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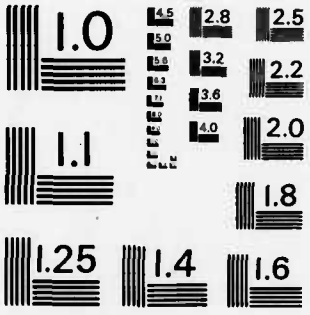

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GENERALIZED MAINTENANCE TRAINER SIMULATOR: TEST AND EVALUATION IN THE LABORATORY ENVIRONMENT

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Three experiments were conducted to evaluate the effectiveness of the generalized maintenance trainer simulator (GMTS) as a supplementary device for laboratory troubleshooting practice. Students using the GMTS scored as well on final tests of performance on actual equipment as did students who had trained on actual equipment. It was concluded that GMTS provides effective laboratory troubleshooting practice.

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FOREWORD

This research was performed in support of Navy decision coordinating paper Z0789, work unit PN.01 (Class "A" Electronic Equipment Maintenance Training System (EEMT)). Its mission sponsor is the Chief of Naval Operations (OP-01); appropriation sponsor, the Chief of Naval Operations (OP-98); and requisition sponsor, the Chief of Naval Material (MAT-08E1).

This is the eighth report describing the generalized maintenance trainer simulator (GMTS) or its successor, the EEMT. The GMTS had its genesis in prototype systems developed under the sponsorship of the Office of Naval Research by the Behavioral Technology Laboratories, University of Southern California. The contributions of the late Dr. Joseph Rigney and of Dr. Douglas M. Towne in developing the concept and carrying the development forward are sincerely appreciated.

The objective of the effort described herein was to determine whether the GMTS performed satisfactorily in the laboratory training environment. Of the previous reports, two described GMTS field evaluations and hardware/software development (NPRDC TRs 80-30 and 81-9); three, the EEMT concept evaluation, system definition, and master plan (NPRDC TN 79-3, TR 81-11, and SR 81-19); and two, the GMTS and the process of developing a data base for training (NPRDC TN 82-6 and SR 82-17).

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Commanding Officer

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Technical Director

SUMMARY

Problem

Operational Requirement 50 of July 1976, which defined the need for the electronic equipment maintenance training (EEMT) system, focused on the problems inherent in using actual equipment for training purposes, the need to improve maintenance training in the Navy, and the need to bridge the gap between basic training and equipment-specific training. One approach to the problem inherent in maintenance training was the development of a maintenance training device having a design completely independent of the design of the equipment being simulated. The generalized maintenance training simulator (GMTS) was designed to satisfy this requirement.

Objective

The objective of this effort was to determine if the GMTS performed satisfactorily in the laboratory training environment.

Approach

Four GMTS systems were installed at the AN/WSC-3 school, Advanced Electronics Schools Department, Service School Command, San Diego. A test of the trainers' effectiveness was performed during the period from December 1980 to September 1981. Three experiments were conducted. In two experiments, an experimental group used the GMTS while a control group used actual equipment. In the third, all students used the GMTS approximately 40 percent of the time. A total of 128 students from 14 classes participated in the three experiments.

Results

Posttraining troubleshooting proficiency measures for the experimental (trainer) and control (actual equipment) groups were not statistically different. Times required for problem solution were essentially the same. Students indicated, however, that they preferred using the actual equipment.

Conclusions

The results indicate that the trainers are an effective substitute for actual equipment in the school environment. The GMTS provided troubleshooting practice equivalent in measured effectiveness to that provided by the use of actual equipment.

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INTRODUCTION

Problem and Background

Informal field tests showed that students were able to develop troubleshooting proficiency for maintenance tasks after practicing with the generalized maintenance training simulator (GMTS) (Rigney, Towne, King, & Moran, 1978; Rigney, Towne, Moran, & Mishler, 1980). GMTS is the development model for an interactive, image-based computer-controlled trainer simulator designed to provide simulated "hands-on" experience to maintenance technicians. It is the physical embodiment of the "Rigney trainer" concept rather than a physical entity in itself. The concept is that of an interactive training system that uses two-dimensional equipment images to reflect the state of the equipment being simulated (Lahey & Malec, 1981). Data bases prepared by subject matter experts are used to display images that simulate manipulation of equipment states and use of test equipment to take readings of equipment parameters.

