of instruction is presented in Appendix A, a student trail for one of the students.

Positive feedback was used for all practice problems. With minor variations, this consisted of "Very Good!" for correct answers and "No. Try again" for incorrect answers to problems. Help sequences were available for all learning objectives. For major objectives, the help sequences gave the correct answers to practice problems.

Experimental Design

The students in the experimental group were informed when they began Module 3 of the BEEINLES materials that they were to go to the CAI laboratory to study the ohmmeter and DC ammeter lessons. Students in the control group used material normally provided by the school. The data collected for comparison of experimental and control group performance were final examination test scores and time required to complete Modules 3 and 4 of the BEEINLES course. It was hypothesized that there would be no difference in final examination scores or in time required to complete the modules.

Procedure

As each student in the experimental group reported to the CAI room, he was placed at a carrel and signed onto an introductory CAI lesson which told him how the lesson materials were arranged and how to use the terminal keyboard for accessing materials and answering practice problems. After completing the introductory lesson, he was transferred automatically to the ohmmeter lesson.

All CAI training was self-paced. Students had substantive control of lesson strategy in that they were free to select any objective at any time. They were also free to select any type of content (i.e., rule, example, practice) in any order and at any time.

The student could take a short on-line quiz on the lesson materials at any time. When the student satisfactorily completed the ohmmeter lesson, he was sent back to the learning center for a performance test and the final examination on Module 3. Upon satisfactorily completing these tests, he returned to the CAI laboratory for the DC ammeter lesson.

When the student finished the DC ammeter lesson, he was asked to complete a 34-item questionnaire which sought his reaction to (1) the lesson materials and (2) computer-based training in general. The questionnaire concluded the CAI experience for each student. He then returned to the learning center to complete the second and third lessons of Module

4, which consisted of studying the DC and AC voltmeter functions of the multimeter. Upon concluding Module 4, he took the school's performance test and the Module 4 final examination.

