Research Note 85-41

Job Skills Education Program: Predictive Cost and Effectiveness Analysis

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March 1985

U. S. ARMY RESEARCH INSTITUTE

FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the

Deputy Chief of Staff for Personnel

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REPORT DOCUMENTATION PAGE

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1. REPORT NUMBER: Research Note 85-41	2. GOVT ACCESSION NO.: AD-A162 911	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): Job Skills Education Program: Predictive Cost and Effectiveness Analysis		5. TYPE OF REPORT & PERIOD COVERED: Interim Report Sept. 1982 - Sept. 1984
		6. PERFORMING ORG. REPORT NUMBER: - -
7. AUTHOR(s): Blair P. Kruger, Florida State University; Beatrice J. Farr, U.S. Army Research Institute		8. CONTRACT OR GRANT NUMBER(s): MDA 903-82-C-0532
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Florida State University, Center for Educational Technology, Tallahassee, Florida 32306		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2Q263743A794
11. CONTROLLING OFFICE NAME AND ADDRESS: U.S. Army Research Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue, Alexandria, VA 22333-5600		12. REPORT DATE: March 1985
		13. NUMBER OF PAGES: 20 pages
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): - -		15. SECURITY CLASS. (of this report): Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE: - -

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

- -

18. SUPPLEMENTARY NOTES

Beatrice J. Farr, contracting officer's representative. This report, together with RNs 85-22, 85-37, 85-40, 85-42, 85-43, 85-44, 85-45, 85-46, and 85-47, forms part of a series on the Army's Job Skills Education Program (JSEP).

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

CTEA (Cost and Training Effectiveness Analysis),
Training Cost Model,
Cost Benefit,
~~JSEP~~
Basic Skills Training.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Job Skills Education Program (JSEP) is designed to provide soldiers with the prerequisite knowledge and skills required for successfully learning their Military Occupational Specialties (MOS). When the JSEP is put into effect, it will replace the Army's current Basic Skills Education Program (BSEP) with a sophisticated, computer based system.

This report identifies the key cost and training effectiveness variables that will be used to analyze JSEP. A variety of models were examined for inclusion (over)

(continued)

in the JSEP model. A description of the planned analysis and data collection plans is also presented.

FOREWORD

The Job Skills Education Program (JSEP) is a multi-phase program begun in Fiscal Year 1982, and designed to enhance enlisted career potential by improving soldier job performance. The sponsor, the Education Division, Office of the Deputy Chief of Staff for Personnel, expects JSEP to replace the Army's current Basic Skills Education Program when it is implemented.

The JSEP program, being developed by Florida State University (FSU) will result in a standardized curriculum for soldiers who demonstrate deficiencies in the knowledge and skills required to successfully learn their Military Occupational Specialty (MOS).

In accordance with current policy, JSEP will be an on-duty program. It will also use a computer-based management system to facilitate an open entry/open exit approach. At present, most of the lessons being developed will be computer delivered; however, the plan calls for using existing materials, and incorporating materials developed as part of other ARI efforts, whenever appropriate.

A unique aspect of JSEP is that it builds upon a very detailed front-end analysis of MOS Baseline Skills. The analysis covered tasks performed by soldiers in the 94 highest density MOSs, in addition to Common Tasks (the skills that all soldiers, regardless of their MOS, need to know). Although the Army has over 300 MOSs, the 94 covered in the analysis represent about 80% of all soldiers. Perhaps the most useful product developed for the analysis was a taxonomy listing more than 200 prerequisite competencies.(P.C.) for these MOSs. The competencies were derived from detailed reviews of Soldier Manuals, and from extensive interviews with subject-matter experts at Army schools. This effort produced a series of tests intended to diagnose deficiencies in the P.C.s. Modified versions of these tests will be used in JSEP.

The JSEP program will include a front-end learning strategies module designed to improve soldier skills in reading, studying, test taking, and problem solving. The curriculum will consist of this strategies-training, plus 180 diagnostic review lessons, and 120 skill development lessons, which are being developed for the PLATO and MicroTICCIT computer systems. The program is being tried out at two TRADOC sites and two FORSCOM sites, prior to an Army-wide phased implementation.

EXECUTIVE SUMMARY

Requirement:

To develop a predictive Cost and Training Effectiveness Analysis (CTEA) model for the Jobs Skills Education Program (JSEP).