Use of the trainer in maintenance (or operator) training has inherent advantages over the use of actual equipment. It will usually be less expensive than the equipment it simulates, will be more easily used and maintained, and will provide training that is otherwise impractical because of hazards to personnel or equipment. The concept is expected to have wide applications in the field of electronic maintenance training, with the possibility of extension into other fields where similar problems exist.

Two major goals are reflected in the design of the GMTS and its successor, Unit 1 of the electronic equipment maintenance training system (EEMT; Device No. 11B106). The first, which is to have a truly generalized trainer capable of simulating a variety of very different actual equipments without requiring computer program changes, has been substantively realized in that several different equipment data bases have been developed, installed in the trainers, and tested, including a fleet communications system (Rigney et al., 1978), the AN/SPA-66 radar repeater (Rigney et al., 1980), and the AN/WSC-3 transceiver system. The second goal, to provide efficient training that meets with student and instructor acceptance, is addressed herein.

Objective

The objective of this effort was to determine whether the GMTS performed satisfactorily in the laboratory training environment.

APPROACH

Four GMTS trainers were installed in the AN/WSC-3 School, Advanced Electronics Schools Department, Service School Command, San Diego. Following an equipment checkout and familiarization phase, which began in the spring of 1980, three separate experiments were conducted using data base systems for the AN/WSC-3 Satellite Communications System (ECHO and LOS versions). Civilian students were excluded from the experiments. These experiments are described below.

Experiment 1

Subjects

Experiment 1 involved all of the military students (N = 61) in seven classes (Nos. 80014 to 81005, held from August 1980 to February 1981) (see Table 1). Prior to starting

Table 1

Distribution of Students

Class	Start Date	Experimental Group (N)	Control Group (N)	Total
		Experiment 1		
80014	8/11/80	3	5	8
80015	9/8/80	6	6	12
81001	10/6/80	3	3	6
81002	11/3/80	5	5	10
81003	12/15/80	5	4	9
81004	1/12/81	5	4	9
81005	2/9/81	3	4	7
Total		30	31	61
		Experiment 2		
81006	3/9/81	6	5	11
81007	4/6/81	5	6	11
81008	5/4/81	5	6	11
Total		16	17	33
		Experiment 3		
81009	6/1/81	--	--	10
81010	7/6/81	--	--	6
81011	8/3/81	--	--	8
81012	9/8/81	--	--	10
Total		--	--	34

the laboratory practice periods, the instructors matched students by experience. One member of each pair was assigned to the experimental group; and the other, to the control group, by means of a coin toss. In classes with an odd number of military students, the "extra" student was sometimes assigned to the experimental group and sometimes to the control group.

Procedure

Experimental and control group students attended classroom lectures together and performed all job sheet assignments on actual equipment. Control group students used

actual equipment to practice the ten troubleshooting practice problems included in the course, while experimental students used the GMTS (ECHO version of the equipment) for eight practice problems and actual equipment for the remaining two. No remediation was given to either group before the final performance test in each class. All students took the final performance tests on actual AN/WSC-3 equipment.

During both practice and final test sessions, the course instructors kept records of (1) the time required by each student to complete each practice problem and each final performance test problem, and (2) the number of replacements made during practice and during the final performance tests. Since single-fault problems require only one replacement, the number of replacements made was a measure of errors. A student who made an error was usually informed by the trainer simulator (experimental group) or by the instructor (control group) that the replacement was wrong and was then allowed to continue the problem. If the student made three errors on a problem, the instructor usually ended the problem for that student. A replacement number of "4" was used to indicate failure.

After finishing the laboratory practice periods, students in each group completed the appropriate form of a questionnaire designed to assess student reaction to the training (see appendix).

Analysis

Performance data were analyzed using one-way analyses of variance (BMDP2V, Dixon, 1981). The number of replacements was analyzed using a chi-square test (BMDP4F, Dixon, 1981). Questionnaire data were analyzed using the Mann-Whitney test (Guilford & Fruchter, 1978, pp. 218-221).

Experiment 2

Subjects

Experiment 2 involved all of the military students (N = 33) in three classes (Nos. 81006, 81007, and 81008, held from March to May 1981) (see Table 1). As in Experiment 1, students were randomly assigned to the experimental and control groups before practice troubleshooting began in each class.

Procedure

The procedure was generally the same as in Experiment 1, except that students in the experimental group did all ten troubleshooting practice problems on the trainer--eight on the ECHO version of the AN/WSC-3 and two on the LOS version.