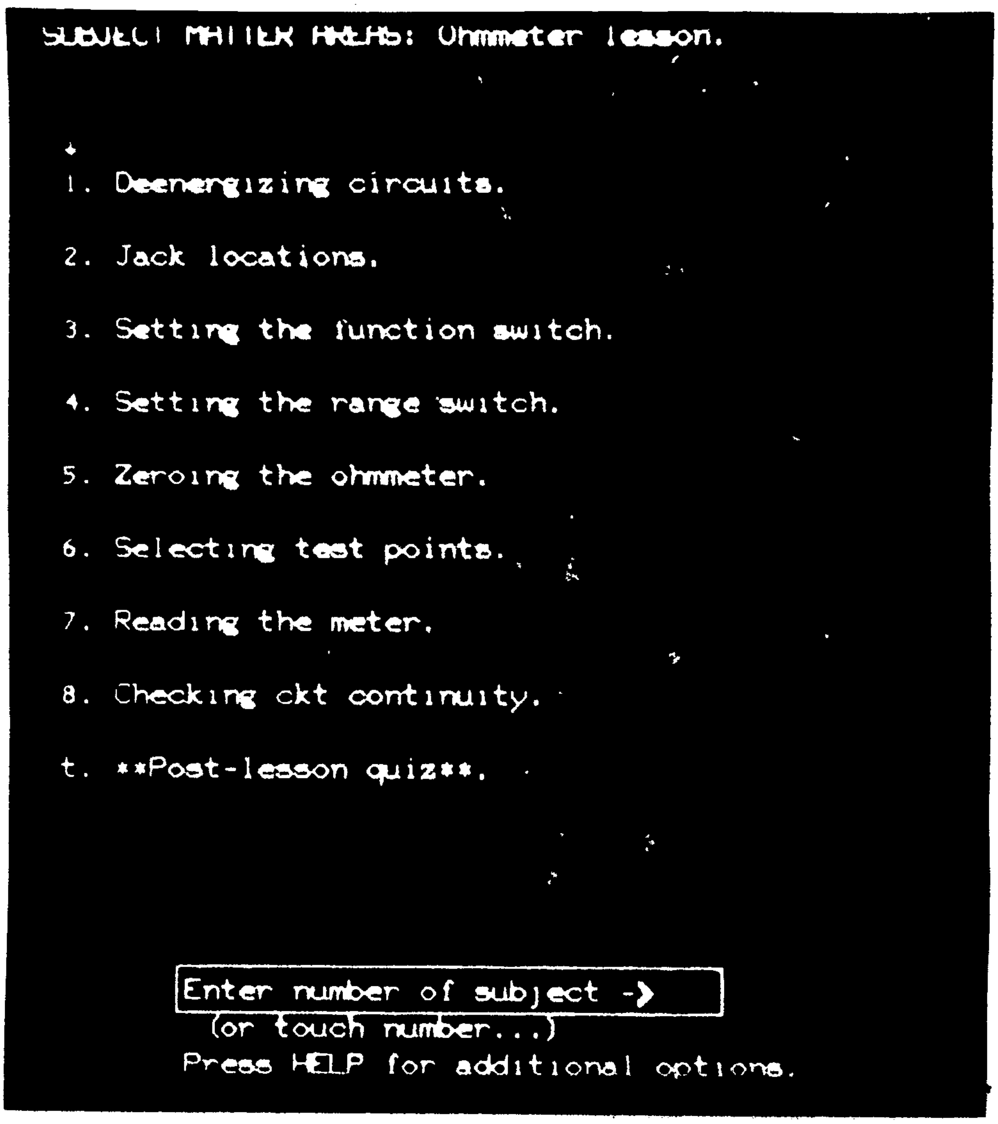


Figure 3. Index of learning objectives, multimeter training.

RESULTS

The data analyzed were: (1) total time required to complete each of the modules, (2) test scores on the final examination given by the school, and (3) answers to the questionnaire. The time required to complete and the final examination scores on Modules 1 and 2, which were common for all students, were used as concomitant variables with time and scores on Modules 3 and 4 in a one-way analysis of covariance. The module data were obtained from computerized BE/E School records. The questionnaire, which was administered online at the PLATO IV terminals, was analyzed separately.

As indicated in Table 1, the experimental group took significantly longer, (roughly 2 hours more) to complete Modules 3 and 4 than did the control group ($F = 4.79$, $df = 1/81$, $p < .05$). There was, however, no significant difference in the overall test scores of the two groups.

TABLE 1

Comparison of Experimental and Control Groups: Multimeter Training

Variable	Experimental Group	Control Group
Module Examination (% correct)	91.9	93.6
Selected Questions (% correct)	92.0	91.0
Training Time (in hours)	13.8*	11.9

*p < .05

Five questions on the module examinations, which were related to reading the multimeter, were considered to be critical to the evaluation of the simulation. A separate analysis of variance was therefore run to compare the experimental and control group responses to these questions.

Selected results of the questionnaire are presented in Appendix B. In general, the student reaction to the training was very enthusiastic, with many students asking if additional lessons would be programmed. In judging the proportions of training which they would prefer to be classroom, individualized training booklets, or computer-aided instruction, the student responses indicated they would prefer equal times for each method. Seven students wanted no classroom instruction, three wanted no individualized training booklets, and only two wanted no computer-aided instruction. Answers to questions about using the special keys (the student's way of selecting content) and writing delays (as occurred when

the multimeter was being put on the screen) indicated that the system of selecting content was acceptable to the students and that there were no objections to the delays. There were no questions related to directly evaluating the learner control mode of learning.

DISCUSSION

This research was primarily exploratory in nature. The intent was to investigate the feasibility of simulating a simple training device, with a view to establishing a criterion for conducting more elaborate simulations. The results were salutory. Students were generally enthusiastic about the training and achieved results comparable to those achieved by individuals using the actual equipment. While they spent more time in training (13.8 hours versus 11.9 hours; $F = 4.79$, $df = 1/81$, $p < .05$), they performed no differently on the laboratory tests (verbal report) or on the module examinations.

It may be assumed that part of the time spent in the computer-assisted instruction is chargeable to the novelty of the situation. At least 3/4-hour of the differential can be charged to getting the students to the CAI laboratory and back, plus getting them indoctrinated. Some of the additional time would appear to be ascribable to overlearning, as quite a few students practiced extensively in reading the multimeter, an area in which the simulation offered an infinite number of examples as opposed to the very limited number of examples available in the school.

Several students had difficulty with the training mode. They did not seem to understand either the extent of their options or the mechanics of accessing different materials. A number of the earlier students exhibited perseverative performance, pressing a particular key again and again because "I didn't know how to get out of there." When these behaviors were observed, the introductory materials were immediately amplified or altered. Toward the end of the research period, students spent less time in the introductory segment and the perseverative behavior was not observed, indicating that the presentation had been considerably improved. The portion of the training time attributable to the lack of understanding of how to manipulate the lesson is not known.

