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ABSTRACT

The process used in the design and evaluation of modules of instruction with the PLATO IV Computer System for stimulus display and response recording is described. Steps in the instructional design process are listed as problem identification and task analysis, identification of entry characteristics, development of performance objectives, development of evaluation instruments, determination of instructional sequence, design of instructional components, and production of instructional materials. Evaluation is discussed in terms of product, evaluation, process evaluation, and system effectiveness. (SK)

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INSTRUCTIONAL DESIGN FOR THE FLORIDA PLATO PROJECT - PROCESS AND EVALUATION

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It is the purpose of this paper to describe the process used in the design and evaluation of modules of instruction with the PLATO IV Computer System available for stimulus display and response recording. It is important to note that the approach is one of considering PLATO as one of several alternative delivery systems and not one of designing instruction to fit PLATO. This point will be elaborated later in the discussion on media selection.

Instructional Design Process

The process of instructional design in the PLATO project is one best described as a systems approach. Figure 1 is a schematic representation of the particular design model used in this project. This model describes the step-by-step procedures which have been used successfully in the design of programmed instruction materials, computer-assisted instruction courses, computer-managed instruction courses, and instructional activities using a variety of media.

Problem Identification and Task Analysis

The first step in this model is to identify the instructional problem for which the materials are being designed. It is important to separate symptoms from problems so that the problem can be stated clearly and unambiguously. The problem statement should indicate clearly what the end