Procedure:

The contractor conducted a review of existing CTEA models, emphasizing those designed for military applications. Areas for discussion included:

- o cost estimation
- o training effectiveness estimation
- o non-quantifiable aspects of training effectiveness
- o integration of cost and effectiveness data
- o alternative system configurations

Findings:

Based on the review of existing CTEA models and the wide range of features in JSEP, we developed a model to accommodate JSEP's unique requirements. The features addressed and their bases include:

- o the self-paced nature of JSEP, which rendered assumptions underlying some of the existing CTEA models inappropriate.
- o the open entry, open access characteristics of the program, which require "open" system methods as opposed to "closed" system ones.
- o the need to synthesize CTEA models into one which addressed JSEP's characteristics.

Because of the need for data not now available, we plan to conduct the predictive CTEA after the Phase II tryout. The effort to date has produced a CTEA model that will address the unique applications problems identified during the analysis and model development.

PREDICTIVE COST AND TRAINING EFFECTIVENESS ANALYSIS

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It is not news that soldiers must be trained to do their jobs. They must be trained so that each Army job is performed competently--regardless of differences in ability and background in newly entering soldiers. To accept less would cause many mission elements to fail.

Moreover, many Army jobs are increasingly dependent upon the soldier's ability to use high technology and the ability to learn new technology as it develops. Soldiers, therefore, need more than training. They need enough education to be able to learn subsequent jobs, to become eligible for promotion, and ultimately, to provide leadership for tomorrow's Army.

The Job Skills Education Program (JSEP) is designed to provide soldiers with job-related basic skills instruction that is prerequisite to learning their skill level 1 and 2 job tasks during their first duty assignments. Based on an extensive job analysis of 94 of the Military Occupational Specialties (MOS) which contain the largest proportion of soldiers and tasks contained in the Soldier's Manual of Common Tasks, JSEP provides functional basic skills instruction in MOS specific requirements.

As it is conceptualized, the JSEP curriculum recognizes that the vast majority of soldiers will have been exposed to similar basic skills instruction before entering the Army. Many entering soldiers, however, will not have learned those basic skills well enough, or will not remember what they learned. To help soldiers learn better and remember more, JSEP incorporates straightforward training in research-based learning strategies that are directly aimed at improving learning and retention.

Research Objective

The purpose of this report is to predict the costs of raising soldiers' educational levels to a certain minimum level, that is, to the level at which they will be capable of learning and performing their first duty assignment jobs. Since JSEP is in its formative stages and this is an analytical report, our approach is to focus on the most important cost and effectiveness aspects of the program rather than details which will differ from post to post and general features applicable to all educational systems. This report will provide an indication of the costs and effectiveness of various configurations of CBI systems.

In addition, however, to preparing for Task 18, Conduct Cost and Training Effectiveness Analysis (CTEA), the Florida State University (FSU) has analyzed various CTEA methodologies (see Appendix for a description of various other models). The conceptual framework presented here will be operationalized and tested in the preliminary and full-scale tryouts. Refinements will then be made on the model on the basis of the data analysis and availability as well as practical constraints and problems.

Scope

CTEA is defined as a methodology that involves the documentation of the comparative effectiveness and costs of alternative training systems for attaining specified performance objectives. Cost refers to the dollar-value of the human and capital resources required to implement and operate an instructional system, in this case, a computer-based instructional (CBI) system. Training effectiveness refers to the degree to which program performance objectives are achieved. In the JSEP context, it is a level of performance that is to be achieved and the purpose of this report is to indicate the costs of alternative systems which will lead to the achievement of that level. The value of CTEA is that it involves the simultaneous consideration of performance and the costs of achieving it.

It should be noted that this report is not intended to evaluate JSEP's contribution to job performance in first duty assignments. At the second In Process Review, the Army Research Institute (ARI) decided that it would independently design a study and evaluate JSEP in this respect (Phase I Report, page 27).

TRAINING EFFECTIVENESS ANALYSIS

The Task 7 Report is an evaluation plan of JSEP which will be implemented and reported upon in the Task 17 Report after the full scale tryout. Since these reports specifically treat the educational effectiveness of JSEP in detail, we will not duplicate those efforts in this report. Instead, we will use some relatively easily calculated, easily understood indicators of effectiveness and relate them to the costs of achieving such levels of effectiveness.