The simulation accomplished in this research depended in large measure on the technology of the PLATO IV system. It required particularly the calibrated point-by-point control of images and the ability to erase as well as write on a portion of the screen without affecting other portions. The plasma screen dynamics were also important. To show the meter response to measurement, the multimeter needle had to deflect quickly and accurately. The degree of needle position control was more than adequate for both the ohmmeter and ammeter presentations, as was the degree of control of the range switch, function switch, and zero ohms rheostat positions.

The PLATO IV typewriter keyboard provided adequate response input capabilities. The function keys situated to the right of the regular typewriter keys, which were used to access the different types of lesson materials, proved quite satisfactory. The directional arrows on the PLATO IV keyboard were used to rotate switches. Only two students indicated a lack of understanding of this latter function.

The simulated multimeter (Figure 2) took several seconds to be displayed on the screen. During the lesson, the multimeter was redrawn for each type of content selected. However, it was possible to keep the meter display on the screen through any set of examples or practice problems, as long as the student stayed in the same file (PLATO unit). The student's acceptance of the delay while waiting for the meter to be redrawn speaks well for their desire to learn and their acceptance of the computer-aided mode. The same may be said for their acceptance of delays while waiting for circuit diagrams to be written. In short, the simulation was successful and was readily accepted by the students in the experimental group. It presages further developments of this type.

Many kinds of training equipments could be simulated using dynamic, interactive, general-purpose computer terminals. The Simpson Model 260-1 multimeter is only one of a great many equipments whose operation naval trainees must learn. While technically easy to simulate and not dangerous in itself, it is representative in its elements of many types of equipments which trainees can easily damage or whose use under particular circumstances could create conditions hazardous to the trainee. Other types of equipment might easily have been selected, but the multimeter offered the distinct advantage of immediate access to students for whom this training was essential.

It might be worthwhile to note that the simulation described herein was developed empirically rather than scientifically. It was concluded that the meter deflections might be developed more economically by trial-and-error with simple algorithms than by trying to find and use the operational algorithm within the equipment. This approach is recommended so long as it is feasible. There is nothing to be gained by developing elaborate algorithms where a simple algorithm will do the job. The opportunity to use either approach suggests that the number of equipments which could be simulated is not limited by technical complexity.

CONCLUSIONS AND RECOMMENDATIONS

This research confirms the capacity of an interactive, general-purpose computer terminal such as the PLATO IV student terminal to simulate training equipment functions. Equipment functions can be dynamically represented and presented via the student terminal, and training seems to transfer adequately to the actual equipment. Use of the general-purpose computer terminal thus becomes an interesting alternative to the purchase and use of special training equipment. It is suggested that additional research on other types of equipment and on the transfer of learning to actual equipments is needed to broaden the findings of this experiment.

REFERENCES

Evans, J. L., Glaser, R., & Homme, L. E. The RULEG system for the construction of programmed verbal learning sequences. Pittsburgh: University of Pittsburgh, 1960.

Ford, J. D., Jr., Slough, D. A., & Hurlock, R. E. Computer assisted instruction in Navy technical training using a small dedicated computer system: Final report. San Diego: Naval Personnel and Training Research Laboratory, November 1972. (Research Report SRR 73-13)

Feurzeig, W. & Lukas, G. Automated instructional monitors for complex operational tasks. Cambridge, MA: Bolt, Beranek, and Newman, Inc., October 1971. (Tech. Rep. 2272)

Higget, G., Davis, D. J., & Rigney, J. W. Computer-aided technical training using electronic equipment on line with the CAI system. Los Angeles: University of Southern California, Department of Psychology, Behavioral Technology Laboratories, June 1968. (Tech. Rep. 59)

Hurlock, R. E. Applications of pretest branching designs to CAI basic electronics training. San Diego: Naval Personnel and Training Research Laboratory, September 1972. (Res. Rep. SRR 73-8)

Lahey, G. F., Crawford, A. M., & Hurlock, R. E. Learner control of lesson strategy: A model for PLATO IV system lessons. San Diego: Navy Personnel Research and Development Center (1975, in press).