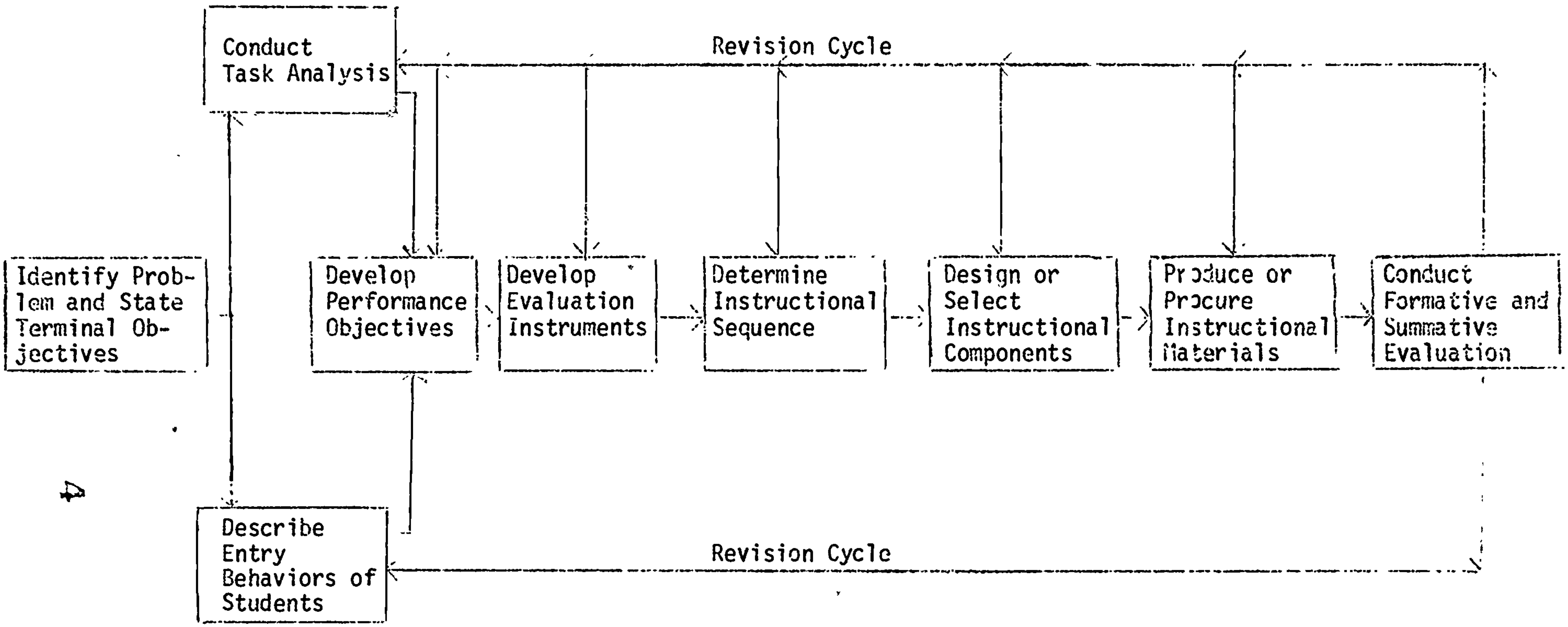

Figure 1. (Adapted from Dick, Merrill, & O'Neil, Systems approach model for development of instructional materials.)

product for the learner is expected to be. From this information one can proceed to task-analyze the desired performance in order to identify its component parts and the relationships among them. The process of task analysis is often an iterative one which is closely related to designing the assessment of performance. The process may include content analysis, test item writing, task identification and then revisions to the point that one is satisfied with the inclusiveness and clarity of the task statements.

Identification of Entry Characteristics

The next step in the model is to identify the entry characteristics of students. This step requires the instructional designer to consider the knowledge, skills, and attitudes that the learners bring to the particular learning situation. By considering the characteristics of the learner two types of errors can be avoided. The situation can be avoided where too much is expected of the learner, i.e., assumptions are made that he has skills which in fact he does not have, and the situation can be avoided where the learner is being taught things he already knows. The characteristics of learners as a group should also be taken into consideration. Such factors as the social situation, the competitive or cooperative spirit and the out of school support or obstacles to learning should be considered.

Development of Performance Objectives

The fourth step in the model is the development of performance objectives. Performance objectives are clear statements of the outcomes of the instruction in terms of what the learners will be expected to do. The development of these objectives is based on the results of the task analysis and the learner analysis. The exact form which these statements of objectives takes varies from one type of learning to another and may even vary from one instructional design team to another.

One form which the objectives may take is that proposed by Mager who argues that if behavioral objectives are to be of real value they must include three characteristics. These characteristics are that they: (1) indicate the conditions under which the performance will take place; (2) indicate what the performance is and (3) indicate the minimum level of acceptable performance.

Some instructional designers prefer to state performance objectives in other ways such as in domains. A domain consists of a subset of knowledge, skills, understandings or attitudes where the essential attributes of the content which the learner is to acquire, and behavior which will demonstrate such acquisition, are carefully described. Domains are an attempt to make clear the instructional intent without being overly precise.

The form of the objectives should not get in the way of the communication between instructor and learner. If what is expected is clearly communicated, the form is not of great significance.

Develop Evaluation Instruments

The next step in the model suggests that before the development of the instructional activities begins, evaluation instruments must be developed. In the development of a particular set of instructional materials, it is not likely that a unique set of evaluation instruments will be produced. Rather, the more general types of instruments discussed in a following section of the paper will be adapted for use in a particular instructional setting.

It will be necessary, however, to develop a unique set of instruments for assessing learning outcomes since they will relate to the particular content of the lesson. These instruments must be designed to assess the performances identified in the objectives. The assessment instruments are not limited to paper and pencil tests but may use human observation and a variety of devices for stimulus presentation and response recording. The crucial factor is that the assessments are valid measures of attainment of the skills, knowledge, and attitudes which are the objectives of the instruction. The development of these instruments is an iterative process and both test items and objectives may be modified as lack of congruence between them is discovered. The revision process should increase the relevance of the objectives and the validity of the test items.

