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Formative Evaluation Plan: Computer-Based Instructional Modules for the Forward Support Battalion

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BDM Federal, Inc.

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United States Army Research Institute for the Behavioral and Social Sciences

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This report documents the formative evaluation process to be applied to the Computer-Based Instructional Modules being developed to instruct personnel in the Forward Support Battalion (FSB). Subsequent sections of this report introduce formative evaluation and related concepts, describe the sequence of evaluation steps to be used in detail, and provide a schedule for executing these steps.

Formative evaluation begins in the design phase where examination of the proposed instructional sequence and choice of materials and examples can be reviewed to determine if they are suitable. In the early developmental phases subject matter experts and instructional designers can examine the content and sequencing to determine whether the instruction seems appropriate. As instructional sequences are completed, they can be tested on real subjects to determine whether they proceed through the material in the anticipated manner. Finally, the subjects can be examined to determine if they have learned from the prototype materials. The results of this testing can be used to diagnose flaws that require revision to the instruction.

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FORMATIVE EVALUATION PLAN:

COMPUTER-BASED INSTRUCTIONAL MODULES FOR THE FORWARD SUPPORT BATTALION

Combat Service Support Training System Development Project

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FORMATIVE EVALUATION PLAN

FORMATIVE EVALUATION PLAN: COMPUTER-BASED INSTRUCTIONAL MODULES FOR THE FORWARD SUPPORT BATTALION

I. PURPOSE

This report documents the formative evaluation process to be applied to the Computer-Based Instructional Modules being developed to instruct personnel in the Forward Support Battalion (FSB). Subsequent sections of this report introduce formative evaluation and related concepts, describe the sequence of evaluation steps to be used in detail, and provide a schedule for executing these steps.

II. FORMATIVE EVALUATION

All CBI courses developed for the FSB are to be subject to a Formative Evaluation. Bloom, Hastings and Madaus (*Handbook on Formative and Summative Evaluation of Student Learning*, New York: McGraw-Hill, 1971) describe formative evaluation of a curriculum in this way:

> . . . formative evaluation involves the collection of appropriate evidence during the construction and trying out of a new curriculum in such a way that revisions of the curriculum can be based on the evidence. (p. 117)[1]

Formative evaluation begins in the design phase where examination of the proposed instructional sequence and choice of materials and examples can be reviewed to determine if they are suitable. In the early developmental phases subject matter experts and instructional designers can examine the content and sequencing to determine whether the instruction seems appropriate. As instructional sequences are completed, they can be tested on real subjects to determine whether they proceed through the material in the anticipated manner. Finally, the subjects can be examined to determine if they have learned from the prototype materials. The results of this testing can be used to diagnose flaws that require revision to the instruction.

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[1] This process is analogous to quality assurance and testing practices used to manufacture products. Starting with the design phase, the suitability of the form and materials to the intended function is examined continuously. Wind tunnel tests or "brassboard" tests of electronic circuits illustrate some of the early tests of whether the concept or principles that motivated the design can, in fact, be realized in hardware. Once the concept is demonstrated, then the process of fabrication needs to be examined to be sure that it does not introduce unanticipated flaws. Similar principles of evaluation can be applied to software development projects and have led to the development of software engineering environments in which the interaction of 'modules' of code is carefully planned and tested. Product recalls and software 'fixes' illustrate that these procedures are not foolproof.

These procedures are difficult to perform on standard classroom-based instructional materials such as textbooks: teachers may prefer to change the sequence of lessons to coordinate with material in another course; testing intact groups of subjects is costly; and considerable information about the use of the material must be gathered in order to use results as an appropriate diagnostic of the quality of the instructional material. Self-paced, interactive materials lend themselves more readily to these procedures: the sequence of the material is 'hard-wired in'; the prototype curriculum can be tested on individuals; test results reflect on instructional quality in a straightforward way.

Computer-based instruction (CBI) has a further advantage over other self-paced, interactive instructional media because it is easy to record student responses to diagnostic quizzes the student takes to obtain feedback on his/her understanding. These quizzes are often used to guide the selection of instructional sequences: the student is sent forward to the next topic, or routed to remedial material depending upon the responses to the diagnostic questions. The instructional developer can compare responses to practice/diagnostic items to related post-test responses to determine whether the student had apparently mastered the objective during the instruction. If students have difficulty with a particular instructional sequence, or if they appear to forget, the instruction itself probably needs to be changed.