During Experiment 2, students were allowed to make only one replacement. If the student replaced the wrong module, the problem was terminated. A replacement number of "2" was used to indicate failure.

Analysis

The analyses were the same as for Experiment 1.

Experiment 3

Subjects

Experiment 3 involved all the military students (N = 34) in four classes (Nos. 81009 to 81012, held from June to September, 1981) (see Table 1). For this experiment, students were not separated into experimental and control groups.

Procedure

All students had access to actual equipment or to the trainers for troubleshooting practice. Students were simply assigned to either the trainer or the actual equipment as one or the other became available. An attempt was made to balance the time students spent on the trainer or on actual equipment so that all had equal GMTS and actual equipment time. However, because of difficulties with both the actual equipment and the trainers, this objective was not always achieved.

The experimental group version of the opinion questionnaire was administered to students in two classes (Nos. 81009 and 81011). A modified version of the questionnaire, which permitted comparison, was administered to students in the other two classes (Nos. 81010 and 81012).

Analysis

Since there was no experimental treatment effect, the only within-experiment analysis possible was a within-group analysis of the response to two questions in the modified questionnaire--one dealing with the effectiveness of GMTS (#2); and the other, with the effectiveness of actual equipment (#3). Also, responses made by Experiment 3 students to key questionnaire items and their performance were compared to the responses and performance of students in Experiments 1 and 2. The analyses were otherwise the same as for Experiment 1.

RESULTS

Table 2 presents the mean practice times, final performance test times, and number of replacements. Tables 3 and 4 respectively present a breakdown by problems of mean performance times and responses to certain questionnaire items. (Differences between Tables 2 and 3 are caused by missing data effects in the analyses used.) Results for each experiment are discussed in the remainder of this section.

Experiment 1

As shown in Table 2, there were no significant differences in time required to solve problems or in number of replacements. There was some interaction between groups and problems during the practice performance tests ($df = 9, 468$, $MSW = 379.2$, $F = 2.01$, $p < .05$), as is indicated in Table 3. The problem breakdown in Table 3 indicates that, although practice times varied in both directions, only those for problems 1 and 5 differed significantly.

Table 2

Mean Problem Completion Times and Number of Replacements

Item	Experiment 1		Experiment 2		Experiment 3
	Exper. Group	Control Group	Exper. Group	Control Group	Total Group
Practice Problems:					
Time required (Min.)	50.3	50.1	48.2	46.8	42.3
No. Replacements[a]	9.5	9.7	10.3	10.6	10.1
Final Test Problems:					
Time required (Min.)	59.3	59.7	50.5	52.3	43.0
No. Replacements[a]	11.2	10.9	8.6	8.7	9.2

Note. None of the differences are significant.

[a]Based on 10 practice problems and 8 final test problems.

Table 3

Problem Completion Times (Min.)

Problem	Experiment 1			Experiment 2			Experiment 3	
	Exper. Group (N=30)	Control Group (N=31)	t test (Exp. vs. Cont.)	Exper. Group (N=16)	Control Group (N=17)	t test (Exp. vs. Cont.)	Total Group (N=34)	t test (Exp. 3 Total Group vs. Exp. 2 Exp. & Cont. Groups)
Practice								
1	62.0	48.7	2.34**	65.0	48.6	NS	48.3	--
2	59.0	69.5	NS	63.7	56.7	NS	54.6	--
3	54.3	52.0	NS	44.6	49.8	NS	50.3	--
4	51.0	54.5	NS	40.2	55.8	2.11**	42.3	--
5	44.9	34.9	2.30**	44.5	43.3	NS	35.0	1.76** (Control) 1.68** (Exp.)
6	55.0	47.5	NS	42.6	42.1	NS	42.0	--
7	42.0	43.5	NS	38.3	46.1	NS	37.6	--
8	38.8	46.5	NS	28.1	41.9	2.81*	40.7	--
9	49.7[a]	54.0	NS	54.3	51.9	NS	42.6	--
10	43.0[a]	42.4	NS	57.7	53.9	NS	43.0	--
Final								
1	49.7	46.2	NS	45.2	49.7	NS	39.8	--
2	55.1	52.2	NS	46.7	44.3	NS	58.6	--
3	48.2	54.1	NS	44.3	42.6	NS	32.3	1.82** (Control)
4	60.5	57.2	NS	48.1	55.6	NS	52.8	--
5	58.6	55.6	NS	57.5	52.1	NS	54.5	--
6	66.2	65.0	NS	57.1	57.0	NS	40.4	3.01* (Control)
7	79.9	80.5	NS	57.4	69.8	NS	45.2	3.26* (Control)
8	54.3	45.5	NS	47.5	47.5	NS	45.3	--

[a]Run using actual equipment.