Determine Instructional Sequence

The sequence of instruction is considered in the sixth step of the model. The most effective sequence (if there is one) for presenting the instructional materials is determined by utilizing the ordered relationships between the subskills revealed by the task analysis procedure. For example, if the subskills are hierarchically related to each other, it is important that the instruction be designed to build one skill upon another until the terminal performance is achieved. In other cases, the most effective sequence may be determined by the student who chooses from a selection of alternative sequences available to him. In all instructional situations, the instructional designer must be aware of the need for the sequencing of instruction, whether the sequence is linear and required of all students, or the sequence is flexible and can be different depending upon student choice.

Design Instructional Components

In designing the instructional components within various courses of the PLATO project the assumption is made that the materials will be used in a largely learner-paced system. The decisions to be made in designing each component begin with determining the specific instructional events needed for the learner to accomplish the objective. For each instructional event, the design team identifies the type of stimuli to be presented to the student, the type of response to be required of the student and the type of response analysis capability required in order to make subsequent instructional decisions.

Paul Merrill's Media Selection Matrix shown in Figure 2 is then used as a guide in selecting media (Merrill 1975). The media included in the matrix are those available to F.S.U. faculty. Included in video are motion pictures as well as television.

The cells of the matrix contain the letters G, F, P, or are left blank. If a cell contains the letter "G" the media category listed at the top of the column is considered to have the capability and does a "good" job of presenting the stimuli, recording the response, or analyzing the response listed at the left of the row. The letter "F" indicates that the medium does a fair job, while the letter "P" means that the medium does a poor job. A blank cell indicates that the medium does not have the required capability.

An example of the process may be useful at this point. An objective might be to have students be able to identify Gothic architecture - a concept acquisition task. The design team

(1) selects pictures, line drawings and spoken words as the stimuli;

	CRT	PLATO	VIDEO	SLIDE	AUDIO	INSTRUCTOR	PRINT
Stimuli							
A. Real World Objects and Models							
B. Pictorial							
1. Still		G	G	G			G
2. Motion			G				
C. Alphanumerics (verbal)							
1. Audio		G	G		G	G	
2. Visual	G	G	G	G			G
D. Symbolic							
1. Still	P	G	G	G			G
2. Animated		F	G	P			P
E. Sounds		F	G		G	P	
Response Recording							
A. Covert							
B. Selective	G	G	(G)	(G)		P	G
C. Constructed	G	G	(G)	(G)		P	G
D. Vocal			(G)		(G)	P	
E. Motor			(G)	(P)		P	
F. Affective	P	P	(P)	(P)	P	P	P
Response Analysis							
A. Covert							
B. Selective	G	G				G	
C. Constructed	P	F				G	
D. Vocal						G	
E. Motor						G	
F. Affective	P	P				F	

Figure 2 - Media Selection Matrix (From Merrill, 1975)

(2) determines that student selective responses should be recorded; and (3) decides that the responses should be analyzed and instructional decisions made as a consequence of the analysis.
Using the Media Selection Matrix one determines that to satisfy all of these requirements will necessitate the use of PLATO or a combination of other media including slide projection, audio-tape, and a CRT computer system. This combination of media can be considered a delivery system which is in essence what PLATO is. The choice of a medium of instruction involves additional consideration of the system in which that medium will be delivered. For example, the television medium can be delivered live by broadcast or closed-circuit; or it can be recorded and delivered in a reel-to-reel, or cassette or soon with a disc system.

Since PLATO has such media capabilities as audio, still pictures, graphics and visual words as well as the ability to input responses by typewriter keyboard or touch panel, it is very tempting to use PLATO when less expensive and more accessible systems would be just as effective and efficient. Paul Merrill points out that PLATO's unique combination of stimulus presentation and response analysis capabilities make it an appropriate medium when the learning activity requires any of the following:

1. Analysis of complex constructed responses (Natural language processing);
2. Analysis of student responses <u>and</u> a coordinated random access presentation of several stimuli such as still pictures, audio sounds, and visual words.
3. Analysis of student responses <u>and</u> the presentation of special symbols (non alphanumeric);

4. Analysis of student responses and the presentation of graphic displays (drawings, figures, charts, diagrams, graphs, etc.); or
5. Analysis of student responses and the presentation of animated displays.

