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Analysis of Navy Technical School Training Objectives for Microcomputer Based Training Systems

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C. Douglas Wetzel, Ph.D.
Donald L. Van Kekerix, Ph.D.
Wallace H. Wulfeck II, Ph.D.

Approved by
Edwin G. Aiken, Ph.D.

Released by
B. E. Bacon
Captain, U.S. Navy
Commanding Officer

and

J. S. McMichael, Ph.D.
Technical Director

Navy Personnel Research and Development Center
San Diego, California 92152-6800

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C. Douglas Wetzel, Donald L. Van Kekerix, and Wallace H. Wulfeck II

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The relative frequency of different types of training requirements was determined through analysis of 34,373 training objectives in 246 Navy technical training courses according to the Instructional Quality Inventory (IQI) classification scheme. From this profile generalizations are made about the applicability of various computer-based instructional (CBI) methods to meet these requirements.

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FOREWORD

This work was funded as part of the Advanced Development project, entitled Low Cost Micro-computer Training systems (Program Element Number 63720N), Work Unit Number Z-1772-ET002). The project was the result of an operational requirement promulgated by the CNO (OP-987H, OP-01B7).

This report examines the training requirements of 246 Navy technical training courses based on an analysis of their training objectives according to a systematic classification scheme. The resulting objective profile is the basis for generalizations about the applicability of various computer-based instructional methods to different types of training objectives.

NPRDC TR 86-25 surveyed the instructional delivery and course management practices of 135 Navy technical training courses and assessed how appropriate and acceptable microcomputer support would be for them.

The results of the present study are primarily intended for the Department of the Navy training community.

B. E. BACON
Captain, U.S. Navy
Commanding Officer

J. S. McMICHAEL
Technical Director

SUMMARY

Problem

The Navy's need for skilled technical personnel is increasing due to the increasing complexity of equipment and number of ships in the Navy. Additionally, recent initiatives to move some shore-based training to shipboard sites will make training and training management more diffuse and harder to conduct in the future.

One response to increased training needs grows out of the long standing interest in exploring the usefulness of microcomputers in military training to improve the delivery of instruction, supplement instructor resources, and provide management tools. Low-cost personal computers (PCs) are now very affordable and may be used to supplement instructor resources or improve the delivery of instruction. Appropriate computer-based instructional strategies can be molded to the task and content of the instructional objectives. However, the application of low-cost personal computers (PCs) for various Navy technical training courses should be guided by an assessment of the types of objectives they employ.

Purpose

This research was conducted to determine a profile of the training requirements through an analysis of actual Navy training objectives and, based on this profile, to make generalizations about the applicability of various computer-based instructional methods to meet these requirements.

Approach

Curriculum outlines and instructor guides from 246 Navy technical training courses, yielded 34,373 training objectives for analysis. The Instructional Quality Inventory (IQI) was used to classify the objectives into 18 categories according to (1) the type of task the student must perform (i.e., Remember or Use) and (2) the type of information the student must learn (i.e., the instructional content of Facts, Categories, Procedures, Rules, and Principles).

Results

About 10 percent of the objectives were major terminal objectives. The remaining 90 percent were enabling objectives that prepare a student to learn the terminal objectives. There was a general trend of enabling objectives to be Remember tasks and terminal objectives to be Use tasks. Fact and Procedure objectives were overwhelmingly the most frequent with Principles a far distant third. The Fact objectives were Remember tasks and generally enabling objectives, while the Procedure objectives were Use tasks and more often terminal objectives. The introductory, familiarization knowledge characteristic of entry A-schools was shown in their use of more Fact objectives than found in advanced C- and F-schools, while the skilled performance nature of these advanced courses was evident in their use of more Procedure and Principle objectives. Predominate emphasis for Use-procedure objectives was found for mechanical, operator, and team occupation courses. Use objectives for Procedures as well as for Rules and Principles were found for electrical and clerical/administrative courses.

Discussion and Conclusions

The substantial requirements for memory and procedures training are applicable to computer-based instruction when drill and practice is so extensive or responses must be so precise that the student-instructor ratio or instructor patience make the traditional classroom setting less practical. Such computer-based instruction can often be relatively easy to implement for learning extensive technical knowledge bases (e.g., remembering facts), or repetition or practice of procedures with equipment, team situations, and other job sequences requiring the learner to run through procedures until well learned.

Application of computer-based instruction should be justified by some beneficial effect like reduced training time or costs, increased instructor flexibility, instructional standardization, on-site individualized training needs, or capability to perform functions not possible without the computer or that are too dangerous, too time consuming, or too expensive to include in the hands-on phase of training. Specific training objectives or course components can be trained with computer-based instruction to supplement limited instructor resources, a use that does not entail computerizing entire curricula.

Subject matter experts who do not possess sophisticated programming skills will need computer-based instruction authoring aids that make these technologies easier to implement. In addition to "how to" aids, they will also need guidelines concerned with "when and what" instruction should be computerized.

Recommendations

The following recommendations are for the Navy education and training community:

1. Selection and introduction of computer-aided and computer-managed instruction into specific Navy schools should be based on the nature of the training objectives, the level of training to be provided, and availability of laboratory equipment and trainees.

2. The high emphasis on training objectives for remembering facts and using procedural steps in Navy schools should be supported with computer-based instruction involving drill and practice and simulation.

3. Computer-aided instruction should be considered for selected training modules judged to benefit from conversion, rather than for all types of curricula. Situations suitable for selective application of computer-based instruction include supplementing instructor resources, laboratories and trainers with excessive wait times, presentation of introductory or familiarization materials, tasks requiring high levels of practice, dynamic graphic representations of difficult concepts, and simulated procedures training in equipment operation and maintenance.

4. Recent initiatives to move some shore-based training to shipboard sites should be supported where appropriate with standard computer-aided instructional delivery and management packages.

5. Continuing work should be supported to develop guidelines as to when computer-based instruction is appropriate and to develop technical aids for authors so they can develop quality computer-based instruction for their students. Many specific computer-based instruction capabilities can be provided by the Computer-based Educational Software System (CBESS) on Navy standard microcomputers.

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INTRODUCTION

Problem and Background

The Navy's need for skilled technical personnel is increasing. This need is driven by the increasing complexity of equipment and the expansion of the number of ships in the Navy. Fleet readiness could eventually be impaired by the more immediate need to assign senior technical personnel to the Fleet instead of to instructor billets. Additionally, recent initiatives to move training out of shore-based schools and into the Fleet will make training and training management even more diffuse and harder to manage in the future. These conditions create a need for more and better trained personnel to attain mandated levels of operational readiness and effectiveness. Increased training needs could be met with more instructors, expanded training facilities, contracted instructors, increased efficiency of current training, or some combination of these.

There has been a long standing interest in exploring the usefulness of microcomputers in military training with the intent to improve the delivery of instruction, supplement limited instructor resources, and to provide management tools (Blaiwes & Regan, 1986; Fletcher & Rockway, 1986). A recurrent problem for training has been that different computers will often not share the same programs, requiring expensive recoding to transport previous work. Fortunately, market forces in recent years have had the beneficial effect of standardizing computer hardware, which has created confidence in investing in systems that will not become obsolete or unavailable overnight.

Low-cost personal computers (PCs) are now quite affordable and may be used to supplement instructor resources or improve the delivery of instruction. Office automation is commonplace and many of us now use PCs to compose, correspond, keep records, tabulate, and even communicate electronically. Simply having low-cost PCs widely available, however, is not sufficient reason to use them for training. Each application should be justified by some beneficial effect such as reduced cost, increased instructor flexibility, instructional standardization, or the ability to perform functions that cannot be performed without the computer or that are too dangerous, too time consuming, or too expensive to be included in the hands-on phase of training.

Appropriate computer-based instructional strategies can be molded to different types of instructional objectives. On a global level, two convenient labels for broad application approaches are computer-aided instruction (CAI) for delivering instruction to students, and computer-managed instruction (CMI) for many administrative aspects of testing, scoring, study assignments, record keeping, tracking, or scheduling. The terms computer-based instruction (CBI) or computer-based training (CBT) are often used to mean either CAI or CMI. More specific levels of CAI applications differ with the task and content of the instruction. CAI can provide various types of instruction such as simulations of principles, drill and practice in remembering facts, and learning procedures for operating or maintaining a piece of equipment.

An indicator of the type of instruction provided by a course is the mix of the kinds of learning objectives used to support the instruction. The application of CBI techniques for various Navy schools' training objectives would be aided by an assessment of the profile of the type of objectives used by the courses. The Navy has used systematic approaches to training design for several years (e.g., NAVEDTRA 106A, NAVEDTRA 110A, NAVSEA OD45519, MIL-STD-1379C). This means that, for a given course, the instructional content and tests are (or should be) derived from the course training objectives. If, across courses, objectives require similar sorts of student performance, then similar sorts of instructional delivery and evaluation methods are likely to be appropriate across those courses too. Thus, if objectives are categorized, then the proportions of objectives in the various categories provide a rough measure of the existing requirements for various instructional delivery capabilities. Documentation of existing patterns may also provide the basis for future emphasis on other patterns of instruction.

NAVPERSRANDCEN developed a scheme for classifying objectives as part of the Instructional Quality Inventory (IQI) (Montague, Ellis, & Wulfeck, 1983). The IQI scheme classifies objectives according to (1) what the student must do (i.e., the task the student must perform), and (2) the instructional content (i.e., the type of information the student must learn). Both content and tasks can be subdivided, as shown later. More generally, the IQI provides a systematic methodology for reviewing the three major products of the Instructional Systems Development (ISD) process (objectives, test items, and instruction) before conducting student tryouts.

Purpose

This research was conducted to determine a profile of Navy training requirements through an analysis of actual Navy training objectives and, based on this profile, to make generalizations about the applicability of various computer-based instructional methods to meet these requirements.

APPROACH

Sample Selection

The curriculum outlines and instructor guides from 246 Navy technical training courses provided the sample of training objectives. These courses represent about 5 percent of all training courses in the Navy (approximately 4,800). The courses sampled included a wide distribution of occupational skill groups (mechanical, clerical, electrical, operator, team, health science), course durations, annual student throughputs, and class sizes. This sample also represents about half of the A-school or entry level courses in the Navy and less than 5 percent of the advanced courses in C- and F-schools in the Navy. Class A or entry level courses are deliberately overrepresented because they generally have the largest student throughput and, therefore, would benefit more from computer assistance that increased efficiency or effectiveness. Additionally, entry level courses sometimes have the manpower and resources to support the development of computer based or managed instruction.

The initial sample consisted of 50 entry level or A-school courses and 207 advanced or C- and F-school courses. Eleven of the 207 advanced course curricula available had objectives that could not be classified by using IQI procedures. Therefore, the final sample consisted of 246 courses, which consisted of 50 A-courses, 93 C-courses, and 103 F- or functional courses. A listing of these courses is given in Appendix A.

Objective Analysis Procedure

The unclassified curriculum outlines and instructor guides of the 246 courses provided the data for an IQI analysis of the training objectives. Informal comparisons with classified training objectives in the same occupational areas disclosed no discernible differences in the type or number of training objectives involved.

The analysis was conducted according to the standards and procedures set forth in the IQI manuals (Ellis, Wulfeck, & Fredericks, 1979; Wulfeck, Ellis, Richards, Wood, & Merrill, 1978) and the Handbook for Testing in Navy Schools (Ellis & Wulfeck, 1982). Raters were trained to work independently in applying IQI rating procedures. Spot checks were conducted by one of the developers of the IQI to assure adherence to IQI principles and standards. The consistency of the ratings was also checked by having several raters classify the same course. The raters generally agreed in their ratings of well written objectives, but they found sub-standard objectives more difficult to classify consistently. Disagreements were submitted to the rater group for discussion and consensus. These objectives and the consensus classification were reproduced for use as guidelines for handling later occurrences of similar objectives.