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

Table 4

Responses to Questionnaires

Question[a]	Experiment 1 Exper. Group (N=30)	Experiment 1 Control Group (N=31)	Experiment 1 z	Experiment 2 Exper. Group (N=16)	Experiment 2 Control Group (N=17)	Experiment 2 z	z (Comparison of Exper. Group Responses in Exps. 1 & 2)	Experiment 3[b] Eval. of Trainer Effec.	Experiment 3[b] Eval. of Act. Equip. Effec.	Experiment 3[b] z
1. Compared to other training (1-1)			2.60*			3.24*	1.78**			
a. Much more enjoyable	0	4		1	4			--	--	
b. More enjoyable	10	15		2	7			--	--	
c. About as enjoyable	10	11		4	6			--	--	
d. Less enjoyable	6	1		4	0			--	--	
e. Much less enjoyable	2	0		5	0			--	--	
f. No response	2	0		0	0			--	--	
2. Learning/practice technique (2-2)			3.86*			4.07*	2.19**			3.73*
a. Very effective	4	13		0	6			1	10	
b. Effective	10	17		2	9			3	4	
c. Both effective and ineffective	13	0		10	2			7	1	
d. Somewhat ineffective	2	0		4	0			3	0	
e. Very ineffective	1	0		0	0			1	0	
f. No response	0	1		0	0			1	1	
3. Trainer equipment easy to use (3-3)			NS			2.20**	NS			
a. Very easy	6	7		3	6			--	--	
b. Easy	17	20		6	11			--	--	
c. Neither easy nor difficult	4	4		6	0			--	--	
d. Difficult	0	0		1	0			--	--	
e. Very difficult	0	0		0	0			--	--	
f. No response	3	0		0	0			--	--	
4. Setting switches (6-4)			3.75*			2.99*	2.00**			
a. Very easy	4	16		2	9			--	--	
b. Easy	10	13		7	8			--	--	
c. Neither easy nor difficult	9	2		3	0			--	--	
d. Difficult	5	0		3	0			--	--	
e. Very difficult	1	0		1	0			--	--	
f. No response	1	0		0	0			--	--	
5. Using test equipment (7-5)			NS			NS	NS			
a. Very easy	8	7		7	8			--	--	
b. Easy	11	20		5	7			--	--	
c. Neither easy nor difficult	7	4		2	2			--	--	
d. Difficult	0	0		0	0			--	--	
e. Very difficult	0	0		0	0			--	--	
f. No response	4	0		2	0			--	--	
6. Problem difficulty (10-6)			NS			NS	NS			
a. Much too difficult	0	0		0	0			--	--	
b. Too difficult	0	0		1	0			--	--	
c. About correct	28	30		12	15			--	--	
d. Too easy	1	1		2	1			--	--	
e. Much too easy	0	0		0	0			--	--	
f. No response	1	0		1	1			--	--	
7. Amount of practice (11-7)			NS			1.87**	NS			
a. Much too little	1	1		1	0			--	--	
b. Too little	11	10		6	1			--	--	
c. About right	15	15		9	16			--	--	
d. More than necessary	0	0		0	0			--	--	
e. Much more than necessary	0	0		0	0			--	--	
f. No response	3	5		0	0			--	--	
8. Prior familiarity with WSC-3 (13-8)			NS			NS	NS			
a. Very familiar	0	0		1	0			--	--	
b. Familiar	1	2		1	0			--	--	
c. Somewhat familiar	5	4		2	5			--	--	
d. Not very familiar	5	5		3	6			--	--	
e. Not at all familiar	18	16		8	6			--	--	
f. No response	1	4		1	0			--	--	

[a]Numbers in parentheses refer to item numbers in experimental and control questionnaires respectively.

[b]Comparison of responses of students in classes 81010 and 81012 (N = 16) to questionnaire items concerning effectiveness of trainer and actual equipment.

*$p < .01$.