PLATO can be used in many other ways such as displaying the text of a book, presently a slide/tape module, or simulating a programmed text. However, there are less expensive media which could be used for those applications.

Produce Instructional Materials

The process of actually producing the instructional materials will vary greatly from one medium to another and from one delivery system to another. The basic requirement in the process, no matter what the medium or delivery system, is that the content specialist be able to communicate his ideas clearly to the ultimate producer.

If the PLATO system is to be used, a set of instructions to the computer must be written in a language called TUTOR. The content faculty member will describe his ideas in a series of commands which are stated in terms of their purpose or function such as those commands which describe what is to be presented or displayed on the plasma panel or screen.

If a video lesson is to be produced, a script must be developed which includes not only all of the narrative, but also identifies each visual or visual sequence, the background music, if any, and any other information that the producer/director needs in completing the video tape.

Once the materials or at least a prototype of the materials are produced, the formative evaluation of the products can begin.

Evaluation

Evaluation is part of most if not all instructional development models, and the commitment to doing something with the data collected is usually represented on a flowchart by a series of lines and arrows labeled revision cycle which may point to all steps of the module. You will note in Figure 1 that the flowchart used in the PLATO Project is of that type.

Evaluation in the PLATO development project will focus on representative parts of the process since extensive data collection is not possible for every project at all points indicated on the flowchart. Data are to be collected, however, on a systematic basis for evaluation of process, of products and of system effectiveness for use in formative and summative types of decisions. There will be some overlap of data from one evaluation to another since these are interrelated rather than discrete entities. The relationship of the focus of the evaluation to the type of decision is shown in Figure 3. The types of data and decision alternatives in the cells of Figure 3 are meant to be examples rather than a listing of all possibilities.

Process Evaluation

One of the underlying goals of process evaluation is to determine whether procedures that were intended actually occurred, and if they did, what the observed consequences were. The basic method of process evaluation is accurate description and documentation. On-going description of activities and person-to-person interactions serves to monitor processes and permits the verification of events that were intended as well as the

Figure 3. Relationship of Evaluation Focus and Decision Type

Focus of Evaluation		Decision Type: Formative	Decision Type: Summative
Process	Types of Data	Documentation of activities Judgment scales Interview schedules Costs - development, implementation, operating	Product effectiveness Costs - development, implementation, operating Documentation of activities Personnel attitudes
	Decision Alternatives	Continue procedures Revise procedures	Adopt procedures Disseminate procedures Adopt alternate procedures
Products	Types of Data	Individual student performance on objective-based tests Student affect toward materials Faculty satisfaction with materials Data on cost of products	Group performance on objective-based tests Group data on student affect Data on cost of products
	Decision Alternatives	Revise segments of materials Select different medium	Adopt materials Disseminate materials Discontinue ineffective modules
System Effectiveness and Efficiency	Types of Data	All data collected for process and products Data on management	All data collected for process and products Data on management
	Decision Alternatives	Shift personnel Retrain personnel Add or delete functions Seek additional resources	Discontinue system Disseminate system

identification of problems or processes that were unintended. Identification of problems, if done on a timely basis, should lead to corrective measures. Judgments regarding the efficacy of procedures also need to be obtained.

Methods for conducting the process evaluation include a thorough documentation and description of activities and procedures by the project staff. These data will be supplemented with information obtained through interviews with content faculty, designers, programmers, and anyone else involved in the instructional development process. In addition to providing descriptive information, the participants will also be asked to share their judgments regarding the efficacy of procedures. Judgments will be recorded on standardized scales. The final areas of information sought for process evaluation will include identification of problems and recommendations for dealing with them.

As seen in Figure 3 the data collected will serve both formative and summative types of decisions with some of the same data used for both decision types.