The raters used two of the three steps in the IQI classification procedure to rate the objectives for this analysis. They first rated the writing of the objectives according to whether they clearly stated the conditions, task, content, and standards. About a quarter of the objectives rated did not meet one or more of the IQI criteria for an adequate objective. The most common faults were failure to include standards of performance, failure to specify the conditions of performance, or requiring multiple actions. Strict application of the IQI criteria would require labeling these objectives as unclassifiable. However, the raters accepted any objective in which the intent could be inferred. Thus, the Results Section understates the actual number of unclassifiable objectives.

For the second step of the IQI procedure, the raters classified each objective according to what the student was required to do with the information to be learned (task), and the type of information the student was to learn (content). The IQI task/content matrix, shown in Table 1, illustrates the 18 possible task/content combinations. Note that facts can only be remembered since they are just knowledge, while other content classes can either be remembered or used (i.e., a skill that is performed). The third step of the IQI procedure (presentation adequacy and consistency) evaluates the instructional material's coverage of the course objectives and was not relevant to this research.

The raters also recorded if the curriculum outline classified an objective as a terminal or enabling objective. Terminal objectives indicate the major attainments a student is expected to master. Enabling objectives indicate what the student needs to learn to master some terminal task. Because a few courses labeled some objectives that were subordinate to enabling objectives as "learning steps," all learning steps were included with the enabling objectives.

RESULTS

The purpose of the data analysis was to establish a profile of findings about training objectives in current usage. These findings then enabled interpretations later in the discussion about the applicability of various computer-based instructional methods to the different types of training objectives.

Table 1

IQI Task/Content Matrix

Task	Content				
	Fact	Category	Procedure	Rule	Principle
Remember-recall					
Remember-recognize					
Use-unaided	NA				
Use-aided	NA				

Note. NA = not applicable.

Content[a] descriptions: The various content categories are defined as follows:

1. Facts are simple associations between objects, names, locations, etc., that can only be remembered.
2. Categories are classifications defined by specified sets of characteristics.
3. Procedures are ordered sequences of operations performed on a single object or in a specific environment.
4. Rules are also ordered operational sequences that are generalized to more than one object or to a variety of environments.
5. Principles involve explanations, predictions, or diagnoses based on theoretical or cause-effect relationships.

Task[b] descriptions: The two main task types are Remember and Use. Each is divided into the following two subtasks:

1. Remember-recognize tasks require the student to identify information that is provided (e.g., choose among alternatives shown).
2. Remember-recall tasks require the student to provide or produce information from memory.
3. Use-unaided tasks require the student to do something with recalled information.
4. Use-aided tasks require the student to do something with information that is provided.

[a]Examples of these content categories are given in Ellis and Wulfeck (1982) and Ellis, Wulfeck, and Fredericks (1979).

[b]Examples of the action verbs associated with each task type are given in Ellis and Wulfeck (1982).

Data Base Characteristics

The 246 courses examined contained 34,420 objectives. Of these, 47 objectives could not be classified, leaving 34,373 objectives to be analyzed. Table 2 summarizes the number of objectives in each of the 18 IQI task/content categories. These objectives consisted of 3,151 (9.2%) terminal objectives that were supported by 31,222 (90.8%) enabling objectives or roughly ten enablers per terminal objective. A complete breakdown of the enabling and terminal objectives has been included in Appendices B and C in terms of averages, standard deviations, and medians. Figure 1 shows these data converted to percentages of either the total number of enabling or terminal objectives. These percentages were computed separately for enabling and terminal objectives because the enabling objectives were far more numerous than the terminal objectives. Each enabling frequency was divided by 31,222 and each terminal frequency was divided by 3,151.

The data base was characterized by a high degree of variability because most courses tended to use just a few of the 18 task/content categories, leaving zero frequencies for the remaining task/content categories. Combining over courses, all task/content categories had a modal frequency of zero (i.e., more zero frequencies than any other frequency count). When the number of objectives in any one cell of the task/content matrix was ranked for all the courses, the median objective frequency was greater than zero in only 4 out of 36 instances (See Appendices B and C). An additional source of variability was that the sum total number of objectives in single courses ranged widely (from 1 to 3,155). Analyses presented later attempt to adjust for this variability when sorts based on occupation groups reduce the number of objectives in a task/content category.

Table 2

Number of Learning Objectives in Each
IQI Task/Content Category

	Content: Number of Objectives					
Task	Fact	Category	Procedure	Rule	Principle	Total
Remember-recall	7,446	1,384	1,229	185	2,202	12,446
Remember-recognize	6,684	770	558	139	842	8,993
Use-unaided	NA	560	6,132	1,577	943	9,212
Use-aided	NA	299	2,884	326	213	3,722
Total	14,130	3,013	10,803	2,227	4,200	34,373

Note. Analyses do not include 47 unclassifiable objectives.

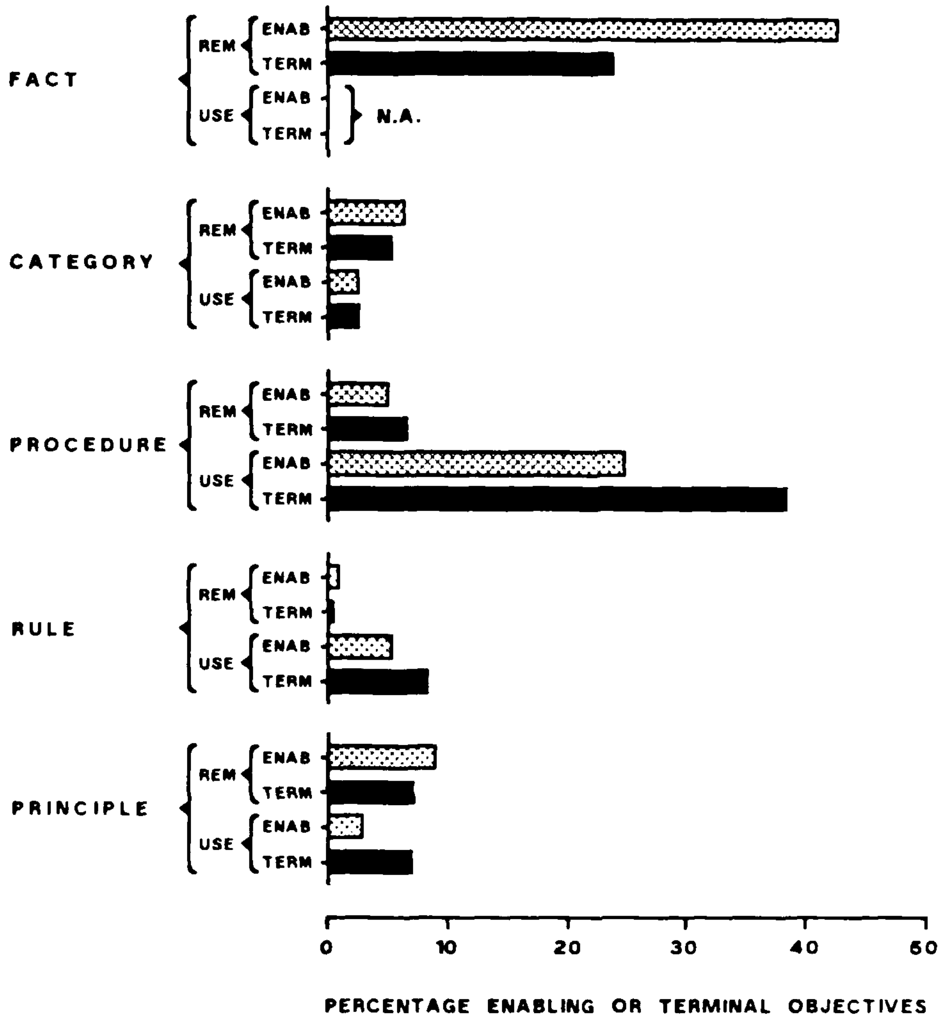

Figure 1. Breakdown of enabling and terminal objectives by task.

Task/Content Patterns

Both Table 2 and Figure 1 show that Navy training is heavily involved with Facts and Procedures. First, the largest number of the objectives address Facts. Facts are taught somewhat more often as Recall or production tasks than they are as Recognize tasks requiring simple identification. These two Remember tasks are more frequent than the two Use tasks. While enabling objectives are most often Facts (43%), Figure 1 shows that 24 percent of terminal objectives are also Facts. Fact and Category enabling objectives support many Procedure terminal objectives. While 25 percent of the enabling objectives and 38 percent of the terminal objectives address Procedures, most Procedures are Use tasks not Remember tasks. Rule content is proportionately less frequent than Procedure content, although they both show a similar pattern of usage in Figure 1. Other patterns to note in these data are that Category and Principle content objectives appear to involve more Remember than Use tasks. The third most frequent content (after Facts and Procedures) is with Principles. Lastly, Use-unaided tasks are between two and three times as frequent as are Use-aided tasks.

Breadth of Task/Content Usage

The breadth of objective use was analyzed to determine the need for multiple instructional delivery methods in a course. The breadth of task/content categories refers to whether a course contained objectives in a few or many different task/content categories. In the preceding analysis, a few individual courses with extremely high frequencies were revealed which could affect the pattern of observed usage. One way of characterizing such data is to examine how many courses employed each type of objective, regardless of how often they did so. Table 3 shows the percentage of the 246 courses that contained at least one objective for each of the 18 task/content categories. These objective percentages were calculated separately for enabling and terminal objectives. Since the percentages were calculated within each task/content category and most courses made use of more than one task/content category, the percentages sum to more than 100 percent.

In Table 3, the highest percentages of enabling objectives were obtained for Facts and Procedures. However, the Category, Rule, and Principle content objectives now appear relatively more prominent than in Figure 1. By reducing the effect of a few courses with high frequencies, this measure of usage indicates that these courses contained objectives in more different task/content categories than indicated above with the overall frequency measure. Since 90 percent of the objectives are enabling objectives, essentially the same pattern shown here was also obtained for all objectives combined. Terminal objectives, on the other hand, show a different pattern with the task/content percentages generally much lower. Use-procedure objectives are most prevalent and Remember-fact objectives are much less frequent.

Figure 2 presents the distribution of the breadth of task/content usage separately for enabling and terminal objectives. Figure 2 shows the percentage of courses using a given number of task/content categories. Over all objectives, the number of different task/content categories in a single course ranged widely from 1 to 17 (out of 18 possible). There is a wide spread in the number of IQI task/content categories for enabling objectives. Nearly two thirds (63%) of the courses employ enabling objectives in six or less task/content categories. But, for terminal objectives, two thirds (63%) of the courses used objectives in three or less task/content categories. These usage patterns indicate that many more task/content categories of enabling objectives support relatively few task/content categories of terminal objectives. Overall, a mixture in the types of objectives for a course would indicate a mixture instructional delivery methods to be used with CBI.

Analysis of the curricula of individual courses revealed two structural styles of objective hierarchies. In one type, several enabling objectives supported a few terminal objectives. Often one terminal objective was served by several lessons. In the second type, the course contained substantially more terminal objectives. Usually each lesson addressed several terminal objectives, each supported by several enabling objectives, often with learning steps at several levels. The number of levels of learning steps supporting an enabling objective ranged from zero to six. In several curricula, as many as five or six learning steps supported a single enabling objective, evidencing exhaustive

Table 3

Percent of Courses Using Each Task/Content Category at Least Once

Task	Content: Course Objectives (%)				
	Fact	Category	Procedure	Rule	Principle
Enabling Objectives					
Remember-recall	64.2	30.1	41.1	13.0	32.9
Remember-recognize	55.7	28.9	26.0	13.0	28.0
Use-unaided	NA	25.2	67.1	40.7	30.1
Use-aided	NA	15.4	42.7	20.3	13.0
Terminal Objectives					
Remember-recall	32.9	10.6	20.3	4.1	18.3
Remember-recognize	20.7	9.8	10.2	1.2	10.2
Use-unaided	NA	8.9	58.9	26.0	22.8
Use-aided	NA	2.0	36.6	9.3	7.7

Note. NA = not applicable.

analysis during the development process. These structural styles did not appear to be related to the sorting criteria here, but apparently reflected the individual preferences of instructional developers. For example, both the advanced and entry courses showed roughly the same 1 to 10 ratio between terminal and enabling objectives.