Several indicators of the training effectiveness of JSEP could be calculated. Some are "internal" to JSEP while others are "external." By internal we mean indicators of JSEP's performance with respect to itself, that is, in an absolute sense. By external, we mean JSEP's performance in comparison to other programs (for example, BSEP) and measures of competency (such as GT scores), that is, in a relative sense.

The internal indicator we will use is the pass rate, that is, if a soldier passes the JSEP Test, he will be considered a graduate of JSEP. The pass rate is an indicator of the quality of the lessons. If it is low the lessons can be considered too difficult, hard to understand, unclear, etc. A pass rate of about 80% is anticipated, based on performance from the preliminary tryout at Fort Rucker, Alabama.

Two external indicators suggest themselves:

1) Changes in GT scores and
2) Changes in reenlistment rates or numbers qualifying for reenlistment.

Changes in GT scores offer an immediate indication of JSEP effectiveness. Soldiers' pre-JSEP GT scores can be compared to their post-JSEP GT achievement or, alternatively, JSEP soldiers can be compared with a control group who have not been in the program. Changes in reenlistment rates or numbers of soldiers qualifying for reenlistment are longer term indicators of JSEP effectiveness and much more difficult to attribute accurately. Reenlistment rates could be dependent, at least in part, on the job market for younger workers and the state of the economy in general.

To answer the question of whether JSEP has any measurable impact on reenlistments would require a longitudinal study of a selected JSEP cohort with appropriately matched controls. We believe that such a study would require tracking soldiers through their first enlistment. Therefore, we will not analyze JSEP's influence on reenlistments, due to the time constraint.

The full impact of the learner strategies instruction will not be discernible at the conclusion of the Phase III trials. While pre-posttest differences may indicate strategies acquisition, it is the transfer of these strategies to the job situation that is critical. However, the learning strategies training will be tested in that this training will not be given to all soldiers. Differences in JSEP test scores between those having had and those in the control group not having had the training will provide a preliminary indication of its impact.

For these reasons, we propose to concentrate on internal measures of JSEP performance, in particular, the results of the JSEP Test and the pass rate. The primary instrument of evaluation to be used at the Phase III trials will be the JSEP Test that is designed to measure the results of instruction. It indicates whether soldiers learned the material assigned.

The pass rate is defined as the ratio of the number of JSEP graduates to the number of JSEP soldiers (PR= number of graduates/number of soldiers). A graduate is a soldier who has passed the JSEP Test for his curriculum. Soldiers are defined as those soldiers entering JSEP regardless of whether they complete it. Some adjustments may have to be made for soldiers who are transferred to another post before completing the program, but the term "soldiers," in general, is meant to include dropouts, those failing the JSEP Test, as well as those passing the JSEP Test. Additionally, however, changes in GT scores will be calculated as an external indicator of JSEP performance.

The statistics described above are effectiveness indicators. In addition, however, the Request For Proposal requires the incorporation of costs into the analysis. The primary indicator of both cost and effectiveness will be the average cost per graduate (AC/G). The AC/G will be the most relevant statistic of the analysis because it is determined by factors on both the cost and the effectiveness sides of the program; it is the link between the two. The other measures are relevant to one or the other but not to both. Since the AC/G can vary due to cost as well as to effectiveness variation, as a comparison, the average cost per soldier (AC/S) will also be calculated. Other indicators of cost-effectiveness that will be calculated are: average cost per terminal hour (AC/TH) and the total cost of each system--PLATO and MicroTICCIT. These other measures will indicate the reason AC/G is what it is. For example, we would like to find a low AC/G and that it is low because the number of graduates is high.

While the AC/G will be emphasized, it should be noted that there are other possible sources of variation, in particular, the number of hours a soldier spends in JSEP (which can impact effectiveness) and the number of workstations in JSEP (which can affect costs). In both cases, however, these are parameters within which we will work.

Variation in the number of JSEP curriculum hours would affect the number of graduates (and the pass rate) depending on the change in the amount of material to be learned due to the change in curriculum hours.