Product Evaluation

Among the concerns in the overall evaluation design is an assessment of PLATO lessons used, their impact on learning, and impact on attitudes toward instructional use of the computer. Although there will still be a reliance on judgment, the methods used for this part of the study will emphasize quasi-experimental evaluation designs and assessment based on standardized, objective measures wherever possible. There will also be some overlap with areas covered by the process evaluation. The sources of data will include a content faculty review panel and a number of learners in both one-to-one and group settings.

Standardized forms will be used to record faculty reviewer's and learner's judgments. When appropriate, responses will be recorded on 5-point Likert-type rating scales. Dimensions on which lessons will be judged would include at least the following:

Instructional Intent

Clarity of purpose

Clarity of instructional objectives

Appropriateness of lesson difficulty for intended FSU students

Content Validity

Representativeness of information presented

Representativeness of terminology and notation used

Accuracy of information presented

Instructional Logic

Adequacy of sequencing

Consistency of logic inherent in the subject matter

Lesson Format and Text

Attractiveness of lesson format

Appropriateness of vocabulary

Tone of feedback statements

Degree of Revision Needed if Lesson Is Adopted

Overall Assessment of Lesson Quality

An important element of the product evaluation is the assessment of learning outcomes to determine whether or not the relative advantage presumed for PLATO does in fact obtain. The relative advantage of PLATO would be verified if: (1) students using PLATO demonstrate equivalent levels of achievement in less time when compared to students in a comparable nonPLATO course, or (2) students using PLATO demonstrate higher levels of achievement in the same or less time when compared to students in a comparable nonPLATO course.

Determining relative advantage will require two types of information: (1) time spent on the course; (2) achievement in relation to course objectives. Moreover, quasi-experimental designs will be used in order to make comparisons between PLATO and nonPLATO groups.

Time spent on the course will be estimated from logs which PLATO and nonPLATO students will be required to keep and hand in on a regular basis. Achievement will be assessed using tests and procedures being used to evaluate students in the respective courses. If there is a difference in measures between PLATO and nonPLATO courses in the same content area, then both sets of tests will be given to each group to see if there is any overall superiority irrespective of the measures used.

The ability to exert strict random assignment is compromised in the natural setting of the college classroom, hence our reliance on quasi-experimental research designs. Not being able to meet the requirement of complete random assignment, we will statistically adjust for group differences in aptitude. This approach is not without its problems as has been pointed out in the work of Lord (1967, 1969). In spite of the shortcomings of adjusting for group differences statistically, there appears to be no other more suitable alternative. In light of this, PLATO and nonPLATO groups will be compared using a one-way nonstandard analysis of covariance using Florida 12th Grade Test score as covariate. This procedure permits the comparison of two groups along selected points of an aptitude continuum. In this way, observed main effects and interactions can be analyzed statistically after initial adjustment for group differences.

Assessment of achievement in each academic area will be approached as follows. Achievement measures used for PLATO and nonPLATO courses will be given to both the PLATO and nonPLATO groups. Care will be taken to classify test items into groups which both the experimental and nonexperimental courses share in common. These common items will form the basis for the least biased comparison. Results based on test items not common to both courses will be analyzed separately to assess overall effectiveness of learning and to make possible comparisons between groups.

System Effectiveness

In an instructional development system the whole is quite likely greater than the sum of its parts. To be able to identify the extent to which the intents of the entire system are accomplished, one focus of the evaluation will be on system effectiveness. This focus will include collecting data on the management system, the training system, as well as the process and products of instructional design.

By systematically collecting data and relating them to intents it is hoped that meaningful revisions in the processes, the products, and the system can be accomplished and that as effectiveness and efficiency are improved, the accomplishments can be documented.

Summary

The PLATO project at FSU is one in which the instructional development effort is placing heavy emphasis on systematic design and evaluation. By clearly identifying the objectives and basing assessments of student performance on these objectives, the effectiveness of products and processes can be more carefully evaluated.

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