III. THE FORMATIVE EVALUATION PROCESS

Our comprehensive plan for formative evaluation can be broken into three distinct phases:

Internal QC -- SME reviews of the storyboards prepared by the instructional developers to be sure that the content is correct and the logic of presentation is appropriate.

Alpha testing -- testing in-house to determine if the courseware tracks with the storyboards and to identify flaws in the logic of the presentation of, or navigation through, the material. This is accomplished by having an SME and/or developer from another team attempt to go through the lesson, noting errors, ambiguities and inconsistencies in logic, navigation, look-and-feel, etc. Problems are documented and fixes are made. At the completion of this phase the instructional development team believes the courseware will accomplish the intended instruction.

Beta testing -- testing using real subjects. This testing is intended to be the first practical run through of the courseware. Subjects are drawn from the pool of target users of the courseware. We have divided this phase into two segments. In the first segment we focus on identifying flaws in the logic of presentation and errors that subjects make in navigation through the course. In the second segment we focus on identifying weak elements in the instruction so that they can be revised. At the completion of this phase, the courseware is ready to be used in the field.

These procedures are explained in further detail in the following paragraphs.

A. Internal QC

In the CSS/FSB project internal QC begins as soon as the instructional developer receives the task analysis from the subject matter expert (SME). As the instructional developer develops the storyboard there is continual interaction with the SME about the nature of the content, the choice of presentation medium, and the sequencing of sub-topics. The SME continually monitors the storyboard for accuracy of content and appropriateness of sequence.

This monitoring continues through the phase of courseware authoring. As the developer completes segments (sub-topics) the SME makes judgements about the adequacy of the content and method of the presentation. Corrections and adjustments are continuous throughout this cycle.

B. Alpha Testing

Once the prototype courseware for a lesson is completed, a different SME/developer diad goes through the lesson, comparing it to the storyboards. All of the branching logic is exercised in this trial to see if there are errors in the navigation or sequencing. This test team also notes any ambiguities that could confuse students, and changes in the 'look and feel' of the system that might interfere with navigation through the course or learning from the presentations. All of the practice and diagnostic quizzes are exercised to be sure that they lead correctly to the next logical sequence of material. Fixes are made to the problems noted, and the test is repeated. At the end of this procedure the instructional development team releases the courseware for beta testing.

C. Beta Testing

Instructional development methodologies (such as the Joint Services Instructional Systems Development [ISD] model) recognize that well-written, technically accurate instructional materials might appear to be effective teaching tools, but it is difficult to predict how students will react to the material. Only the target trainees can provide evidence about instructional effectiveness; hence the importance of beta testing as part of the formative evaluation process.

The two segments of beta testing focus on the same concerns, but to different degrees:

- Can the student navigate through the courseware successfully?
- Does the student learn from the material?

The first segment focuses mostly on the first concern. Clearly, if students have difficulties navigating through the course, they can not be expected to learn from the material. In addition to strictly navigational concerns, it is important to determine if the content presentation is obviously incorrect or ambiguous. Problems like these will reduce the value of the pre-test to post-test comparisons.

During this segment of beta testing, the trainees are told that they may ask the observing SME questions when they encounter difficulty and the SMEs can intrude by asking why a trainee

responded as he or she did to a particular practice item. The SME can provide additional information to help the trainee over the rough spot; and the SME will, during the lesson, as well as after completion of the post-test, gather interview data useful in making the subsequent lesson revisions.

The primary purpose of this segment of beta testing is to learn as much as possible about the interaction between each trainee and the lesson. Some of this kind of information is revealed, of course, in the data regarding responses required during the lesson and on the post-test. Allowing for staff intrusion and queries aims directly at the ongoing thought processes of the trainee working through the lesson. The intrusions may be prompted by such indicators as expression, body language, utterances, and, of course, their requests for assistance and their responses to queries by the staff.

We have planned for three subjects to go through this testing in sequence, with fixes made to the courseware after each run-through. This helps us to be sure that in fixing one error we have not introduced problems elsewhere.