Increases in the number of workstations could lead to economies of scale, that is, decreases in average cost due to an increase in the number of workstations. For example, a single host processor of a MicroTICCIT system can accommodate up to 64 workstations. The cost of a host processor is the same regardless of the number of terminals linked to it; therefore, the AC/terminal (and implicitly AC/G) falls as the number of terminals is increased up to 64. The same phenomenon occurs with statistical multiplexers and modems in the PLATO system (up to 32 terminals). We will indicate where such potential economies of scale may occur.

Throughout the analysis we will assume that the number of soldiers in JSEP and the number of hours of CBI they take are given by the Army. Approximately 128 hours of CBI will be taken by each soldier (the exact number of hours may vary somewhat from curriculum to curriculum). In addition, the amount of time required to complete the curriculum will vary among soldiers due to JSEP's self-paced nature. The number of soldiers participating in the full-scale tryout will be limited both by the Army as well as by the amount of equipment available.

Using data from the preliminary and full-scale tryouts, the number of graduates will be statistically predictable. Furthermore, life cycle costs of the systems will also be predictable. The ratio of the present value of the life cycle costs of the system to the number of graduates is another interpretation of an average cost per graduate that is, AC/G = PVS/number of graduates. Alternatively, costs could be amortized and a statistic such as "Total cost per year/number of graduates per year" could be computed which would also be interpretable as average cost per graduate. Such calculations are not intended to generate identical results, instead, they are meant to show that a statistic can be interpreted in a variety of equally valid ways.

Costs calculations will draw heavily on the Task 8 Report (Cost-Benefit Tradeoff Analysis). In addition, all statistics will be given for both PLATO and MicroTICCIT. Since the instructional content will be comparable on both systems (implying identical effectiveness), cost differences become significant. However, ARI will independently investigate whether both systems are in fact equally effective. In the meantime, however, we will assume both systems deliver the same product and that the relevant question is which system can do it at the lowest cost.

RESOURCE AND COST ANALYSIS

JSEP costs can be separated into 4 broad categories:

1) Research and Development (R & D) Expenditures,
2) Capital Equipment and Operating Expenses,
3) Personnel Requirements, and
4) Facilities Requirements.

Research and Development Expenditures

Since the purpose of this report is the prediction or estimation of the most cost effective configuration of JSEP, R & D Expenditures should not be considered. These expenditures are sunk costs, that is, these funds have already been spent and are unrecoupable. Since the relevant decision is whether to spend additional money on JSEP, for example, to expand it Army-wide, it is immaterial how much has already been spent. The question of interest is how much a CBI system costs to operate; therefore, to include R & D Expenditures would merely inflate the cost. The Army already owns 420 hours of courseware (though it is still being developed) and can use it as it wishes at no additional cost. The cost of updating and revising the courseware should be included as an operating expense but not the entire cost of developing the program.

An alternative approach with respect to R & D expenditures is that the Army could license a publishing company to market the JSEP materials. Several educational institutions (for example, the New York Commissioners of Education Office) have expressed an interest in adopting or adapting JSEP to their systems. Another possibility is for the Army to simply allow any institution desiring use of the courseware to have access to it, that is, provide it as a public service or for public relations purposes.

With either of these alternative approaches R & D expenditures could be considered to pay for themselves wholly or in part. It is immaterial, however, for JSEP purposes which approach is taken since the funds have already been spent.

Capital Equipment and Operating Expenditures

Capital Equipment and Operating Expenses are discussed in detail in the Task 8 Report and, therefore, are only summarized briefly in Tables 1 and 2. It should be emphasized that it is in this cost category that differences in costs between the two systems, PLATO and MicroTICCIT, are likely to arise. That is, all other costs of JSEP, such as facilities and personnel, are essentially the same. All prices listed in the Tables refer to single units of the various items; the numbers in parentheses refer to the number of units of that item required for the full scale tryout in the Spring, 1985. Only cost data is given for Optional Equipment because the ratio of the number of units of such equipment to the number of terminals is yet to be decided.