Effect of Course Duration

The total number of classifiable objectives in each course (terminal objectives plus enabling objectives) was sorted into five groups based on course duration. Table 4 shows that one third of the courses surveyed lasted 5 days (1 week) or less and 60 percent lasted 20 days or less. The longest course required seven months of instruction; and the shortest, one day. The mean number of objectives per course (Table 4) does not increase linearly

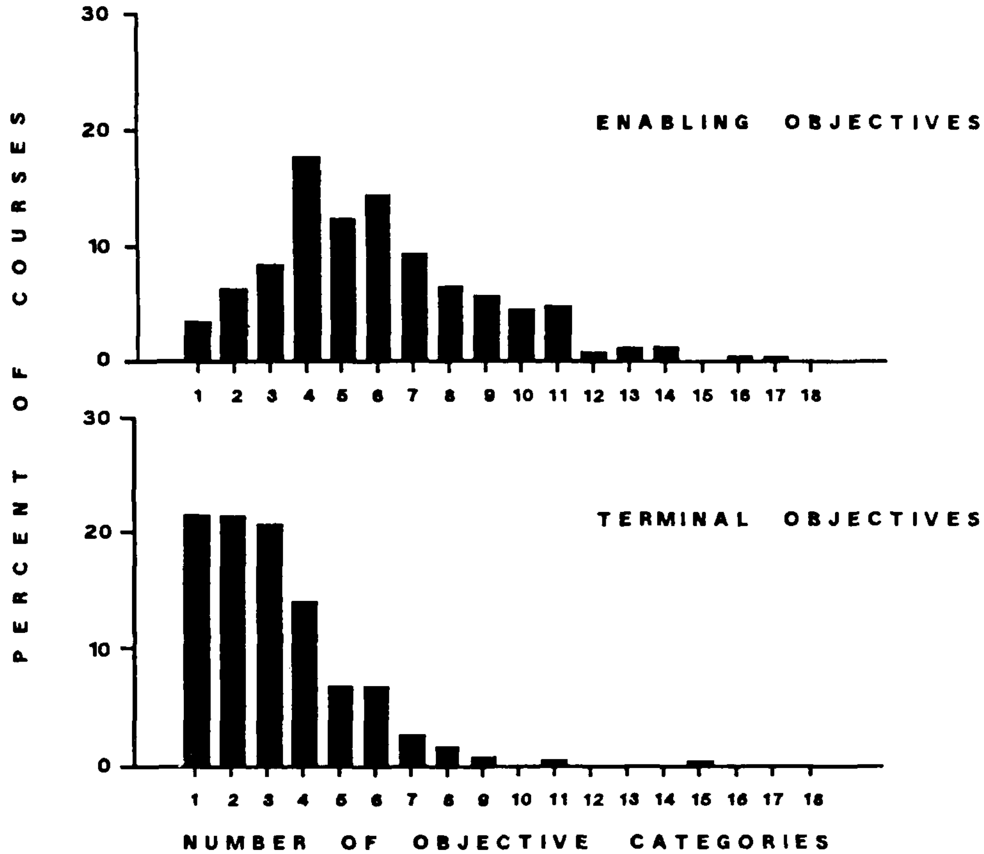

Figure 2. Range of task/content usage.

Table 4

Number of Objectives by Course Duration

Course Duration	Number of Objectives per Course			
	Mean	SD	Median	Total
1 to 5 days	60.2	103.8	30.0	81 (32.9%)
6 to 20 days	136.9	222.7	60.5	66 (26.8%)
21 to 40 days	118.5	87.8	88.5	32 (13.0%)
41 to 80 days	154.2	114.2	117.0	44 (17.9%)
80 plus days	429.8	658.7	189.0	23 (9.3%)

Note. SD = standard deviation.

with course duration. The number of objectives dips in the 6-20 day range and was accompanied by a large standard deviation due to two courses with over 1,000 objectives each, which seriously biased the mean number of objectives. Consequently, medians were computed to obtain a more stable index of central tendency. The medians increase linearly, as expected, and are also substantially smaller than the means, confirming that a few courses with exceptionally large number of objectives biased the means.

Course-by-Course Percentage Transformation

In order to analyze smaller groupings of objectives, a data transformation was developed to account for the bias caused by large variability and the positive relationship between course duration and the number of objectives per course. The biasing effect of a few courses with either extremely high or low objective frequencies was reduced by transforming the data to percentages on a course-by-course basis prior to averaging over courses. Thus, for each individual course, the number of objectives in each of its task/content categories was divided by the total number of objectives in that course. These percentages were then summed over the different courses within each task and content category and averaged by dividing by the number of courses. Figure 3 shows the reduced bias (right-hand bars) from this course-by-course percentage transformation in comparison to percentages based on the entire sample. The other percentages (left-hand

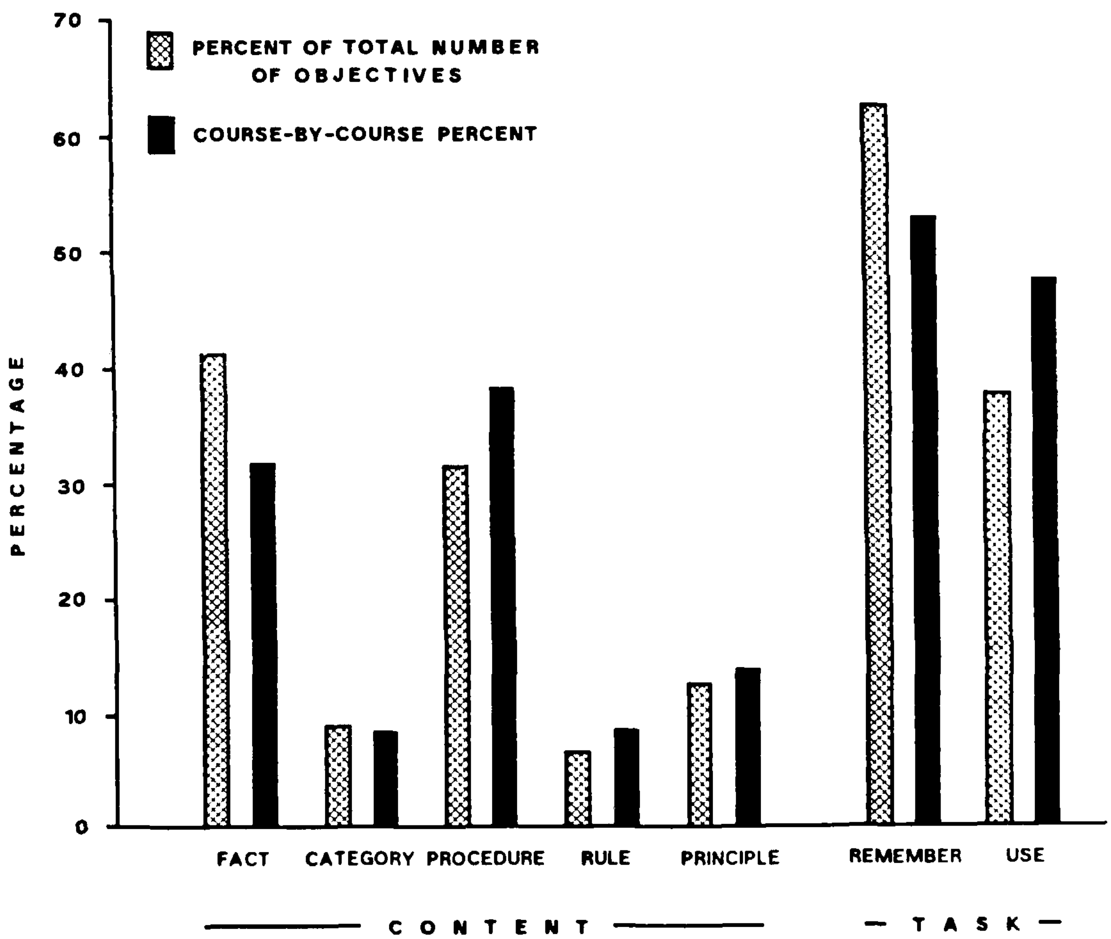

Figure 3. Effects of correction for bias.

bars) were obtained by dividing the number of objectives in a particular task/content cell in Table 2 by the total number of objectives in all courses (34,373).

The most noticeable effect of the course-by-course transformation is a decrease in the emphasis on Facts and an increase in the emphasis on Procedures. Likewise, Remember tasks decreased correspondingly since they involve Facts, and Use tasks increased since they involve Procedures. This reduced bias from the extreme "outlier" cases demonstrates the usefulness of the course-by-course percentage transformation in subsequent analyses that break the data into smaller occupational groupings.

Occupational Course Profiles

The extent to which different training courses have unique or specific patterns of training objectives was examined. To reveal any unique patterns, the courses were categorized into six broad occupational groups (Table 5) and according to whether they were entry or advanced courses. The broad occupational clusters followed those used by Wetzel, Van Kekerix, and Wulfeck (1987) plus health science. The health science group was included for completeness, although it comprised only four courses.

Table 5

Surveyed Courses by Occupational Group

Occupational Group	Number of Courses	Percent of All Courses
Electrical	49	19.9
Mechanical	43	17.5
Clerical/administrative	51	20.7
Health science	4	1.6
Operator	82	33.3
Team	17	6.9
Total analyzed	246	

The number of objectives for each occupational group was converted to percentages by using the course-by-course transformation just described (i.e., computed for each course separately, then averaged over courses). This percentage transformation was employed because dividing the data base into smaller subsets (occupational groups) would accentuate the effects of course duration and extreme frequencies. Figures 4 and 5 show the percentages of enabling and terminal objectives by occupational group and content and task area respectively. A more exhaustive breakdown of these data is given in Appendix D.

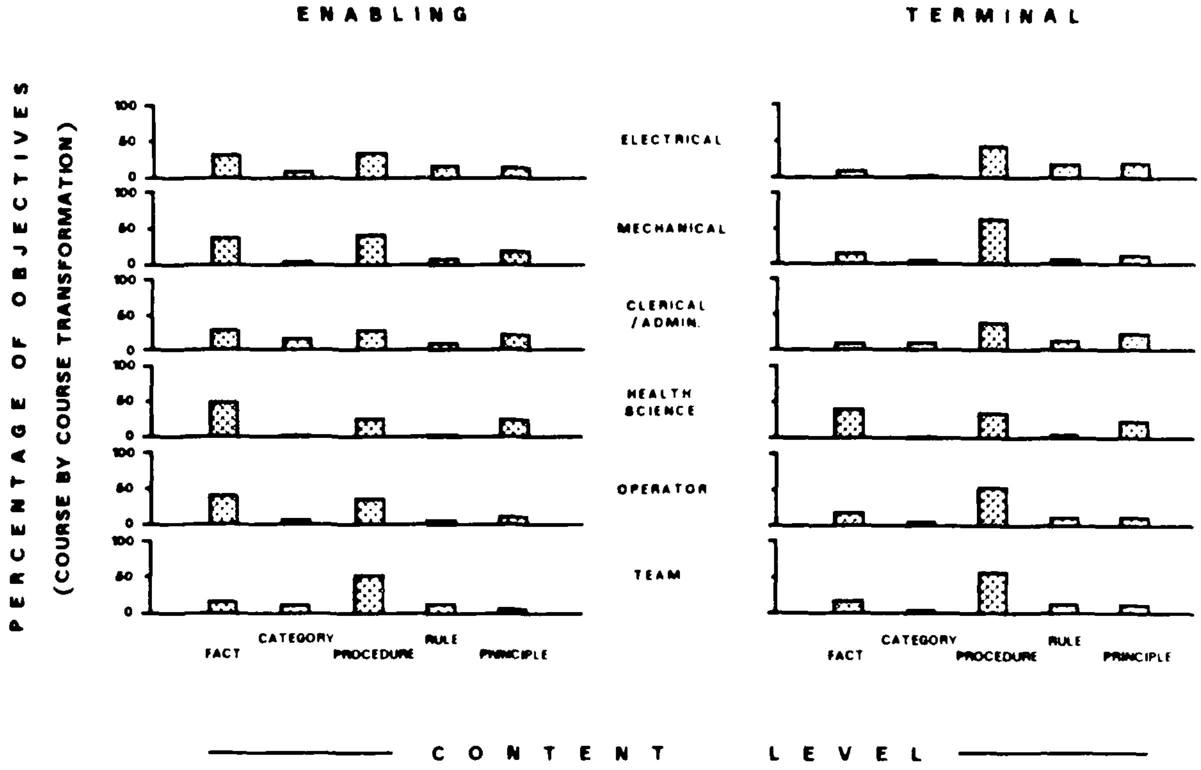

Figure 4. Content emphasis by occupational group.