The second segment of beta testing focuses mostly on the learning outcome. The goal is to have subjects take the lessons without intervention from a member of the development team. Completing a lesson under these conditions would indicate that the courseware is ready to be sent to the field. Furthermore, comparing the pre-test to the post-test results for this subject would be indicative of the learning that the courseware produces. Specific weaknesses can be diagnosed from the post-test and these can be compared to the subject's performance in the practice and diagnostic quizzes for that section of material. All of this evidence can be used to determine what correction needs to be taken to improve the courseware.

Obviously, if a flaw in navigation or critical ambiguity has eluded the earlier testing, then the person monitoring the test subject will have to intervene to allow the subject to proceed. Results from a trial with this kind of problem will not be as useful in determining the utility of the courseware.

In this segment of beta testing the observing and note-taking SMEs are limited to intruding only when a trainee becomes completely lost. The purpose is to determine whether the lessons are in fact ready to go to the field where they must function independently of the developers, and that they will induce learning. In addition, the time required for the subject to complete the course (including pre- and post-testing) will be useful information for training managers wishing to use these course materials.

Our plan, with respect to the Lanes-based lessons has been to test about three additional subjects during this segment of beta testing. Given the limited number of subjects, inferences about course quality will entail a more qualitative than statistically rigorous quantitative analysis. For the FSB Officer courses, we will have to rely on even smaller samples of subjects.

IV. BETA TESTING PROCEDURES IN THE FSB PROJECT

The lessons are designed to allow a trainee to determine, after taking the pre-test, which topic or topics he or she needs to take, and then enter a lesson and take only those topics. During validation trials, however, all test trainees will complete all segments of the lesson, to provide test data on the complete lesson.

Beta test trials will be conducted on individual trainees one at a time. After each trainee completes the pre-test -- lesson -- post-test cycle, the post-test results and the lesson responses -- as well as observations made during that cycle and during a final interview -- are analyzed. Weak spots in the lesson sequence and structure are identified and the development team specifies changes to be made to the lesson materials. Depending on their nature, those changes can be made immediately, before the next test trainee takes that lesson, or held until all trainees have completed the beta testing. This sequence of test-revise-test is continued with additional trainees until each lesson meets the performance criterion established for it.

Each trainee is observed while proceeding through the lesson and during the pre- and post-tests. Frowns, gestures of frustration, paging back-and- forth--all indicate problems within the lesson. During the first segment of beta testing trainees are queried immediately about the nature of the problem, and are assisted as they proceed through a lesson. In the second segment, there should be very little evidence of this type of problem, and no interventions will be allowed. Completion times for the lesson and scores on the post-test are also recorded, for use in describing both the effectiveness of the lessons and the time factors that should be allowed for personnel taking the lessons.

Trainees will be interviewed following each lesson. Some of the interview questions will deal with subject matter and objectives; some will ask the trainee to identify problems or difficulties encountered during the lesson; some will ask which topics or portions of the lesson seemed smoother or more enjoyable; some will ask for subjective comments, suggestions, and criticisms. The focus of the interviews will be modified by feedback from the early interviews.

These tests will be closely observed, and notes will be taken to indicate any apparent difficulties encountered by each trainee. These notes are valuable sources of information to the developers developing modifications to the courseware.

The development staff will document everything that happens during the testing of the lessons. This will include pre- and post-test performance, responses to lesson exercises and questions, comments by trainees, the nature and content of all SME interventions, and interview information. The subsequent analyses and revision specifications will be described, and tied to the data listed above, for each trainee trial. In this way a documentation track will show how each lesson proceeded through the validation sequence. The guidelines to be followed by project developers and SMEs further define the validation procedures. These guidelines appear in the Appendices to this report.

V. SCHEDULE FOR BETA TESTING

Given adequate availability of soldiers who are members of the target audience for each lesson, the complete series of beta tests and revisions for a lesson can be completed in two calendar weeks. The National Guard project SMEs will obtain test soldiers for the validation trials. It is possible that the number of test trainees might, in some cases, have to be increased, if necessary to evaluate the adequacy of revisions made during validations trials.