**$p < .05$.

DISCUSSION

For training purposes, operational military electronics systems are usually more expensive, more easily damaged, and more hazardous than are simulator trainers. Further, the introduction of problems in actual equipment is time consuming and can seriously degrade the unit's durability and maintainability. Trainer simulators can be used very effectively to improve training where one or more of these conditions holds true. If the actual equipment is very expensive, a training facility that can afford only one or very few actual units could provide significantly more troubleshooting practice by installing a number of trainers to support use of the actual equipment.

The experiments reported herein address the question of whether using a trainer simulator like the GMTS to support hands-on electronic maintenance training is an effective alternative to the use of actual equipment. The results indicate that students taught to troubleshoot on the trainer performed as well during practice and on the final performance tests as did students taught on the actual equipment, although they also suggest that students preferred use of the actual equipment in their training. This result was to be expected, as the AN/WSC-3 is a relatively simple unit to troubleshoot, and there was no obvious advantage to using the trainer. Student preference can therefore be attributed to a natural desire to function in an environment as close to the real environment as possible. In other circumstances, where GMTS significantly expedites training or provides practice not possible when using actual equipment, a clear advantage would be expected. In the current instance, with no other changes to the curriculum, the trainer's availablity shortened the course from 4 to 3 weeks, by providing 8 systems rather than 4 to work with during laboratory periods.

There were a number of difficulties in the conduct of the research that significantly impacted the results. The Graf-pen caused a number of problems, but they were minor compared to problems with the microfiche system, which was difficult to align and maintain. Moreover, the carriers holding the microfiche had to be replaced frequently due to scratches on the surfaces that created disturbing streaks on the projection screen. In addition, dust accumulated on the mirrors, lens, and the microfiche itself, creating large "blobs" on the projection screen. Changes to the system to eliminate these faults during the research period would have required extensive modifications that were beyond the scope of the current task. These problems did, however, lead to selection of a videodisc for image presentation and touch panels for input for the EEMT (Device No. 11B106).

During the course of the research, there were three complete turnovers of instructor personnel, with resulting differences in instruction and test monitoring. In addition, there were administrative changes, including a reduction in the number of replacement opportunities during Experiments 2 and 3, each of which altered the climate in which the research was conducted. For example, the reductions in completion times in the later stages of the research are an indication of increased pressure being applied to the students during the research.

A third problem was with errors in the data base. Even though the data base developer and available subject matter experts (instructors) reviewed the training in detail prior to the start of the research, data base errors kept cropping up throughout the experimental period. Student use uncovered missing images, improper test equipment readings, and improperly defined touch points. While these errors were not fatal to the simulation, they were irritating to both the students and their instructors. Some errors

were corrected on the spot or in very short order. Some errors remained throughout the entire experimental period, however, producing negative feelings.

In spite of the problems that impacted the final results, the trainer was shown to provide effective transfer. Learning with the trainer required approximately the same time as using actual equipment and transferred successfully to use of actual equipment. While students and instructors may have preferred the use of actual equipment, the trainer simulator provided an effective way to supplement training. In the present instance, it reduced overall training time by providing more units. In other circumstances, it could provide training not otherwise available to students.

CONCLUSIONS

This trio of experiments demonstrated that the GMTS concept can be an effective alternative to the use of actual equipment in the training environment. The results suggest that the EEMT, which incorporates improvements such as touch panels and a videodisc system rather than the Graf-pen and microfiche projector, should be even more effective than the GMTS and will provide meaningful training in electronic maintenance techniques and equipment familiarization. The EEMT can provide a means to expedite training and to reduce training costs. Its use will reduce safety hazards to personnel and equipment and will provide opportunities for more practice in those situations where the availability or usability of actual equipment is limited.

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APPENDIX

STUDY QUESTIONNAIRES

EXPERIMENTAL GROUP QUESTIONNAIRE

1. Name _____ Student # _____

2. Rating _____

3. Number of years experience in fleet electronics _____

4. AESD student _____
   Yes/No

5. Education level _____
   Years 1-16

6. Are you a graduate of:

   a. Naval Electronics "A" School? _____
      Yes/No

   b. Naval Electronics "B" School? _____
      Yes/No

   c. Approxmate number of "C" Schools attended? _____

7. Previous experience on WSC-3 systems? _____ _____
   Yes/No Years

8. Previous experience with other communications equipment? _____ _____
   Yes/No Years

CIRCLE THE LETTER IN FRONT OF ONE CHOICE FOR EACH QUESTION

1. Compared to other experiences with similar subject matter, my experience with the BTL trainer for troubleshooting practice was:

   a. Much more enjoyable.
   b. More enjoyable.
   c. About as enjoyable.
   d. Less enjoyable.
   e. Much less enjoyable.