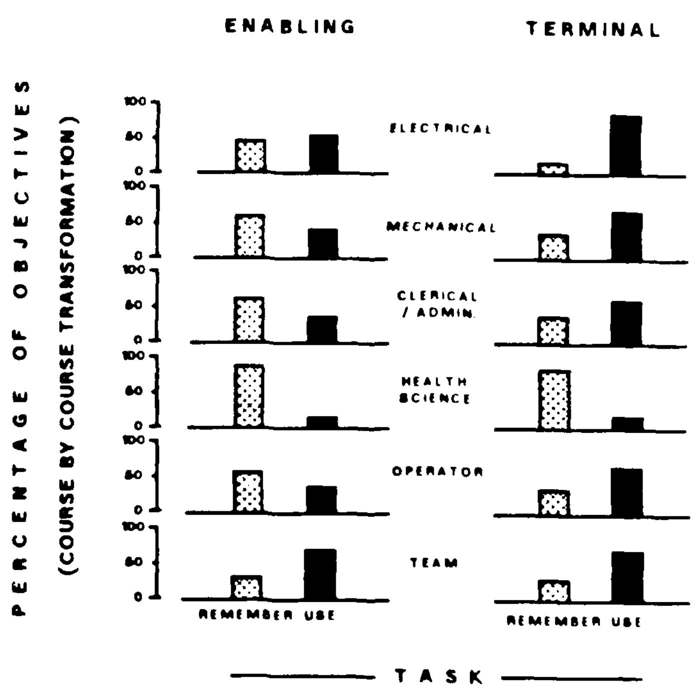

Figure 5. Task emphasis by occupational group.

Figures 4 and 5 show the same overall pattern observed earlier; Facts to be Remembered, Procedures to be used, and, to a lesser extent, Principles are the most frequently occurring objectives. Figures 4 and 5 also show that a greater proportion of enabling than terminal objectives address Remember tasks. At the same time, terminal objectives address more Use tasks than do enabling objectives.

Comparing the occupational groups for Facts reveals that the health science, electrical, mechanical, and operator courses involved many enabling and terminal Fact objectives, while team training involves few Facts. Courses for all groups had few Category objectives with the clerical/administrative courses having the most. Procedures were employed quite frequently by mechanical, operator, electrical and team courses, although the level shown by the remaining groups was not trivial. Rule objectives were used most often by electrical, team, clerical/administrative, and operator courses. Principles were found most often in health science, clerical/administrative, electrical, and mechanical courses.

For each occupational group, both Remember tasks (Recall and Recognize) and both Use tasks (Unaided and Aided) were summed separately for the enabling and terminal objectives to divide the objectives into more "academic" and "hands-on" tasks respectively. Figure 5 shows three different patterns. First, mechanical, clerical/administrative, and operator courses show the most typical pattern of shifting from more Remember than Use enabling objectives to more Use than Remember terminal objectives. Second, electrical courses involve more Use than Remember tasks particularly in terminal objectives. Third, the small number of health courses contain many more Remember than Use objectives, regardless of whether they are enabling or terminal objectives.

Entry and Advanced Course Profiles

An analysis of the level of training was performed to determine if the task/content pattern of training objectives varied between entry courses in A-schools and advanced courses in C- and F-schools. Figure 6 presents these results in terms of the same course-by-course percentage transformation used earlier. Entry courses employ about 12 percent more Remember-fact objectives than do advanced courses. By contrast, the advanced courses employ nearly 6 percent more Procedure and Principle objectives. The entry courses employ about 5 percent more Remember tasks; the advanced courses, about 5 percent more Use tasks.

DISCUSSION AND CONCLUSIONS

Task/Content Patterns

This study identified the pattern that most Navy training course objectives consist of facts and procedures. The bulk of these objectives serve to enable a student to perform a smaller number of terminal objective tasks. Both entry and advanced courses showed this pattern.

Ninety percent of the training objectives were enabling objectives for the remaining 10 percent of terminal objectives. The distinction between enabling and terminal objectives proved to be sensitive to the different measures computed herein and useful for distinguishing among the IQI task/content categories. In general, terminal objectives state the major attainments the developer expects the student to master. The enabling

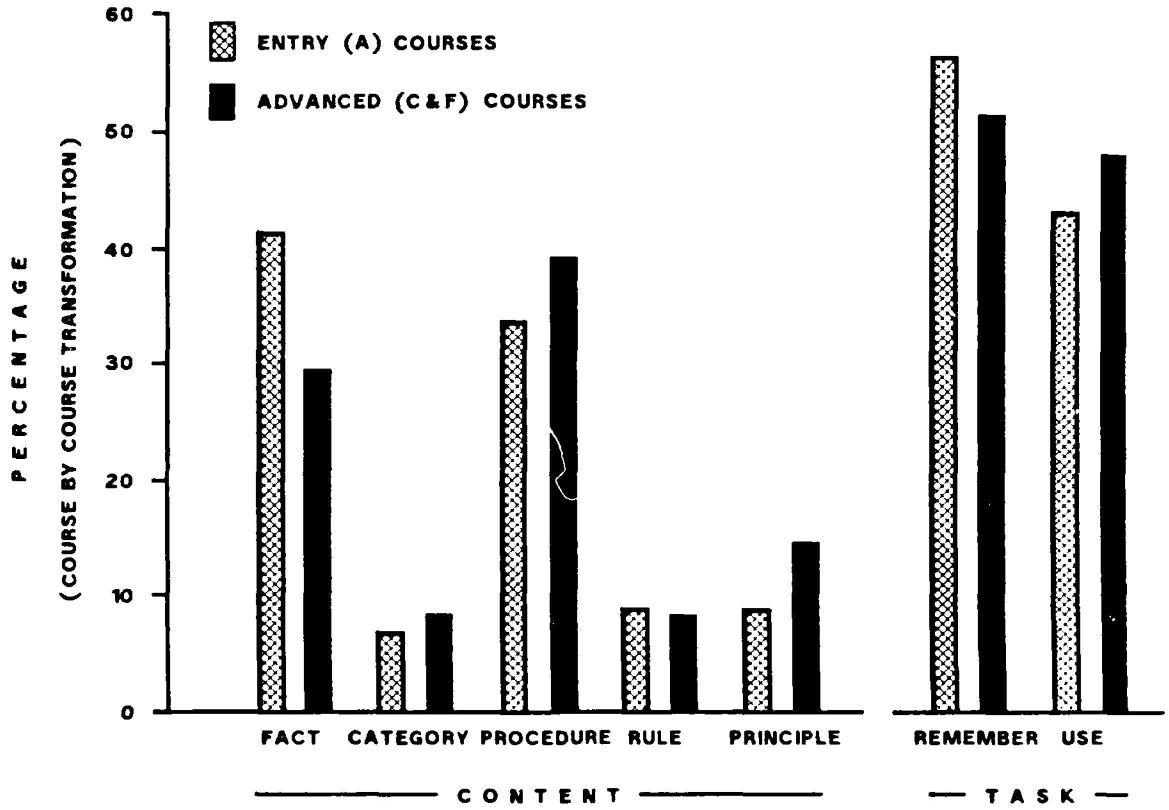

Figure 6. Task/content profile of objectives in entry and advanced courses.

objectives state what the developer expects the student to learn to master the terminal task. Neither set includes items of prior knowledge. Many Rule, Principle, or Procedure terminal objectives may be supported by enabling objectives in other categories, especially Facts. The Fact objectives are necessarily Remember-level tasks (i.e., knowledge) that support performance of other Use-level tasks (i.e., skills).

Fact and Procedure objectives were overwhelmingly the most frequent objectives with their pattern differing meaningfully between terminal and enabling objectives. On a percentage basis, enabling objectives contained more Fact and, to a lesser extent, Category objectives than did terminal objectives. By contrast, terminal objectives contained more Procedure and, to a lesser extent, Rule and Principle objectives than found with enabling objectives. This shift from enabling Fact and Category content to terminal Procedure, Rule, and Principle content is an expected general trend resulting from the hierarchical nature of instructional systems development. The breadth of usage measures calculated herein showed that more types of enabling objectives support fewer types of terminal objectives. This mixture of objectives within a course indicates a corresponding mixture of instructional delivery methods should be considered in applications of CBI. For example, CBI might be easily implemented for enabling Fact and Category objectives early in a course. Conversely, simulation based CBI for many Procedure, Rule, and Principle terminal objectives might be judged of greater importance because of their closer approximation to an actual target job. The infrequent use of Category, Rule, and Principle objectives in the surveyed courses should not detract from their importance since they could be the critical terminal skills in a training program. However, expectations of lower-level enabling objectives supporting higher-level terminal objectives are tempered by the finding that some courses still contain a substantial number of Fact terminal objectives as well as many enabling Procedures.

The emphasis on the Fact and Procedure content areas corresponds to the general impression that Navy training provides "lean" instruction by limiting the conceptual and theoretical emphasis. Thus, the many Procedures identified here are for specific job situations and equipment. Procedures are similar to Rules, except that Procedures are limited to one situation. Principles are, in turn, more generic than Rules. The results suggest that much of the training in the Navy is concerned with specific situations as opposed to generic training to be applied over many situations. Occupations that call for complex troubleshooting or problem-solving tasks (e.g., electrical) show higher levels of Rule and Principle objectives although the total amount of such training is still small. It might be hypothesized that the ability to cope with novel, unexpected situations (e.g., troubleshoot equipment) depends on familiarity with conceptual models incorporating factual knowledge and the Principles that establish the relationships among Facts. Criticisms from the Fleet that course graduates do not know theory stem from the fact that there are not many theory objectives. The present documentation of existing objective patterns does not imply an endorsement of the status quo. In fact, it may provide the basis for future emphasis on other patterns of objectives.

For both Remember and Use tasks, the data showed more objectives for performing tasks without eliciting stimuli or aids. That is, with Remember tasks, recall tasks were more frequent than recognition tasks and, with Use tasks, the unaided tasks were more frequent than aided tasks. Part of this finding reflects appropriate training since many job situations require that tasks be performed without aids. However, the fact that there are any recognize objectives for Procedures, Rules, and Principles suggests problems with the task analysis method used to develop the instruction (cf., Ellis & Wulfeck, 1982). The present data also do not indicate to what extent objectives may have been written inadequately (e.g., failure to specify that technical documentation can be used during performance). The scope of this study also did not include examining whether the more frequent unaided and recall objectives classified here were matched by the appropriate testing format (e.g., recall objectives tested inappropriately by recognition).