The following schedule is based on the delivery schedule in the proposed modification to the delivery order. Some lessons, indicated by asterisks in the schedule, have already been through preliminary beta testing. Most lessons will enter the test sequence before the 'not later than' (NLT) dates shown. The schedule identifies the enlisted MOSs and the officer branch designation representing the target audiences for which the lessons were designed, and which are required for validating the related lessons.

A. Lessons to Begin Beta Tests NLT 1 September

Company/Lane	Lesson	Soldier MOSs Required
Supply Company	Inspection of POL products	MOS 77F
Maintenance Company	* Inspect/Troubleshoot Tracked Vehicle Auto. Sys.	MOS 52, 63B/S/H
	Repair Diesel Power Pack	MOS 63H
Medical Company	* Plan for Evacuation	MOS 67B, 91B Officer 50A
	* Control Bleeding	MOS 91B
Defend Company Sector	Terrain Analysis	Co. Grade Officers, Sr. NCOs
	* Plan Sector Defense	Co. Grade Officers, Sr. NCOs

B. Lessons to Begin Beta Tests NLT 1 October

Company/Lane	Lesson	Soldier MOSs Required
Supply Company	Tanker Opns and Safety	MOS 77F
Maintenance Company	Repair Traversing Systems	MOS 45K
	Organize/Dispatch Maint. Support Team	MOS 52, 63 Officers
Medical Company	* Triage/Survey Patients	MOS 91B/C Officer 67B, 60A
Defend Company Sector	Prepare Support Plan	Co. Grade Officers, Sr. NCOs
	Defend/Prepare Level I, II, III Threat Attack	Co. Grade Officers, Sr. NCOs

C. Lessons to Begin Beta Tests NLT 1 November

Company/Lane	Lesson	Soldier MOSs Required
Supply Company	Direct POL Environment/ Security Controls	MOS 77F
Maintenance Company	Supervise/Perform BDAR	MOS 63H, Officer
Medical Company	General Medical Treatment	MOS 91B, Officer 67B
	Treating Respiratory Dysfunction	MOS 91B, Officer 67B
Defend Company Sector	Perform Withdrawal Under Fire	Co. Grade Officers, Sr. NCOs

D. Lessons to Begin Beta Tests NLT 1 December

Company/Lane	Lesson	Soldier MOSs Required
Supply Company	Supervise Receipt/Storage POL Products	MOS 77F
Maintenance Company	Troubleshoot/Repair Radio Sets	MOS 63H, 29E
	Repair BFV TOW ISU	MOS 63H, 27E
Medical Co.	Casualty Management	MOS 91B, Officer 67B
Defend Company Sector	Conduct Hasty Displacement	Co. Grade Officers, Sr. NCOs
	Collective Training Lane	Co. Grade Officers, Sr. NCOs

E. Beta Tests of Staff Training:

Appropriate subjects for validation trials will be officers and NCOs per the current TO&E for the Forward Support Battalion and Support Battalion. These tests will include both the CBI and computer-managed instruction (CMI) lessons. The following schedule is based upon receipt of beta-tested CBI and CMI from the Battle Staff Training System Development Project for all duty positions except SPO and BMMO. The dates shown are based upon receipt of these materials at least two weeks in advance of the projected beta testing start date.

Lessons to Begin Beta Tests NLT 1 November: Common Core, S2, SPO

Lessons to Begin Beta Tests NLT 15 November: S1, S3

Lessons to Begin Beta Tests NLT 1 December: S4, XO

Lessons to Begin Beta Tests NLT 15 December: S2/S3, BMMO

VI. APPENDIX A

BETA TESTING -- Segment One

1. Read the following to the soldier:

You are going to go through a lesson presented by the computer. First I'll describe the lessons, how they work, and what you are to do as you proceed through them, then I'll show you how to use the computer and certain aspects of the software programs. Don't worry, if you aren't experienced with computers, I'll tell you about the computer only to the extent that you need to know in order to proceed.

Each lesson is designed to function as a tutor -- an individual source of instruction just for you. Each lesson is interactive -- which means that you will be asked to use information as it is presented to you. The computer does not simply present a lecture: it will ask questions, and you will enter your answer using the computer keyboard. Some questions will be multiple-choice, some matching, and sometimes you will be asked to enter one or more words, typing them in. Each time you make an entry, the computer will tell you whether your answer was correct or incorrect. Then you will go on to the next step. This interaction between you and the computer lesson will help you learn.