2. As a technique for learning and practicing troubleshooting, the BTL trainer was:

   a. Very effective.
   b. Effective.
   c. Both effective and ineffective.
   d. Somewhat ineffective.
   e. Very ineffective.

3. The BTL trainer was:

   a. Very easy to use.
   b. Easy to use.
   c. Neither easy nor difficult to use.
   d. Difficult to use.
   e. Very difficult to use.

4. The initial instruction given on how to use the BTL trainer was:

   a. Much more than adequate to my needs.
   b. More than adequate to my needs.
   c. Adequate to my needs.
   d. Less than adequate to my needs.
   e. Much less than adequate to my needs.

5. It took me the following time to learn to use the BTL trainer:

   a. About 1/2 hour or less.
   b. About 1 hour.
   c. About 1-1/2 hours.
   d. About 2 hours.
   e. More than 2 hours.

6. Setting switches by use of the touch-pen was:

   a. Very easy.
   b. Easy.
   c. Neither easy nor difficult.
   d. Difficult.
   e. Very difficult.

7. Using the simulated test equipment (oscilloscope and multimeter) by means of the touch-pen was:

a. Very easy.
b. Easy.
c. Neither easy nor difficult.
d. Difficult.
e. Very difficult.

8. The microfiche slides were:

a. Very easy to interpret.
b. Easy to interpret.
c. Both easy and difficult to interpret.
d. Difficult to interpret.
e. Very difficult to interpret.

9. The symptoms exhibited by the BTL trainer for the malfunctions were:

a. Very accurate.
b. Generally accurate.
c. Both accurate and inaccurate.
d. Generally inaccurate.
e. Very inaccurate.

10. For me, the problems on the BTL trainer were:

a. Much too difficult.
b. Too difficult.
c. About the correct difficulty.
d. Too easy.
e. Much too easy.

11. The amount of troubleshooting practice in the course was:

a. Much too little.
b. Too little.
c. About the right amount.
d. More than necessary.
e. Much more than necessary.

12. If I had 20 hours to practice system troubleshooting, I would divide my time as follows between the BTL trainer and the actual WSC-3 equipment:

_____ hours on the BTL trainer.
_____ hours on actual equipment.

13. Prior to this course I was:

a. Very familiar with the WSC-3.
b. Familiar with the WSC-3.
c. Somewhat familiar with the WSC-3.

d. Not very familiar with the WSC-3.
e. Not at all familiar with the WSC-3.

We are interested in your comments, especially if you have ideas or criticisms that are not conveyed by your responses to the questions above.

My comments:

CONTROL GROUP QUESTIONNAIRE

1. Name _____ Student # _____

2. Rating _____

3. Number of years experience in fleet electronics _____

4. AESD student _____ Yes/No

5. Education level _____ Years 1-16

6. Are you a graduate of:

   a. Naval Electronics "A" School? _____ Yes/No

   b. Naval Electronics "B" School? _____ Yes/No

   c. Approxmate number of "C" Schools attended? _____

7. Previous experience on WSC-3 systems? _____ Yes/No _____ Years

8. Previous experience with other communications equipment? _____ Yes/No _____ Years

CONTROL GROUP QUESTIONNAIRE

1. Compared to other experiences with similar subject matter, my experience with the actual WSC-3 equipment for troubleshooting practice was:

a. Much more enjoyable.
b. More enjoyable.
c. About as enjoyable.
d. Less enjoyable.
e. Much less enjoyable.

2. As a technique for learning and practicing troubleshooting, the WSC-3 equipment was:

a. Very effective.
b. Effective.
c. Both effective and ineffective.
d. Somewhat ineffective.
e. Very ineffective.

3. The WSC-3 equipment was:

a. Very easy to use.
b. Easy to use.
c. Neither easy nor difficult to use.
d. Difficult to use.
e. Very difficult to use.

4. Setting switches on the WSC-3 equipment was:

a. Very easy.
b. Easy.
c. Neither easy nor difficult.
d. Difficult.
e. Very difficult.

5. Using the test equipment (oscilliscope and multimeter) was:

a. Very easy.
b. Easy.
c. Neither easy nor difficult.
d. Difficult.
e. Very difficult.