Lahey, G. F., Hurlock, R. E., & McCann, P. H. Post lesson remediation and student control of branching in computer-based training. San Diego: Naval Personnel and Training Research Laboratory, April 1973. (Res. Rep. SRR 73-19)

Mager, R. F. On the sequencing of Instructional content. Psychological Reports, 9, 1961.

Mager, R. F. & Clark, C. Explorations in student controlled instruction. Psychological Reports, 13, 1963.

Mager, R. F. & McCann, I. Learner-controlled instruction. Palo Alto, CA: Varian Associates, 1961.

McCann, P. H., Lahey, G. F., & Hurlock, R. E. A comparison of student option versus program controlled CAI training. San Diego: Naval Personnel Training Research Laboratory, April 1973. (Res. Rep. SRR 73-17)

Merrill, M. D. Premises, propositions, and research underlying the design of a learner controlled computer-assisted instruction system: A summary for the TICCIT system. Provo, UT: Brigham Young University, Division of Instructional Services, June 1973 (Working Paper 44).

Rigney, J. W., Bond, N. A., Jr., Mason, A. K., & Macaruso, R. B. Training corrective maintenance performance on electronic equipment with CAI terminals: I. A feasibility study. Los Angeles: University of Southern California, Behavioral Technology Laboratories, Department of Psychology, December 1966 (Tech. Rep. 51).

Rigney, J. W., Morrison, D. K., Williams, L. A., & Towne, D. M. Description and initital evaluation of a computer-based individual trainer for the radar intercept observer. NAVTRAEQUIPCEN: USN Training Equipment, November 1973, NAVTRAEQUIPCEN Task No. 2752-01 (Tech. Rep. 71-C-0219-1).

Rigney, J. W., Towne, D. M., & King, C. A. Interactive computer graphics for performance-structured-oriented CAI. Los Angeles: University of Southern California, Department of Psychology, Behavioral Technology Laboratories, July 1974 (Tech. Rep. 73).

Slough, D. A., Ellis, B. D., & Lahey, G. F Fixed sequence and multiple branching strategies in computer-assisted instruction. San Diego: Naval Personnel and Training Research Laboratory, September 1972 (Res. Rep. 73-6).

Stern, H. W. Transfer of training following computer-based instruction in basic oscilloscope procedures. San Diego: Navy Personnel Research and Development Center, July 1975 (Res. Rep. 76-1).

APPENDIX A

STUDENT TRAIL

STUDENT TRAIL

The student trail reported here and shown on Table A-1 is roughly typical of those made by students taking these lessons. It shows the responses made to the ammeter lesson for one student. The sequence proceeds down the first column then to the top of the next column, etc. The code for each response identifier is as follows:

<u>1st Digit</u> - Lesson objective number (e.g., 9 = test).

<u>2nd Digit</u> - Type of content (i.e., 1 = rule, 2 = example, 3 = practice)

<u>3rd Digit</u> - Level of difficulty (i.e., 1 = easy, 2 = medium, 3 = hard)

<u>4th Digit</u> - Nature of response (0 = sequencing, 1 = right answer to practice, 2 = wrong answer to practice, 3 = help sequence)

This student took the objectives in order (as indicated by the first digit in each response identifier). He also adapted a rule-example-practice strategy (as indicated by the second digit). He made about the average number of responses before taking the lesson quiz. His quiz score was excellent. (As indicated by the last digits in the 9000 series responses), he had one wrong for a score of 94%. Data on the effect of content selection is being developed separately.