Before you begin the lesson, you will take a test designed to determine how much you already know and can do. The computer will examine your test results and indicate which portions of the lesson you can skip and which portions you should take. You will always have the choice of skipping or taking a lesson segment. You might want to review something you already know, because that's worthwhile practice. After you have completed the lesson, you will take a post-test, to determine what you have learned, and what might require going through the post test lesson a second time. Again, the computer will report your test scores to you, and record the results in our record-keeping system.

You are helping us test these lessons. We want you to help us find the "bugs" in them. We want you to tell us when something is not clear, or is confusing, or when you have problems of any kind. One of us will be watching you to see how smoothly the lesson works, and to identify any errors you make, so we can revise the lesson so the next soldier won't make that error. If you run into a problem, tell one of us, ask us for clarification, tell us what isn't clear. Chances are that if you have trouble, it isn't your fault, the fault is in the lesson. Sometimes we might ask you a question if we think there is something you can tell us. Try to relax. The lesson is on the spot; you aren't.

2. Have the soldier sit before the computer. Explain the use of the mouse and any other features of the computer, software, and any unique features of the lesson.

3. Administer the pre-test. Discuss the results with the soldier. Make notes on any questions the soldier asks. We will use this information to prepare a brief intro for future test soldiers.

4. Show the soldier how to access the opening frame and then let him or her proceed.

5. Sit where you can see the soldier's profile and the monitor screen. Look for the following:

a. Frowns, puzzled looks, head shaking, any body language that indicates some form of difficulty, taking a long time to make a response. When you spot one of these actions, ask the soldier what's wrong. Note everything he or she says. If you have to provide additional information to help the soldier continue, note the information.
b. Errors by the soldier. Note the question and the wrong response.
c. If a soldier asks you a question, note the question, as well as the nature of the information you had to provide to get past the problem.
d. If the soldier decides to skip any component of the lesson, check the pre-test scores to see if that option was offered based on the score.
e. Note any other problems, deviations in procedures, and all comments made by the soldier about any part of the lesson.

6. When the soldier has completed the lesson, conduct a brief interview, asking the following questions:

a. How did you like the lesson?
b. Did the lesson feel like a tutor individually trying to teach you the subject matter?
c. Were the directions always clear? Could you always tell exactly what you were being asked to do?
d. Was the level of the vocabulary about right? Or did the lesson use words that made the lesson difficult?
e. Did the lesson use any names or words or technical terms that were confusing? If so, can you give an example?
f. Was the feedback helpful--the information the lesson gave you after you answered a question or did a task? How might it have been more helpful?
g. Do you have any suggestions on how we can make the lesson more interesting, easier to understand, or how we can make it more effective?

7. Administer the post-test. Go over the results with the soldier. As you do, look for any additional information from the soldier that can help us improve the lesson.

8. Rewrite your notes if necessary to make them easily readable. Add any additional clarification or ideas that occur to you.

9. Complete the attached form.

VII. APPENDIX B

BETA TESTING -- Segment Two

1. Read the following to the soldier:

You are going to go through a lesson presented by the computer. First I'll describe the lessons, how they work, and what you are to do as you proceed through them, then I'll show you how to use the computer and certain aspects of the software programs. Don't worry, if you aren't experienced with computers, I'll tell you about the computer only to the extent that you need to know in order to proceed.

Each lesson is designed to function as a tutor -- an individual source of instruction just for you. Each lesson is interactive -- which means that you will be asked to use information as it is presented to you. The computer does not simply present a lecture: it will ask questions, and you will enter your answer using the computer keyboard. Some questions will be multiple-choice, some matching, and sometimes you will be asked to enter one or more words, typing them in. Each time you make an entry, the computer will tell you whether your answer was correct or incorrect. Then you will go on to the next step. This interaction between you and the computer lesson will help you learn.