Table 1

ESTIMATED PLATO COSTS

Equipment Costs:	
Viking terminal--CDC 110 (32)	$3250
Data circuit installation (2)	500
Multiplexers (4)	3710
Modems (4)	3674
Equipment cabinets (2)	160
Cables (1/terminal)	75
(2/mux-modem)	50
(1/printer)	50
Annual Expenses:	
Port charges and libraries (32)	3900
Data circuit (2)	12000
Maintenance	2000
Optional Equipment:	
Epson FX80 Printer	595
Digitized Audio	3421
Videotape	895
Videodisc	5370

Port charges and libraries are the rates charged by the FSU Computer Center (FSUCC) for PLATO services. Data circuit cost estimates are based on estimated average distances from the central computer located at the FSUCC over commercial communications lines at commercial rates. The Army is currently installing a PLATO computer (CYBER 825) at Ft. Leavenworth. The Joint Committee on Computer Based Instruction (JCCBI) estimates a chargeback of $500/terminal/month or $6000 annually per terminal for the use of Army facilities, in particular, the CYBER at Ft. Leavenworth and Army communications lines. In addition, a single CYBER 825 can accommodate only 500-600 terminals; if larger systems are desired, additional central computers will have to be purchased (approximately $600,000).

Table 2

ESTIMATED MicroTICCIT COSTS

Capital Equipment:	
Host processor-IIIC (2)	$104600
Terminal (44)	7400
Annual Expenses:	
Maintenance	21140
Optional Equipment:	
Epson FX100 printer	1300
Random-access audio	645
Videotape	500
Videodisc	5500

Personnel Requirements

In considering Personnel Requirements, both instructor and soldier costs should be considered, in particular, JSEP demands on both will be given in terms of their monthly salaries and benefits. It has been estimated (Butman, p.13) that an instructor in a CBI system could accommodate up to 40 soldiers, however, for the full-scale tryout JSEP is being designed with an instructor-soldier ratios of 1:16 for PLATO and 1:20 for MicroTICCIT. These instructor-soldier ratios were determined by ARI as large enough to adequately test JSEP in the full-scale tryout. There is nothing inherent in these ratios as regards CBI and in this sense they are essentially arbitrary.

Instructors will have to learn to teach with CBI as well as learn to operate the systems. That is, they will have to learn certain procedures, for example, starting up and shutting down the system, however, even with CBI they are an integral part of the system. CBI is not meant to replace them, rather, it is to aid them in doing their jobs and thereby make them more effective instructors. The Technology Transfer Plan (Task 19) will deal with this issue at length. Instructors manuals will be prepared explaining the procedures for operating the systems. For the full scale tryout, one week will be allocated to training instructors in the use of the systems.

Soldiers' time is a similar matter; assuming soldiers are released from their regular duties to attend JSEP, their time will be valued at their gross monthly salaries and estimated benefits. A JSEP curriculum consists of 128 hours--approximately equivalent to one month of full time instruction. If soldiers attend JSEP only half time for example, their salaries and benefits will be prorated accordingly. However, soldiers may choose to spend additional, off-duty time in JSEP; such time will be considered free to the Army and not valued at all.

Valuing soldiers' time is somewhat arbitrary in that some soldiers are presumably very competent and their absence from the job will be a burden to their supervisors and co-workers. In addition, some soldiers, if they were not in JSEP, would be in BSEP or some other program in which case JSEP would not be incurring any additional costs. However, with these caveats, the value of soldiers' time will be estimated according to their monthly earnings plus benefits.

Facilities Requirements

It was anticipated that no new facilities, for example, classrooms or lighting will be needed for the full scale tryout, that JSEP would merely replace BSEP with respect to classroom space. However, additional facilities may have to be constructed at Fort Lewis, Washington due to a lack of classroom space. Otherwise, JSEP requirements in terms of wiring and electrical outlets have already been described in the Task 5 Report and will not be detailed further.

ALTERNATIVE CONFIGURATIONS

PLATO and MicroTICCIT can be configured in a variety of comparable ways, therefore, the discussion of alternative configurations will be in terms of a system since the essential differences are in terms of costs which are documented in the Task 8 Report and summarized above. The basic system consists of a workstation (primarily the terminal) linked to a computer providing the courseware. To this basic system, several optional pieces of equipment such as a printer or videodisc can be added.

The Task 5 Report is instructive with respect to the effectiveness of the options or add-ons. The Task 5 Report contains an analysis of 184 PCs. Of these, 21 were not deemed feasible for CBI, of the remaining 163, 128 were considered teachable with CBI alone--the rest could be enhanced by various auxiliary devices in addition to the CBI.