STUDENT TRAIL: ROMERO

SAN 2 — RESPONSE NUMBER

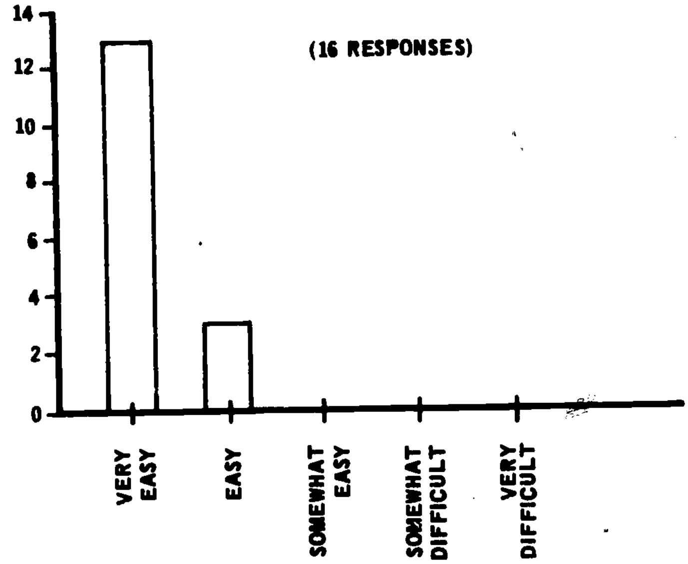
1	31	61	91	121	151	181	211	241	271
index	312Ø	532Ø	6322	7331	8321	9ØØ1			
index	313Ø	5321	6321	732Ø	832Ø	9ØØ1			
index	322Ø	533Ø	633Ø	7321	8322	9ØØ1			
112Ø	323Ø	531Ø	6331	733Ø	8322	9ØØ1			
113Ø	321Ø	5313	index	7331	8321	9ØØ1			
122Ø	332Ø	index	712Ø	733Ø	8321				
123Ø	3321	index	722Ø	7331	833Ø				
1233	3323	612Ø	7221	index	index				
123Ø	3323	613Ø	722Ø	812Ø	832Ø				
132Ø	333Ø	613Ø	7221	822Ø	8322				
1321	index	613Ø	722Ø	823Ø	8321				
133Ø	412Ø	611Ø	7221	832Ø	8321				
1332	413Ø	622Ø	723Ø	8322	832Ø				
133Ø	411Ø	622Ø	7232	8321	8321				
131Ø	422Ø	622Ø	7232	8322	8321				
1311	423Ø	622Ø	7231	8321	832Ø				
index	421Ø	622Ø	732Ø	8322	index				
index	432Ø	623Ø	7322	8321	index				
212Ø	4321	6232	7322	8322	9ØØØ*				
211Ø	433Ø	623Ø	7322	8321	9ØØ1				
222Ø	431Ø	623Ø	7321	8321	9ØØ1				
223Ø	4313	632Ø	732Ø	832Ø	9ØØ1				
221Ø	4313	6321	7321	8322	9ØØ1				
232Ø	index	632Ø	732Ø	8321	9ØØ2				
2321	512Ø	6321	7321	8321	9ØØ1				
233Ø	511Ø	632Ø	732Ø	832Ø	9ØØ1				
231Ø	522Ø	6321	7321	8322	9ØØ1				
index	5221	633Ø	732Ø	8322	9ØØ1				
index	523Ø	6331	7321	8322	9ØØ1				
index	index	632Ø	733Ø	8321	9ØØ1				

*The 9000 preceding the test sequence is a test identifier.