Thirty-nine percent of the course managers interviewed by Wetzel et al. (1987) reported inadequate learning objectives. Inadequate learning objectives include objectives written in nonbehavioral form, insufficient content scope and depth, or an imbalance in the types of objectives; for example, too few Facts to support the use of a Procedure. One caution in drawing conclusions from the pattern of objectives obtained here is that the pattern may reflect poor objective writing directed at the use of poor testing procedures. That is, because of convenience there may be too much emphasis on easy test methods (e.g., true-false and multiple-choice recognition), which are less optimal than unaided recall or using knowledge to perform a task. For example, a recognize-procedure task/content combination can be created when a recall-procedure objective is forced into a multiple-choice testing format. This should be avoided since there is no real-world example of a recognize-procedure task and most real-world recognize tasks address Facts. Test item writing guidance for Navy instruction is available in Ellis and Wulfeck (1982) and Ellis, Knirk, Taylor, and McDonald (1987).

Only a few patterns emerged when the objectives were separated by course level and occupational group. Entry courses employed more Fact objectives than did advanced courses, but advanced courses employed more Procedure and Principle objectives than did entry courses. Thus, these findings reflect the introductory, familiarization-knowledge nature of entry courses and the skilled performance nature of advanced specialized courses. In examining the objectives by occupational groups, three patterns emerged. Mechanical, operator, and team courses emphasized Procedures with Use tasks. Use objectives for Procedures, Rules, and Principles were found for electrical and clerical/administrative courses. Lastly, the very few health courses in the sample had the fewest Use objectives and many Remember Fact, Principle and Procedure objectives. These occupational group patterns correlate with several findings from questionnaire data concerned with delivery methods rather than classification of the objectives (Wetzel et al., 1987). The objectives of at least half of the Navy courses called for extensive drill and-practice, simulation, human interaction, and variable responses. Team occupation courses contained most of these objectives, followed by operator courses, and then electrical or mechanical courses. Only operator courses reported significant numbers of objectives calling for automated cues and prompts, where an operator is allowed little control over the occurrence or rate of events from automated equipment. That survey also found that only electrical and operator courses reported many objectives for computer utilization.

CBI Applications

Currently about 12.6 percent of a sample of Navy courses with large annual student throughput use some form of CMI or CAI (Wetzel et al., 1987). This CBI is employed more in entry level courses (20%) than in advanced courses (5.6%) and is highest in electrical courses (30%). Additionally, 27 percent of the course managers can nominate at least one course module as being suitable for CBI. The pattern of learning objectives obtained here provides another indicator of the requirements for various instructional delivery capabilities. Many of these requirements can be served with low-cost microcomputer-based training or management. CAI can range from simply computerizing conventional instruction to applications not possible without computerization. The most common CBI applications involve presenting new information to be learned with drill and practice and testing, which is sometimes combined with prescriptions for additional study. Other techniques are simulation, games, data base inquiry, computational aids, functions ancillary to more sophisticated devices, and electronic chalkboard group presentations. More than one of these CBI techniques can be used to train specific IQI task/content combinations but some techniques predominate more in some IQI task/content combinations than do others. Thus, CBI is well suited to general drill and practice for Facts, yet it is general enough to be applicable to all the content and task catagories.

The following sections discuss CBI applications in terms of the IQI content levels. The easiest way to implement CBI is through "authoring" systems or languages that provide a general facility for creating CBI without the need for extensive training in formal programming languages. But, for many specific training applications requiring complex data bases or special presentation formats, such general authoring languages may require excessive programming or be incapable of achieving the desired function. Examples of such specific strategies are found in the personal computer (PC) programs in the computer-based educational software system (CBESS) being developed at NAVPERSRANDCEN. CBESS includes specific packages tailored to memorizing factual data bases, learning technical vocabularies, and solving equipment trouble-shooting problems (cf., Brandt, 1987a, 1987b; Brandt, Gay, Othmer, & Halff, 1987).

Facts and Categories

Facts and Categories can be repetitively presented for learning and testing according to a number of CBI drill and practice schemes. In general, this entails various kinds of practice repetitions until the student attains some level of success, such as a criterion involving number of tries, accuracy or time, and involving some form of automated testing and scoring. Both Fact and Category content can involve relational data bases or test item banks with automated selection algorithms. Tests of recognize-fact objectives usually consist of multiple-choice questions or matching items while recall-fact objectives employ recall or constructed answer questions. Category content implies a classification task of discriminating between stimuli differing along relevant and irrelevant dimensions. The greater variability inherent in the multiple instances of Category information should be tested by classification or sorting tasks or by multiple-choice, matching, or constructed response items. For example, Category objectives can be tested either by giving the Category name and asking for specific instances, or by giving the instances and asking if it belongs to a certain category. Because of the repetitive nature of Fact and Category learning, concern should be given to increasing student interest by applying gaming or simulation techniques as well as graphic enhancement (e.g., subtle distinctions or important points can be annotated or highlighted graphically). Additionally, feedback should be given to evaluate the response and identify which responses are acceptable.

Learning technical vocabulary and facts is usually required in entry level courses as well as in the early modules of many courses. An example of programs specialized for this function can be found in the CBESS programs (Brandt, 1987a). The language skills computer-assisted instruction (LSCAI) program originally developed by Wisher (1986) provides training in general and technical vocabulary and reading through exercises and games. This package contains common drill and practice exercises such as true-false, multiple-choice, and matching as well as some game-like exercises; for example, definition building in which the student selects short phrases to complete a definition phrase by phrase. Students' entering skills can also be supplemented with commonly available CBI. In the case of deficient basic skills (e.g., reading), commonly available commercial CBI can be used in conjunction with special materials oriented to developing the vocabulary and literary skills associated with a specific Navy content. The nature of this curriculum is not rapidly changing and is in rather general use in many educational settings.

Fact and Category information can often involve large organized data bases. Thus, a good CBI application is one where there is too much information to be dealt with effectively by manual methods. For example, the Jane's Fighting Ships (1986) compendium contains so much information that it is ungainly for the purpose of learning. NAVPERSRANDCEN previously developed programs for Tactical Action Officers (TAOs) to use in memorizing U.S. and Soviet ship characteristics (Crawford & Hollan, 1983; McCandless, 1981). This large body of categorized facts was represented in a hierarchical semantic network of nodes and relations that permitted disparate elements to be quickly accessed. These programs were recently rewritten for more general use on PCs as part of the CBESS computer-based memorization system (CBMS) (Brandt et al., 1987). The programs include a Browser for traversing the data base and various games such as Flashcard and Picture for constructing factual or graphic questions from the data base (e.g., "What radar does a particular ship have?" or "What ship is shown?").

Procedures and Rules

The courses in the sample contained many Procedure objectives, especially as terminal objectives. Procedures often involve an ordered sequence of steps. Training of Procedures with equipment, in team situations, and in other job sequences requires the students to repeat the procedures until they are practiced enough to transfer to the real task. In the Navy, procedures frequently involve operation and maintenance of equipment and functioning in group interaction scenarios. Rule objectives, which apply to more than one situation, were much less frequent than Procedure objectives, indicating that most Navy training objectives are specific to just a single situation. Rule objectives require transfer or generalization of knowledge or performance to new situations. To provide enough practice, the instruction needs to be supported with enough examples to cover the range of the rule.

Procedure and Rule objectives usually involve some sort of simulation. Procedures can involve simulated representations of the situation or equipment with varying levels of fidelity to the real life situation. With CBI, the physical fidelity is generally lower than the functional or psychological fidelity (cf., Su, 1984). While simulations are best represented graphically for objects, textual description of steps may be appropriate for many situations (e.g., office procedures, verbal radio communication, etc.). Graphic embellishments of verbal steps might only consist of arranging the text in flowchart boxes that illustrate the sequence and interrelations. The practice for simulation of a Procedure or a Rule can range from free-play exploration to a more controlled guided tour through the steps. This guidance could involve (1) direct identification of the critical elements at each step and how or why they lead to one another (e.g., audio or textual labeling), and (2) then fading or gradually removing this guidance until the procedure or rule is executed without aid. Procedures and Rules lend themselves to flowcharting techniques; but, since they are often not linear, they may involve many "if-then" decisions. Enhancements to these techniques are on-line help and feedback informing students if the answer is right or wrong and what steps to take after an error.

For conventional instruction, the testing formats for Procedure and Rule objectives that are actually performed (the real task) are checklists and rating scales. Some simulations or instances where the steps can be written may be tested with fill-in or multiple-choice items. With CBI, the potential exists to automate the scoring of additional dimensions (e.g., both correctness and speed of performance, as well as complex sequence records, etc.).

Simulations can represent a complex and even dangerous piece of equipment or demonstrate complex relations not easily illustrated with conventional methods or without recourse to the actual equipment. For example, the STEAMER project represents a complex ship propulsion system in a manner that allows students to quickly see the effects of making system adjustments (Hollan, Hutchins, & Weitzman, 1984). The workings of the propulsion system are simulated in a fashion that cannot easily be envisioned in real life. Time compression permits lengthy events to happen quickly so that students can easily associate actions with their consequences. The benefit of time compression is greatest with skills involving procedural steps that require much practice. An example would be video-based practice of when to initiate turns during rendezvous of planes for air traffic control (Schneider, Vidulich, & Yeh, 1982; Vidulich, Yeh, & Schneider, 1983). Here, performance that takes many trials of making judgments can occur much faster than if practice were in real time.

Another CBESS program applicable for procedure objectives is the equipment problem solving trainer (EPST) (Brandt, 1987b), which is based on work originated by Rigney (Rigney, Towne, King, & Moran, 1978; Rigney, Towne, Moran, & Mishler, 1980). EPST is a two-dimensional video trainer/simulator designed to reduce reliance on the use of actual equipment trainers in learning to operate, maintain, and troubleshoot malfunctions. In EPST, videodisc frames show various views of the equipment (e.g., main panel, subpanels, interior circuitry). For example, the front panel of a communications radio might be shown, with student pointing responses then causing the display of enlarged images of the subpanels. Students might respond further by pointing to panel switches and dials to change their state so that the operation of the equipment is simulated. Other commands provide readings from the test equipment and allow malfunctioning parts to be replaced and the cost of replacement to be reported.

Principles

Principles were the third most frequently used content area, although they comprised only 12 percent of the total number of objectives. There should be more Principle objectives because they involve behavior in situations not specifically encountered previously. Principles involve remembering, interpreting, explaining, diagnosing, and predicting the how and why of situations or events based on theoretical or cause-effect relationships. Thus, instead of having to remember each possible situation or event and its effects, students can apply principles to a variety of situations not encountered before. To test explanation objectives, students are asked to explain how a particular system operates. For prediction objectives, students are given some initial boundary conditions or assumptions and asked to predict the result. The situation is reversed in the case of troubleshooting or diagnosis; students are given a particular set of symptoms and asked to determine what caused them. In testing Remember-principle tasks, students are given an example to be recalled or recognized later; for Use-principle tasks, the problem would not have been previously presented, flowcharted, or proceduralized. While multiple-choice items can be used, fill-in or short-answer (constructed response) items are best for written testing of Principles because the many possible correct answers can vary in level of detail. Most CBI authoring systems accept multiple synonym responses but extensive pretesting is required to generate a complete list of synonymous answers.