These optional devices are:

1) Printers, handouts, paper and pencil assignments--19 PCs,
2) Video capability (interactive and passive)--13 PCs,
3) Audio capability--3 PCs,
4) Hand-held tutor--2 PCs,
5) Calculator--1 PC,
6) Instructors, objects, or equipment--20 PCs.

Numbers 3 and 4 are immediately suspect with respect to cost effectiveness. Audio is required for such things as following instructions presented from multiple sources; tutors are to be used to practice commonly misspelled words. Number 5, a calculator, is needed for arithmetical operations, however, both PLATO and MicroTICCIT have calculators programmed into the systems which can be accessed by any soldier in JSEP.

Of the other three options, instructors were never considered optional and little or no justification is required. Printers will probably prove to be cost effective, especially in light of the fact that the 19 PCs noted above are those that require a printer specifically. In addition, it is likely that many other PCs would benefit from the availability of printers (as is implied in the RFP which specifically requires a hard copy capability). Furthermore, a hard copy capability would facilitate the soldier management system. Video is somewhat more complicated in that the 13 PCs include both passive and interactive video.

The ratios of the number of terminals per optional device has not been decided. For example, considerable capacity redundancy would result if printers were purchased on a one-to-one basis with terminals. Furthermore, some options need not be attached or interfaced with a terminal at all. Videotape players, for example, can stand alone in a separate workstation and a soldier could simply take a videotape to it, sit and watch it.

The Delphi or expert opinion method was used to determine the technology best suited to teach the various PCs. Additionally, the same method will be used to judge the efficacy of a video capability.

NON-QUANTIFIABLE FACTORS

Part of learning strategies training is expressly designed to be demonstrated with video or audio media. The mood management module, for example, is very dependent on video in that the techniques are demonstrated by actors in "real life" situations. The actor-instructor shows the soldier how to alter his mood and serves as a role model for him. Such a technique has been shown (Gage and Berliner, chapter 15) to be more efficacious than mere description or statement.

The benefits of the learning strategies training are relatively long term in that they will occur only after the soldier is back on the job. An interim test for the effects of the learning strategies is that, in the full scale tryout, some soldiers will be given the training while others will be given JSEP instructional materials without, however, the learning strategies component.

In some cases, new equipment will not have to be purchased since many Education Centers already have such items as cassette players. Video equipment is also commonplace and may not have to be purchased specifically for JSEP. The costs of producing videotapes, videodiscs, and audiotapes depend on the specifics of the scripts.

DATA COLLECTION

Training effectiveness data will be collected as described in the Task 7 Report. It will be a relatively simple matter to obtain numbers of soldiers, graduates, and pass rates from the course management systems.

Cost data, however, will be much more detailed. We will use a JSEP-oriented modification of the TECEP approach (see Appendix for a description of TECEP). Table 3 shows the cost categories for which data will be collected. Cost data will be collected separately for PLATO and MicroTICCIT.

Table 3

COST DATA

Symbol	Variable Description	Value	Units.
Equipment			
EQCISP	Equipment costs independent of the number of student positions		dollars
LOFEQ1	Expected life of EQCISP assets	7	years
EQIMPC	Equipment costs per student position		dollars
TSPOSD	Percent of operating time student position down		percent
COPMT1	Operating and maintenance cost of equipment per student position per year		dollars
OMFEQ1	Operating and maintenance cost of fixed equipment (annual)		dollars
SUPPLY	Cost of expendable supplies per student while in course		dollars
Instructional Material (IM)			
UPDATE	Percentage of original development cost required annually to maintain instructional material		percent
EVIM	Percentage of original development cost remaining at end of planning period		percent
CIMD	Average cost of developing one hour of instructional material		dollars
Personnel			
INTSPO	Instructor to student position ratio		decimal
SALINR	Annual salary and benefits/instructor		dollars
STUDSL	Annual salary and benefits/student		dollars
Miscellaneous			
N	Number of years in planning period	3	years
PRATE	Pass rate		percent
DRATE	Discount rate	10	percent
WSCHOP	Weeks school operates per year	52	weeks
TLENGH	Average time spent in training per student per week	6.4	weeks
TLEGTH	Average hours per week student spends in training	20	hours

Note: All percent values are entered as decimal equivalents.