6. For me, the problems on the WSC-3 equipment were:

a. Much too difficult.
b. Too difficult.
c. About the correct difficulty.
d. Too easy.
e. Much too easy.

7. The amount of troubleshooting practice in the course was:

   a. Much too little.
   b. Too little.
   c. About the right amount.
   d. More than necessary.
   e. Much more than necessary.

8. Prior to this course, I was:

   a. Very familiar with the WSC-3.
   b. Familiar with the WSC-3.
   c. Somewhat familiar with the WSC-3.
   d. Not very familiar with the WSC-3.
   e. Not at all familiar with the WSC-3.

We are interested in your comments, especially if you have ideas or criticisms that are not conveyed by your responses to the questions above.

My comments:

COMPARISON QUESTIONNAIRE

1. Name _____ Student # _____

2. Rating _____

3. Number of years experience in fleet electronics _____

4. AESD student _____
   Yes/No

5. Education level _____
   Years 1-16

6. Are you a graduate of:

   a. Naval Electronics "A" School? _____
      Yes/No

   b. Naval Electronics "B" School? _____
      Yes/No

   c. Approximate number of "C" Schools attended? _____

7. Previous experience on WSC-3 systems? _____ _____
   Yes/No Years

8. Previous experience with other communications equipment? _____ _____
   Yes/No Years

CIRCLE THE LETTER IN FRONT OF ONE CHOICE FOR EACH QUESTION

1. Compared to other training experiences with similar subject matter, my experience with the BTL trainer for troubleshooting practice was:

   a. Much more enjoyable.
   b. More enjoyable.
   c. About as enjoyable.
   d. Less enjoyable.
   e. Much less enjoyable.

2. As a technique for learning and practicing troubleshooting, the BTL trainer was:

   a. Very effective.
   b. Effective.
   c. Both effective and ineffective.
   d. Somewhat ineffective.
   e. Very ineffective.

3. As a technique for learning and practicing troubleshooting, the real equipment was:

   a. Very effective.
   b. Effective.
   c. Both effective and ineffective.
   d. Somewhat ineffective.
   e. Very ineffective.

4. The BTL trainer was:

   a. Very easy to use.
   b. Easy to use.
   c. Neither easy nor difficult to use.
   d. Difficulty to use.
   e. Very difficult to use.

5. The initial instruction given on how to use the BTL trainer was:

   a. Much more than adequate to my needs.
   b. More than adequate to my needs.
   c. Adequate to my needs.
   d. Less than adequate to my needs.
   e. Much less than adequate to my needs.

6. It took me the following time to learn to use the BTL trainer:

   a. About 1/2 hour or less.
   b. About 1 hour.
   c. About 1-1/2 hours.
   d. About 2 hours.
   e. More than 2 hours.

7. Setting switches by use of the touch pen was:

a. Very easy.
b. Easy.
c. Neither easy nor difficult.
d. Difficult.
e. Very difficult.

8. Using the simulated equipment (oscilloscope and multimeter) by means of the touch-pen was:

a. Very easy.
b. Easy.
c. Neither easy nor difficult.
d. Difficult.
e. Very difficult.

9. The microfiche slides were:

a. Very easy to interpret.
b. Easy to interpret.
c. Both easy and difficult to interpret.
d. Difficult to interpret.
e. Very difficult to interpret.

10. The symptoms exhibited by the BTL trainer for the malfunction were:

a. Very accurate.
b. Generally accurate.
c. Both accurate and inaccurate.
d. Generally inaccurate.
e. Very inaccurate.

11. For me, the problems on the BTL trainer were:

a. Much too difficult.
b. Too difficult.
c. About the correct difficulty.
d. Too easy.
e. Much to easy.

12. The amount of troubleshooting practice in the course was:

a. Much too little.
b. Too little.
c. About the right amount.
d. More than necessary.
e. Much more than necessary.

13. If I had 20 hours to practice system troubleshooting, I would divide my time as follows between the BTL trainer and the actual WSC-3 equipment:

_____ hours on the BTL trainer.
_____ hours on actual equipment.

14. Prior to this course I was:

a. Very familiar with the WSC-3.
b. Familiar with the WSC-3.
c. Somewhat familiar with the WSC-3.
d. Not very familiar with the WSC-3.
e. Not at all familiar with the WSC-3.

We are interested in your comments, especially if you have ideas or criticisms that are not conveyed by your responses to the questions above.

My comments:

_____

_____

_____

_____

_____

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