Computer-based instruction can provide some aid to the problem resulting from the observation that there seem to be too few Principle objectives. In computerizing the training and testing of Principles, many problems may need to be stored in a large linear or relational data base from which to retrieve or generate problem questions. For Principles in the form of mathematical/logical relationships, computational programming can easily be used so that students can vary parameters to see the effects on other variables in the equation/relationship (e.g., logic and electrical circuits). If possible, such programming reduces the need to store a large number of problems in a data base. Graphic representation of such relationships can increase comprehension tremendously. Computers can demonstrate complex principles dynamically in ways not possible with conventional methods. Such "working models" can involve basic principles of electricity, physics, or operation of specific Navy equipment. In addition to one-on-one learning-station or computer-laboratory applications, presentations to groups can be made by using the computer as a sort of electronic chalkboard to demonstrate points in a lecture (Schiffman, 1986a, 1986b).

Selective Application of CBI

Most courses have many types of objectives, some of which are better adapted to CBI than others. Therefore, for most Navy training courses, CBI might be better thought of as a part than as a whole. Instead of computerizing all types of curricula, CBI should be integrated with conventional classroom and laboratory instruction in selected applications that offer some form of improvement for specific training objectives or course components. CBI should be used as an ancillary tool or aid for the instructor where it can make a significant contribution, rather than replacing the instructor. Thus, the Navy should not talk about computerizing entire schools or courses but rather particular task/content topics or objectives.

Judgment that CBI would make a significant contribution to existing training can be based on one or more practical reasons. CBI offers the opportunity to standardize instruction over many sites and can meet needs for onsite individual training, such as on board ships. Compared to higher-fidelity trainers, CBI could reduce costs when use of a part-task trainer is appropriate. Although CAI/CMI has reduced training time up to about 30 percent, this effect is primarily due to individualization, since little difference was found between individualized conventional and individualized computerized instruction (Orlansky & String, 1981). CAI/CMI studies in secondary education have also found positive effects on student achievement (Bangert-Drowns, Kulik, & Kulik, 1985). Two final contributions of CBI are supplementing limited instructor resources and offering a learning capability not possible with conventional methods.

Supplementing what are often limited instructor resources is a major benefit of automated instructional delivery and management. In many of these situations, CBI could be relatively easy to implement. Particularly good candidates for application of CAI are courses requiring such extensive practice or such precise responses that the student-instructor ratio or instructor patience make the traditional (classroom) setting less practical. The substantial number of memory and procedures objectives identified in the present study suggest that many such instances exist.

Selective use of CBI for particular objectives as prescribed here is a more general idea than that of the part-task trainer/simulator (cf., Su, 1984), since physical or functional similarity to a specific device is not always involved. However, costly, high fidelity, laboratory training equipment could be supplemented with lower cost microcomputer training devices. Costly training devices often act as bottlenecks when students have to spend substantial time waiting for access to limited quantities of laboratory equipment (Van Kekerix, Wulfeck, & Montague, 1982). Severe waits for such equipment have been reported for 20 percent of A-school courses and 25 percent of electrical courses (Wetzel et al., 1987). Such high cost equipment can be supplemented by simulating selected functions so that students are occupied more productively. Electronic targets or signals need not actually be presented on the actual piece of equipment and can be practiced in isolation for decision or classification tasks like those just cited. A further standalone supplement might present students with introductory or familiarization training for the equipment they will actually use later in a laboratory.

A final supplement to instructors results from the need for general administrative and clerical computer support. The lowest common denominator among the course managers surveyed by Wetzel et al. (1987) was the desire for support in registering, student and resource scheduling, tracking, test scoring and recording, and general record keeping. General office automation provides relief from many tedious clerical activities such as these and is most easily provided locally by low-cost microcomputers and widely available spreadsheet and word processor software. Programs like these require no research and development since they can be readily purchased and implemented.

Selective use of computerized instructional delivery offers the opportunity for new learning capabilities not easy to achieve with conventional instruction. Complex systems represented in graphic manipulative models exemplify this potential, although it is also achieved by simply being able to access large amounts of information quickly. Computerized practice environments can be designed to free mental resources and direct attention to the crucial aspects of the tasks to be learned, with knowledge presented in concrete visual form (Halff, Hollan, & Hutchins, 1986). Conceptual difficulty in the to-be-learned material is a particularly good situation to identify for the application of interactive and/or graphic CAI presentations. One instance might be information that can be represented in different ways that students experience difficulty in translating one into the other. Examples are linear versus logarithmic sonar displays, or understanding maneuvering board problems in terms of rectangular geographic displays versus relative polar coordinates (Hutchins & McCandless, 1982; Hutchins, McCandless, Woodworth, & Dutton, 1984).

Instructional quality is difficult to achieve regardless of the method of delivery (Montague & Wulfeck, 1984). Our recommendations stress selective application of CBI and acknowledge that not all instruction is appropriate for CAI. Computers as instructional tools are in a rudimentary state of development so that improving instruction through CAI will be a relatively slow and evolutionary process. Improvements in either instructional design or computer-based delivery will depend on fundamental changes in the scientific base that yield more sophisticated programs. Subject matter experts who do not possess sophisticated programming skills will need CBI authoring aids to make these new technologies easier to implement.

RECOMMENDATIONS

The following recommendations are for the Navy education and training community:

1. Selection and introduction of CAI and CMI into specific Navy schools should be based on the nature of the training objectives, the level of training to be provided, and availability of laboratory equipment and trainees.

2. The high emphasis on training objectives for remembering facts and using procedural steps in Navy schools should be supported with computer-based instruction involving drill and practice and simulation.

3. CAI should be considered for selected training modules judged to benefit from conversion, rather than for all types of curricula. Situations suitable for selective application of CBI include supplementing instructor resources, laboratories, and trainers with excessive wait times and presentation of introductory or familiarization materials, tasks requiring high levels of practice, dynamic graphic representations of difficult concepts, and simulated procedures training for equipment operation and maintenance.

4. Recent initiatives to move some shore-based training to shipboard sites should be supported where appropriate with standard computer-aided instructional delivery and management packages.

5. Continuing work should be supported to develop guidelines as to when CBI is appropriate and to develop technical aids for CBI authors so they can develop quality CBI for their students. Many specific CBI capabilities can be provided by the Computer-based Educational Software System (CBESS) on Navy standard microcomputers.

REFERENCES

Bangert-Drowns, R. L., Kulik, J. A., & Kulik, C.-L. C. (1985). Effectiveness of computer-based education in secondary schools. Journal of Computer-Based Instruction, 12, 59-68.

Blaiwes, A. S., & Regan, J. J. (1986). Training devices: Concepts and progress. In J. A. Ellis (Ed.), Military contributions to instructional technology (pp. 83-170). New York: Praeger.

Brandt, R. C. (1987a). Language skills computer-aided instruction (LSCAI): User's manual. Salt Lake City: University of Utah, Department of Computer Science.

Brandt, R. C. (1987b). Equipment problem solving techniques (EPST): Author's manual. Salt Lake City: University of Utah, Department of Computer Science.

Brandt, R. C., Gay, L. S. Othmer, B., & Halff, H. M. (1987). Computer based memorization system (CBMS): Author and instructor manual. Salt Lake City: University of Utah, Department of Computer Science.

Chief of Naval Education and Training. (1981). Procedures for instructional systems development (NAVEDTRA 110A). Pensacola: Author.

Chief of Naval Education and Training. (1975). Interservice procedures for instructional system development (NAVEDTRA 106A). Pensacola: Author.

Chief of Naval Technical Training. (1981). Submarine training materials development guidelines and production specification (NAVSEA OD 45519). Memphis: Author.

Crawford, A. M., & Hollan, J. D. (1983). Development of a computer-based tactical training system (NPRDC SR 83-13). San Diego: Navy Personnel Research and Development Center.

Department of Defense. (10 Dec 1985). Military standard, military training programs (MIL-STD-1379C).

Ellis, J. A., Knirk, F. G., Taylor, B. E., & McDonald, B. A. (1987, March). The course evaluation system (NPRDC TR 87-19). San Diego: Navy Personnel Research and Development Center. (AD-A178 521)

Ellis, J. A., & Wulfeck, W. H. (1982, October). Handbook for testing in Navy schools (NPRDC SR 83-2). San Diego: Navy Personnel Research and Development Center. (AD-A122 479)

Ellis, J. A., Wulfeck, W. H., & Fredericks, P. S. (1979, August). The instructional quality inventory: II. User's manual (NPRDC SR 79-24). San Diego: Navy Personnel Research and Development Center. (AD-A083 678)

Fletcher, J. D., & Rockway, M. R. (1986). Computer-based training in the military. In J. A. Ellis (Ed.), Military contributions to instructional technology (pp. 171-222). New York: Praeger.

Halff, H. M., Hollan, J. D., & Hutchins, E. L. (1986). Cognitive science and military training. American Psychologist, 41, 1131-1139.

Hollan, J. D., Hutchins, E. L., & Weitzman, L. M. (1984). Steamer: An interactive inspectable simulation-based training system. AI Magazine, 5, 15-28.

Hutchins, E., & McCandless, T. P. (1982). MANBOARD: A graphic display program for training relative motion concepts (NPRDC TN 82-10). San Diego: Navy Personnel Research and Development Center.

Hutchins, E., McCandless, T. P., Woodworth, G., & Dutton, B. (1984). Maneuvering board training system: Analysis and redesign (NPRDC TR 84-19). San Diego: Navy Personnel Research and Development Center. (AD-A139 496)

Jane's fighting ships 1985-86. (1986). New York: Jane's Publishing, Inc.

McCandless, T. P. (1981). Computer-based tactical memorization system (NPRDC TN 81-8). San Diego: Navy Personnel Research and Development Center.

Montague, W. E., Ellis, J. A., Wulfeck, W. H. (1983, August). The instructional quality inventory (IQI): A formative evaluation tool for instructional systems development (NPRDC TR 83-31). San Diego: Navy Personnel Research and Development Center. (Also published in Performance and Instruction Journal, 1983, 22(5), 11-14.) (AD-A132 251)

Montague, W. E., & Wulfeck, W. H. (1984). Computer-based instruction: Will it improve instructional quality? Training Technology Journal, 1, 4-19.

Orlansky, J., & String, J. (1981). Computer-based instruction for military training. Defense Management Journal, 46-54.

Rigney, J. W., Towne, D. M., King, C. A., & Moran, P. J. (1978, October). Field evaluation of the Generalized Maintenance Trainer-Simulator: I. Fleet communications system (Technical Report 89). Los Angeles: University of Southern California, Behavioral Technology Laboratories.

Rigney, J. W., Towne, D. M., Moran, P. J., & Mishler, R. A. (1980, July). Field evaluation of the Generalized Maintenance Trainer-Simulator: II. AN/SPA-66 radar repeater (Technical Report 80-30). San Diego: Navy Personnel Research and Development Center.

Schiffman, S. S. (1986a). Software infusion: Using computers to enhance instruction; Part one: What does software infusion look like? Educational Technology, 16(1), 7-11.

Schiffman, S. S. (1986b). Software infusion: Using computers to enhance instruction; Part two: What kind of training does software infusion require? Educational Technology, 16(2), 9-15.

Schneider, W., Vidulich, M., & Yeh, Y. (1982). Training spatial skills for air-traffic control. Proceedings of the Human Factors Society, 10-14.

Su, Y.-L. D. (1984, April). A review of the literature on training simulators: Transfer of training and simulator fidelity (Report 84-1). Atlanta: Georgia Institute of Technology, School of Industrial and Systems Engineering.

Van Kekerix, D. L., Wulfeck, W. H, II, & Montague, W. E. (1982, February). Development, test, and evaluation of the computer-assisted study management system in a Navy "C" school: Summary report (NPRDC TR. 82-33). San Diego: Navy Personnel Research and Development Center. (AD-B062 846)

Vidulich, M., Yeh, Y., & Schneider, W. (1983). Time-compressed components for air-intercept control skills. Proceedings of the Human Factors Society 161-164.