The data will be used to calculate the following cost variables for each system:

01. Total undiscounted cost per year =
    Total annual operation & maintenance & equipment acquisition costs +
    Annual maintenance costs of instructional materials +
    Total annual salary & benefits of instructors +
    Total annual cost of student supplies +
    Total annual student salaries & benefits

02. Total undiscounted cost =
    Sum of annual undiscounted costs +
    Total equipment acquisition costs +
    Total implementation cost of instructional materials -
    Remaining value of all facilities, equipment & instructional material at end of program (discounted)

03. Present value =
    Sum of discounted annual costs +
    Total equipment acquisition costs +
    Total implementation costs of instructional materials -
    Remaining value of all facilities, equipment & instructional material at end of program (discounted)

04. Average discounted cost per student position =
    Present value /
    Number of student positions

05. Average discounted cost per graduate =
    Present value /
    Number of graduates

06. Annual average undiscounted cost per student position =
    Total undiscounted cost /
    Number of years of program X number of student positions

07. Annual average undiscounted cost per graduate =
    Total undiscounted cost /
    Number of years of program X number of graduates

08. Annual average discounted cost per student position =
    Present value /
    Number of years of program X number of student positions

09. Initial system acquisition cost =
    Total facilities acquisition costs +
    Total equipment acquisition costs +
    Total implementation costs of instructional materials

10. Initial system acquisition cost per student position =
    Initial system acquisition costs /
    Number of student positions

11. Average discounted cost per terminal hour =
Total discounted cost /
Number of hours of instruction per year X number of years
of program

12. Average undiscounted cost per terminal hour =
Total undiscounted cost /
Number of hours of instruction per year X number of years
of program

It is anticipated that these cost variables will provide Army decision-makers with all of the necessary information with which to evaluate JSEP. These cost variables include annual, average, and total costs of the PLATO and MicroTICCIT systems.

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APPENDIX A

Cost-Effectiveness Models

Cost-Effectiveness Models

Our proposed model will incorporate salient attributes gathered from the body of knowledge relating to cost models. Among these models which undergird our efforts are the following:

1) Training Effectiveness-Cost Effectiveness Prediction (TECEP). The Navy's technique for selecting cost-effective instructional systems for proposed training programs. This 1975 model serves as an aid to a learning system designer. Given a specific set of training objectives and learning algorithms, one experienced in system designs could, theoretically choose the cost-effective instructional delivery system or combination of systems. Included in the consideration is the estimated cost of using each alternative delivery system to obtain the required number of students to support objectives.

2) Educational Technology Assessment Model (ETAM). A follow-up of TECEP, ETAM was developed by IBM for the Navy. This model is designed to assess the cost/effect of a change or innovation in a course of instruction. There are several unique areas in the model. For example, a "job/task cost model" calculates the costs relative to errors in job performance. ETAM appears to be a well-integrated, functional, and comprehensive cost/effective model. However, its main objective is to quantify the impact of educational innovation upon existing courses.

3) MODIA. This Air Force model designed by the RAND Corporation appears to be oriented toward new development planning. It is essentially a cost model structured for situations characteristic of the Air Force. At the same time, MODIA has the potential for exportation to other services with restructuring of its program budget and appropriation categories.

4) Vadhanapanick Model. The doctoral dissertation by Saisawan Vadhanapanick in 1976 described a cost effectiveness model for application in the development of instructional delivery systems. She aggregated instructional technology costs into research and development, investment, and operating. Additionally, she developed an effectiveness model which considered a number of learner variables, such as student achievement and attitude. also included were hardware variables such as equipment capability, down time, and availability. Her cost-effectiveness model is an integration of the separate cost and effectiveness models. The purpose of the integrated model is to combine the cost per student contact hour and probability of system effectiveness into one index for each course of action examined.

5) Cost-Effectiveness Specification for Computer Based Training Systems. This model was developed by HumRRO for the Army to "facilitate the purchase, monitoring, and evaluation of computer based training systems." This 1977 model provides a standardized specification through which training system costs can be discovered. This specification is broken into three distinct volumes oriented toward training that is administered, aided, or managed by computer. The cost methodology concentrates on the total inputs (personnel, money, material) required by a CBI system over its life cycle.