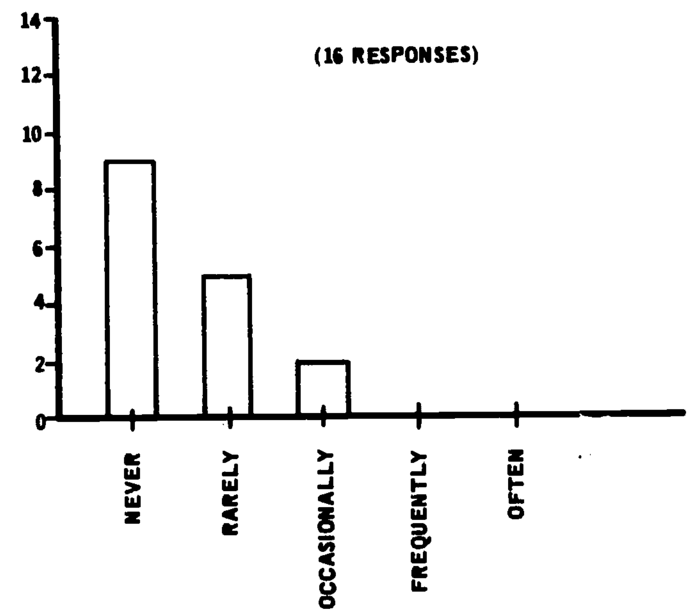
APPENDIX B

RESPONSES TO SELECTED QUESTIONNAIRE ITEMS

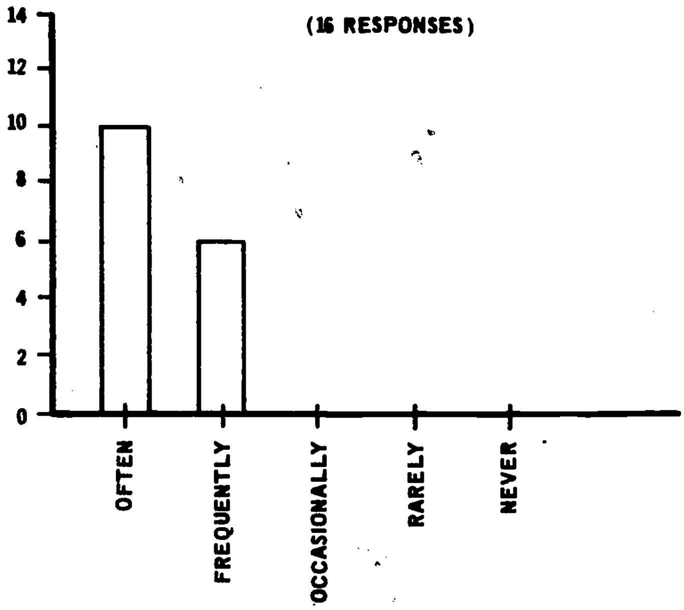
3. Using a scale from one to five, rate the ease of using the special keys:



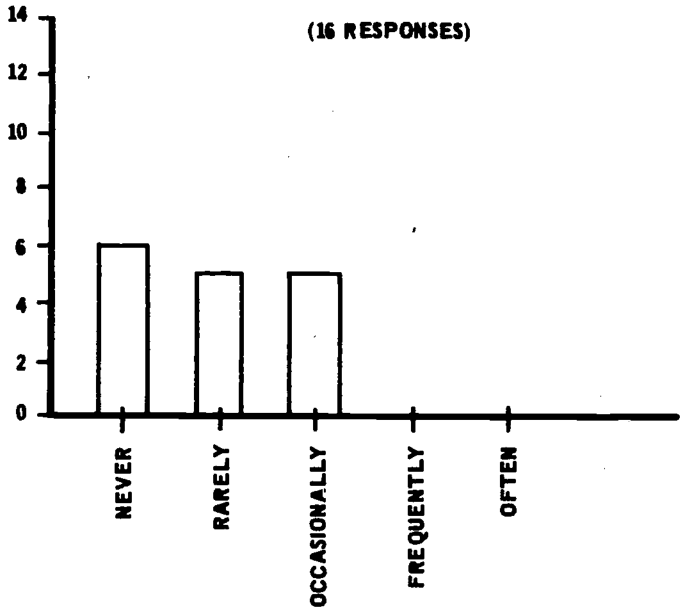
10. Did you experience any degree of fatigue or strain while taking your training?



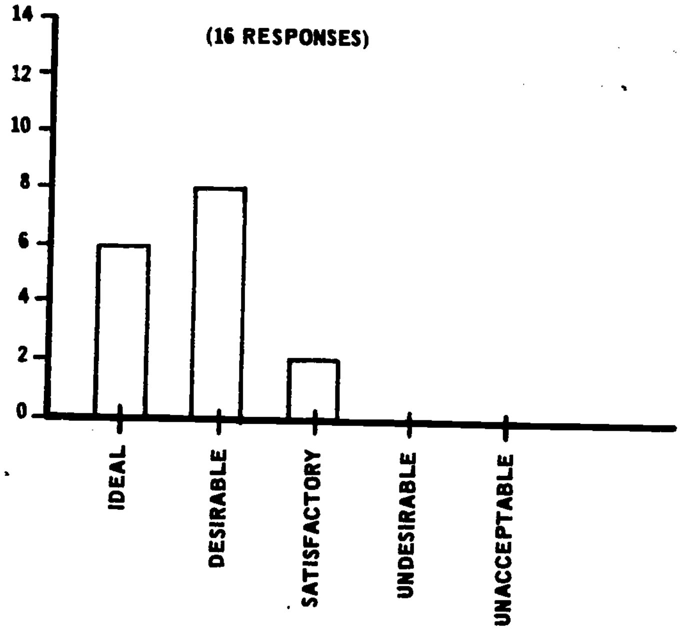
13. Were the words, drawings and figures clear and easy to read?