Wetzel, C. D., Van Kekerix, D. L., & Wulfeck, W. H. (1987, May). Characteristics of Navy training courses and potential for computer support (NPRDC TR 87-25). San Diego: Navy Personnel Research and Development Center. (AD-A180 609)

Wisher, R. (1986). Generative approaches to computer-assisted reading instruction. In T. G. Sticht, F. R. Chang, & S. Wood (Eds.), Advances in Reading/Language Research, Volume 4 (Cognitive Science and Human Resources Management), pp. 97-106. Greenwich, CT: JAI Press.

Wulfeck, W. H., Ellis, J. A., Richards, R. E., Wood, N. D., & Merrill, M. D. (1978, November). The instructional quality inventory. I: Introduction and overview (NPRDC SR 79-3). San Diego: Navy Personnel Research and Development Center. (AD-A062 493

APPENDIX A

DETAILED LISTING OF COURSE TITLES

DETAILED LISTING OF COURSE TITLES

CIN[a]	Course Title
	Entry Courses in Class A Schools
C-222-2010	Air Traffic Controller
C-191-2010	TD (A-1) Diagnose and Repair Computer
C-210-2010	Aviation Anti-Submarine Warfare Operator School A-1
C-602-2012	Aviation Electronics Mate Training
C-601-2010	Aviation Machinists Mate A-1
C-646-2010	Aviation Ordinance A-1
C-780-2010	Aircraft Firefighting and Rescue A-1
C-602-2015	Aviation Structural Mechanic Safety Equipment
C-603-2010	Aviation Structural Mechanic A-1
C-602-2025	Aviation Support Equipment Technician A-1
C-000-2010	Fundamentals of Aviation AP
C-100-2010	Advanced First Team Avionics A-1
C-600-2010	Basic Helicopter Course A-1
A-102-0209	Electronic Warfare (EW) Operations
A-100-0062	Electronic Technician (ET) Class A School
A-662-0016	Electricians Mate (EM) A School
A-531-0016	Data Processing Technician A School
A-202-0014	Radioman A School Common Core
A-495-0035	Hull Maintenance Technician A-1
C-602-2017	Aviation Structural Mechanic Hydraulic Course
C-602-2019	Aviation Support Equipment (Electrical) Technician A-1
A-551-0014	Storekeeper Class A School
X-777-7773	Fireman Apprentice
A-702-0019	Machinery Repairman A School
A-100-0010	Basic Electricity and Electronics (Modules 1-14)
A-041-0010	Gunner's Mate A School
A-510-0012	Yeoman A School
A-510-0015	Yeoman Flagwriter Course
A-100-0059	Job Occupational Basic Skills (JOBS) Operations Course
A-100-0060	Job Occupational Basic Skills (JOBS) Electronics Course
A-800-0013	Mess Management Specialist A Course
A-652-0018	Engineman Class A Course
A-113-0010	Fire Control Technician A School, Phase I
A-113-0019	Fire Control Technician A School, Phase II
A-651-0053	1200 PSI Steam Propulsion Plant Operator
A-651-0082	600 PSI Steam Propulsion Plant Operator
X-777-7772	Seaman Apprentice
A-790-0012	Patternmaker Class A School
X-777-7770	U.S. Navy Recruit Training
A-495-0010	Hull Maintenance Technician A-2
X-777-771	Airman Apprentice Training Course

[a]CIN = course identification number.

CIN[a]	Course Title
	Entry Courses in Class A Schools (Continued)
C-100-2013	Avionics Technician Course Class A-1
A-823-0012	Ship's Serviceman Class A School
C-551-2010	Aviation Storekeeper Course Class A
A-500-0014	Personnelman Class A-1 School
C-555-2010	Aviation Maintenance Administration Course A-1
A-950-0062	Navy Prior Service Veterans Indoctrination Training
A-623-0105	Interior Communication Electrician (IC) Course
A-061-0012	Quartermaster (QM) Class A School
A-203-0001	Signalman Class A School
	Advanced Courses in Class C Schools
A-102-0212	AN/SLQ-17A(V) Presail/Underway Operations Course
C-103-2010	Marine Air Traffic Controller Navigation Prep.
C-103-2012	Carrier Equipment Maintenance C-1
C-103-2013	Carrier Air Traffic Control Equipment Maintenance C-1
C-103-2027	Air Traffic Controller Maintenance C-1
C-103-2024	Carrier Air Traffic Control Equipment Maintenance C-1
C-103-2015	Air Traffic Control Maintenance (Radar) C-1
C-222-2011	Radar Air Traffic Controller Operator Course C-1
C-222-2012	Carrier Air Traffic Controller Operator Course C-1
C-103-2031	Marine Air Traffic Control Radar Repair C-1
C-103-2030	Marine Air Traffic Control Navigation Aids C-1
C-555-2011	Data Analysis
C-103-2042	Carrier Air Traffic Control Simulator Maintenance
C-103-2036	Airport Surveillance AN/TRX-42A(V)10
C-103-2037	Air Traffic Control Maintenance (Radar) C-1
C-103-2041	Air Traffic Control Simulation Mainttenance
C-103-2031	Marine Air Traffic Control Radar Technician
C-4D-2010	Aircraft Maintenance Officers Course
B-300-0025	Urological Technician
B-300-0020	Ocular Technician
A-160-0023	Teletype Maintenance C
A-012-0011	Instructor Basic
A-100-0034	Miniature/Microminiature Electronic Repair (2M)
J-041-0140	Small Arms, Expert Rifle
A-500-0025	Administration and Operation of Ships' 3-M System
C-601-3676	S3A Power Plants and Related Systems Organizational Maintenance
K-233-0022	Surface Electronic Warfare Operator Intermediate
A-651-0041	Hagen Automatic Boiler Control
J-495-0414	Air Capable Ship Helicopter Firefighting

[a]CIN = course identification number.

CIN[a]	Course Title
	Advanced Courses in Class C Schools (Continued)
C-602-3231	Aviation Support Equipment HLU 196 E Bomb Hoisting
C-602-3239	Aviation Support Equipment LHA-1 Pallet Transporter
C-102-3684	OA/8770/ASH Recording Group Intermediate Maintenance
C-102-3091	APN 202 Radar Beacon Set Intermed. Maint. Course
C-102-3686	AYK/10(V) GPDC Memory Unit Pin and Wire Replacement
C-2C-3388	SH-2F Aircraft Familiarization (Pilots)
C-102-3378	RO32 Magnetic Distortion Recorder Intermediate
A-500-0032	Overseas Diplomacy Coordinator
A-431-0039	Free Diving Bouyant Ascent Technique
A-202-0036	Communications Quality Monitoring System Operator
C-602-3394	SH 2F Airframes Hydraulics and Flight Controls
C-102-3679	APS 116 Search Radar
C-198-3679	Dynamic Alignment Test Set (DATS)
C-198-3680	Dynamic Alignment Test Set Intermediate Maintenance
A-701-0025	Basic Welding Class C
A-651-0025	EM Maintenance C
A-130-0213	Sonar Communication Set AN/WQC-2/2A Operation and Maintenance
A-012-0011	Instructor Basic Course
A-012-0036	Individualized Instruction Techniques Course
A-2G-0041	Amphibious Planning
A-652-0231	Small Boat Operating Engineer
A-2G-0038	Combat Cargo Indoctrination
A-060-0028	Bow Ramp Operator
A-3A-0036	Counterinsurgency Orientation
A-652-0230	Small Boat Engine Overhaul
A-2E-4619	Boat Group Officer
A-060-0029	Hatch Crew Training
A-060-0027	Landing Craft Beach and Surf Salvage
A-020-0010	CIC Landing Craft Control Procedures
A-062-0010	Assault Boat Coxswain
A-2G-0037	Amphibious Warfare Indoctrination
A-2G-0040	Naval Gunfire Liaison Officer
A-431-0037	Basic Underwater Demolition/SEAL Indoctrination Course
A-00-0125	Construction Battalion Civic Action Team Overseas
A-00-0115	High Impact Personnel Overseas Duty Training
H-2G-5439	Naval Gunfire Airspotter Special
A-431-0024	Basic Underwater Demolition/SEAL Training Department
A-041-0014	Fire Support Man
A-2G-0047	Amphibious Objective Area Threat and Counters
A-433-0022	Diver Second Class
A-652-0019	Engineman C School

[a]CIN = course identification number.

CIN[a]	Course Title
	Advanced Courses in Class C Schools (Continued)
K-4H-2149	Patrol Gunboat Engineering Systems PCO/PXO Familiarization
A-101-0138	AN/WSC-3 Communications Set and OE-82B/WSC-1(v)
A-100-0016	Electronics Technician Class C-7
A-012-0037	Company Commander School
C-646-3104	CV/CVN Air Launched Weapons General Ordnance
C-102-3405	AN/ASN-123 Tactical Navigation Set and AN/ASM-614 Electronic Set
C-646-3118	Strike Armament Equipment--Intermediate Maintenance
C-103-2034	Air Traffic Control Maintenance Course AN/TPX-42-A
C-103-2026	Air Traffic Control Maintenance Course, Miniature
C-130-3396	SH-3A/D AN/AQS-13A Sonar Intermediate Maintenance
A-823-0016	Navy Exchange/Commissary Store Middle Management
C-191-2011	TD (C7) Follow-on to AVI/AEI Courses
B-300-0019	Advanced Hospital Corpsman
C-602-2014	Addendum I Aviation Electrician's Mate Intermediate
A-431-0038	Submarine Lock Out/Lock In Using Free Swimming
A-431-0041	Midshipman/Cadet: Naval Special Warfare Orientation
A-651-0036	Automated Propulsion System/APS-OP/Operators
A-431-0048	Scuba Diving Supervisor
A-431-0021	Special Operation C Section Technician
A-651-0045	Automated Propulsion System Maintenance
A-130-0074	AN/UQN-4 Sonar Sounding Set
C-103-2028	Air Traffic Control Maintenance Course: Interrogator Set AN/TPX-42A
C-000-3678	S3A Publication Course
	Advanced Courses in Class F Schools
K-491-2143	Engineering Bulk Fuel Systems Shipboard
K-4H-2146	POL Fleet Oiler Prospective CO/XO/EO Familiarization
J-495-0400	Damage Control Petty Officer
K-233-0023	Surface Electronic Warfare Threat Recognition
K-221-0054	LHA Management Information System Basic Operation
K-221-0056	LHA Management Information System Operator Advanced
K-160-0057	LHA Radio Communication System Basic
K-221-0096	CIC Amphib Boat Control Team Training
K-221-0116	MK XII IFF Operator Training
K-222-0100	Helicopter Direction Center Teams Training
J-495-0413	Shipboard Aircraft Fire Fighting Training
J-495-0418	Shipboard Fire Fighting Team Training
J-495-0412	General Shipboard Fire Fighting Training
K-221-0122	Surface Ship Harpoon Training
K-221-0120	LHA NTDS Tactical Air Control Center Team Training

[a]CIN = course identification number.