Before you begin the lesson, you will take a test designed to determine how much you already know and can do. The computer will examine your test results and indicate which portions of the lesson you can skip and which portions you should take. You will always have the choice of skipping or taking a lesson segment. You might want to review something you already know, because that's worthwhile practice. After you have completed the lesson, you will take a post-test, to determine what you have learned, and what might require going through the post test lesson a second time. Again, the computer will report your test scores to you, and record the results in our record-keeping system.

You are helping us test these lessons. We want you to help us find the "bugs" in them. We want you to tell us when something is not clear, or is confusing, or when you have problems of any kind. One of us will be watching you to see how smoothly the lesson works, and to identify any errors you make, so we can revise the lesson so the next soldier won't make that error. If you run into a problem, work your way through it if you can, then we'll discuss it later -- don't ask us any questions until later. Chances are that if you have trouble, it isn't your fault, the fault is in the lesson. Try to relax. The lesson is on the spot; you aren't.

2. Have the soldier sit before the computer. Explain the use of the mouse and any other features of the computer, software, and any unique features of the lesson.

3. Administer the pre-test. Discuss the results with the soldier. Make notes on any questions the soldier asks. We will use this information to prepare a brief intro for future test soldiers.

4. Show the soldier how to access the opening frame and then let him or her proceed.

5.Sit where you can see the soldier's profile and the monitor screen. Look for the following:

a. Frowns, puzzled looks, head shaking, any body language that indicates some form of difficulty, taking a long time to make a response. When you spot one of these actions, ask the soldier what's wrong. Note everything he or she says. If you have to provide additional information to help the soldier continue, note the information.
b. Errors by the soldier. Note the question and the wrong response.
c. If a soldier asks you a question, note the question, as well as the nature of the information you had to provide to get past the problem.
d. If the soldier decides to skip any component of the lesson, check the pre-test scores to see if that option was offered based on the score.
e. Note any other problems, deviations in procedures, and all comments made by the soldier about any part of the lesson.

6. When the soldier has completed the lesson, conduct a brief interview, asking the following questions:

a. How did you like the lesson?

b. Did the lesson feel like a tutor individually trying to teach you the subject matter?

c. Were the directions always clear? Could you always tell exactly what you were being asked to do?

d. Was the level of the vocabulary about right? Or did the lesson use words that made the lesson difficult?

e. Did the lesson use any names or words or technical terms that were confusing? If so, can you give an example?

f. Was the feedback helpful--the information the lesson gave you after you answered a question or did a task? How might it have been more helpful?

g. Do you have any suggestions on how we can make the lesson more interesting, easier to understand, or how we can make it more effective?

7.Administer the post-test. Go over the results with the soldier. As you do, look for any additional information from the soldier that can help us improve the lesson.

8.Rewrite your notes if necessary to make them easily readable. Add any additional clarification or ideas that occur to you.

9.Complete the attached form.

VIII. CBI LESSON BETA TESTS

____BETA 1 ____BETA 2

TITLE OF LESSON _____

NAME OF PERSON CONDUCTING TEST_____DATE_____

SOLDIER's NAME _____ RANK _____ MOS _____

POSITION _____ UNIT/LOCATION _____

PRE-TEST SCORE _____ # ITEMS MISSED: _____

POST-TEST SCORE _____ # ITEMS MISSED: _____

----------Timing Information----------

Pre-test start time _____ finish time _____ Elapsed time (minutes) _____

Lesson start time _____ finish time _____ Elapsed time (minutes) _____

Post-test start time ____ finish time _____ Elapsed time (minutes) _____

COMMENTS ON POST-TEST ITEMS MISSED (Interviewer will determine, as far as possible, why the soldier answered incorrectly, or did not know the correct answer. Use the NOTE section to record this information.)

IX. QUESTIONNAIRE (After post-test)

1. How did you like the lesson?

2. Did the lesson feel like a tutor individually trying to teach you the subject matter?

3. Were the directions always clear? Could you always tell exactly what you were being asked to do?

4. Was the level of the vocabulary about right?

5. Did the lesson use any names or technical terms that were confusing? If so, what were they?

6. Was the feedback helpful the information the lesson gave you after you answered a question or did a task? How might it have been more helpful?

7. Do you have any suggestions on how we can make the lesson more interesting, easier to understand, or how we can make it more effective?