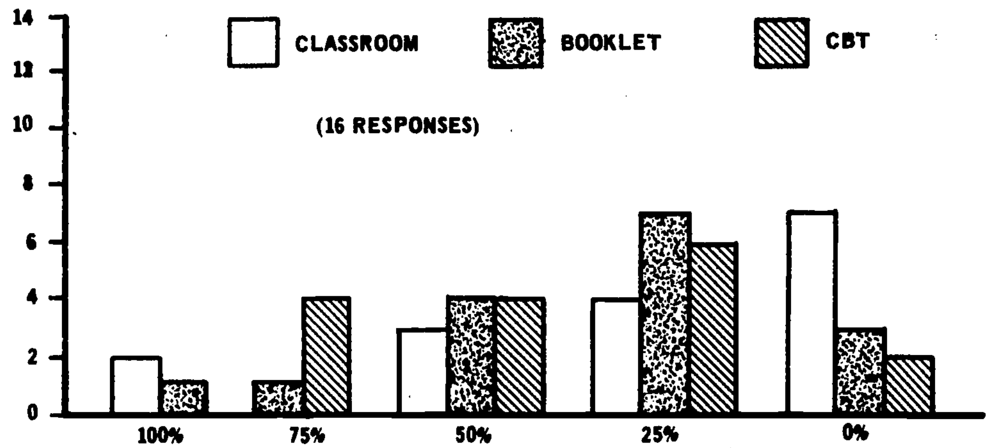
16. Did the delay in having to wait for new displays to fill the screen bother or annoy you?



25. How do you rate CBT (computer-based training)?

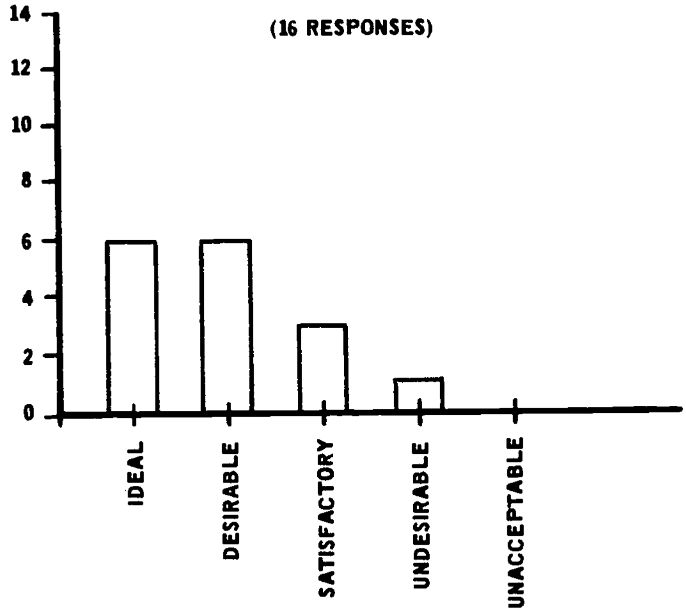


27-28. Please indicate the proportion of classroom and textbook, self-instructional module booklets, computer-based training you would prefer?

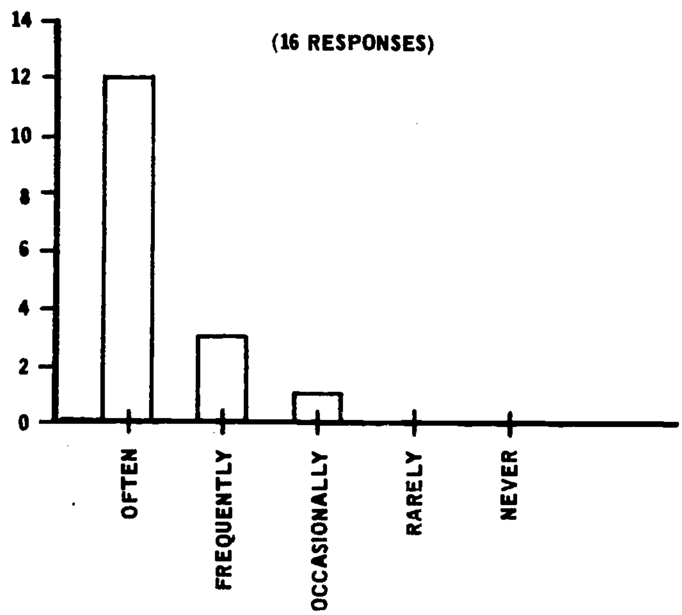


29

30. Rate the instructional effectiveness of the lesson:



34. Arrangement (spacing, format, distribution, etc.) of materials on the screen was excellent.



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