CIN[a]	Course Title
	Advanced Courses in Class F Schools (Continued)
K-2G-0074	DD963 Naval Tactical Data System Data Utilization
J-210-0513	Surface Ship ASW Attack Team Training
J-243-0981	Enlisted Intelligence Assistant Course (EIAC)
K-222-0035	Carrier Air Traffic Control Center NTDS
K-2G-0004	Tactical Data Systems Inoperability
K-221-0075	DD963 Naval Tactical Data Systems Data Input
K-221-0088	Naval Tactical Data System Input Common Core
K-2G-0093	Naval Tactical Data System CG Data Utilization
K-221-0084	Intermediate Combat System Team Training
K-233-0086	Electronic Warfare Supervisor NTDS Mode
K-221-0099	Naval Tactical Data Systems Track Supervisor
K-2G-0098	PCO/PXO/Senior Staff Officer Naval Tactical Data Systems Overview
K-2G-0091	VC Naval Tactical Data System Utilization Basic
K-221-0077	Force Track Coordinator Basic
K-2G-0079	Fleet Combat Center
K-2G-0011	Tactical NAV Warfare Orientation
K-221-0085	Advanced Multi-Threat Team Training
K-2G-0117	CG Naval Tactical Data Systems Combat Systems Interface Course
K-2G-0010	Fleet Exercise Workup CIC Team Training
K-221-0118	CV Naval Tactical Data Systems Automatic Detector Tracker/Bkn Video
K-221-0119	CG Naval Tactical Data Systems Automatic Detector Tracker/Bkn Video
K-2G-0087	Naval Tactical Data System User
K-160-0058	LHA Message Processing Subsystem
K-221-0080	Air Intercept Controller Refresher
K-221-0092	Naval Tactical Data System CV Data Input
K-221-0094	Naval Tactical Data System CG Data Input
K-221-0090	LHA Data Input Operator Qualification
K-221-0015	Air Intercept Controller Supervisor Course
K-830-2122	Master at Arms (Afloat) Indoctrination
K-7C-2135	Administration - Personnel - Basic
K-510-2045	Military Justice Clerical Procedures
K-500-2040	Career Information and Counseling
K-060-2138	Second Class Swimmers Course
K-060-2023	Pilot Rescue and Associated Water Survival
K-060-2136	Pilot Rescue Team Training
K-2E-2103	Officer of the Deck, Basic
K-060-2119	Underway Replenishment Simulator
K-662-2150	Static Exciter and Voltage Regulator
K-493-2099	Unit Safety Supervisor Orientation Course
K-652-2157	Sewage Disposal System Operation and Maintenance
K-652-2141	Shipboard Sewage Collection Holding and Transferring

[a]CIN = course identification number.

CIN[a]	Course Title
	Advanced Courses in Class F Schools (Continued)
K-510-2092	Engineering - Administration Management
K-652-2126	Engineering - Distilling Plant Operator - Basic
K-720-2043	Engineering Refrigeration and Self-Contained Air Conditioning
K-2G-2155	Officer Shiphandling (Basic)
K-041-2140	Gun Mount 5"/54 MK 42 Mod 9 and 10 Operation and Maintenance
K-041-2019	Independent Variable Depth Sonar SQA-13(v)
K-652-2094	Fundamentals of Diesel Engines
K-201-2001	Communications-Pacific Fleet Communications Systems Team
K-2E-2182	Off-Shore Sail Training Watch Captain (Intermediate)
K-2E-2180	Off-Shore Sail Training Crewman (Basic)
K-061-2158	Navigation-Loran C AN/SPN-40 Operator
K-652-2146	Hydraulic Systems and Components
K-651-2169	Organizational Steering System Operation
K-041-2048	Magazine Sprinkler System Operation, Maintenance and Repair
K-041-2137	Magazine Sprinkler Systems Inspector
K-495-2179	Foam Generating System Operation and Maintenance
K-495-2184	Foam Generating Systems Engineering Operator Personnel
K-495-2180	CV Foam Generating System Operation and Maintenance
K-830-2120	Shore Patrol Orientation
K-113-2067	Solid State Theory and Digital Electronics
K-050-2131	Lamps Aviation Ordnance Training
K-123-2134	Torpedo MK 46 and SVTT MK 32 Operation and Maintenance
K-121-1021	ASROC Missile Assembly and Maintenance, PHASE I
K-041-2052	3"/50 Caliber Rapid Fire Gun Mount Maintenance
K-041-2051	MK 35 Power Drive Maintenance
K-2E-2034	Bridge Tactical Team Trainer
K-2E-2104	Shiphandling Review-PCO/PXO
K-2E-2108	Safe Shiphandling
K-243-5013	Enlisted Intelligence Assistant-Qualification
K-652-2148	Patrol Gunboat/PG/Engineering Systems Operation
K-821-2145	Engineering Bulk Fuel Systems Shore
E-500-0001	Individual Material Readiness List (IMRL)
E-555-0004	Naval Air Maintenance Control Administration
H-00-1010	Amphibious Planning Course for Senior Allied
H-2G-5444	Naval Gunfire Staff Officer
H-041-5449	Shore Fire Control Party Mod for USMCR
J-221-0345	Radar Navigation Team Training
C-102-3679	AN/APS 116 Search Radar and Peculiar Ground
C-602-3398	AH-3 Electrical Components Intermediate
K-670-2152	Gyro Compass Technician MK 27 Maintenance Course
A-300-0010	Surface Force Medical Indoctrination

[a]CIN = course identification number.

CIN[a]	Course Title
	Advanced Courses in Class F Schools (Continued)
K-821-2142	Engineering Propulsion Fuels and Oil Shipboard
K-821-2144	Fuel Accountability Shipboard
K-821-2039	Engineering Fuel Systems JP-5--Shipboard
D-555-0003	Naval Aviation Maintenance Material Control
H-000-5326	LST 1179 Bow Ramp System Maintenance
A-500-0034	Leadership and Management Education and Training LPO

[a]CIN = course identification number.

APPENDIX B

SUMMARY STATISTICS FOR ENABLING OBJECTIVES FOR ALL 246 SCHOOLS

SUMMARY STATISTICS FOR ENABLING OBJECTIVES FOR ALL 246 SCHOOLS

IQI Category	Frequency	Mean	Std. Dev.	Median
Recognize fact	6,438	26.17	71.25	1.5
Recognize category	683	2.77	9.60	0.0
Recognize procedure	511	2.07	5.86	0.0
Recognize rule	136	0.55	2.67	0.0
Recognize principle	781	3.17	10.11	0.0
Recall fact	6,940	28.21	142.80	2.0
Recall category	1,302	5.29	26.79	0.0
Recall procedure	1,067	4.33	16.43	0.0
Recall rule	174	0.71	3.13	0.0
Recall principle	2,034	8.26	31.26	0.0
Use-unaided category	490	1.99	7.62	0.0
Use-unaided procedure	5,383	21.88	71.99	5.0
Use-unaided rule	1,383	5.62	21.38	0.0
Use-unaided principle	769	3.13	12.19	0.0
Use-aided category	287	1.16	8.88	0.0
Use-aided procedure	2,420	9.84	29.77	0.0
Use-aided rule	259	1.05	3.68	0.0
Use-aided principle	165	0.67	2.74	0.0
Total classifiable objectives	31,222			
Unclassifiable objectives	39	0.16	1.87	0.0
Total enabling objectives	31,261			

Note. Each entry based on 246 observations.

APPENDIX C

SUMMARY STATISTICS FOR TERMINAL OBJECTIVES FOR ALL 246 SCHOOLS

SUMMARY STATISTICS FOR TERMINAL OBJECTIVES FOR ALL 246 SCHOOLS

IQI Category	Frequency	Mean	Std. Dev.	Median
Recognize fact	246	1.00	3.96	0.0
Recognize category	87	0.35	2.17	0.0
Recognize procedure	47	0.19	0.85	0.0
Recognize rule	3	0.12	0.11	0.0
Recognize principle	61	0.25	1.09	0.0
Recall fact	506	2.06	7.97	0.0
Recall category	82	0.33	1.28	0.0
Recal procedure	162	0.66	2.71	0.0
Recall rule	11	0.45	0.23	0.0
Recall principle	168	0.68	2.39	0.0
Use-unaided category	70	0.29	1.57	0.0
Use-unaided procedure	749	3.05	6.62	1.0
Use-unaided rule	194	0.79	2.10	0.0
Use-unaided principle	174	0.71	2.28	0.0
Use-aided category	12	0.05	0.39	0.0
Use-aided procedure	464	1.89	5.66	0.0
Use-aided rule	67	0.27	1.48	0.0
Use-aided principle	48	0.19	0.94	0.0
Total Classifiable objectives	3,151			
Unclassifiable objectives	8	0.03	0.34	0.0
Total terminal objectives	3,159			

Note. Each entry based on 246 observations.

APPENDIX D

TASK/CONTENT CATEGORIES OF ENABLING AND TERMINAL OBJECTIVES BY OCCUPATIONAL GROUP

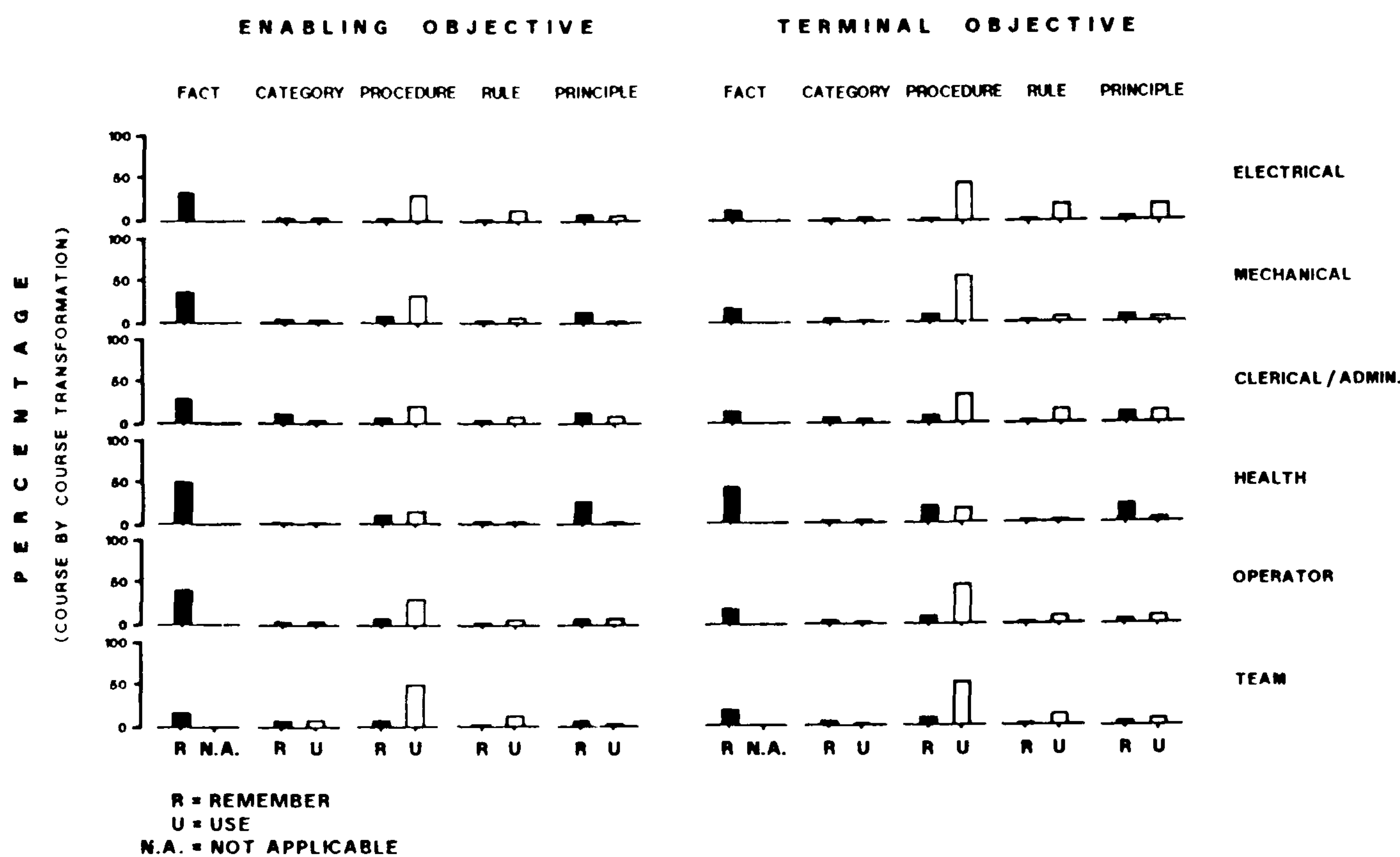

Figure D-1. Task/content categories of enabling and terminal objectives by occupational group.

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