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Analysis of Task Analysis Procedures

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Abstract. For the new developer, deciding which task analysis procedures to use can be confusing. In this article, we describe the five functions comprising the task analysis process: inventorying, describing, selecting, sequencing, and analyzing tasks. We then describe some critical distinctions in the task analysis process: micro/macro level, top-down/bottom-up, and job/learning task analysis. We then combine the functions and distinctions in task analysis into a quasi-algorithm to suggest which of thirty task analysis procedures may be used to fulfill each of the functions. Those procedures are described briefly in the Appendix.

Introduction

This article is predicated on three assumptions:

1. Task analysis, regardless of how it is defined, is an integral part, probably the most integral part, of the instructional development process. All instructional development models to date include some task analysis procedures (Andrews & Goodson, 1980). Most developers indicate that a poorly executed task analysis will jeopardize the entire development process.

2. Task analysis may be the most ambiguous process in the development process. Task analysis represents one or more steps in the instructional development process, which purports to be a science; however, it contains uncertain knowledge and multiple interpretations. We contend that the ambiguity results from the diversity of procedures and definitions of the process. Definitions of task analysis range from the "breakdown of performance into detailed levels of specificity" to "front-end Analysis, description of mastery performance and criteria, breakdown of job tasks into steps, and the consideration of the potential worth of solving performance problems" (Harless, 1980, p. 7). This article evolved from the confusion experienced by an instructional design class trying to conceptualize the task analysis process. Trying to reconcile the myriad task analysis procedures performed at different levels in different situations can be exasperating. The option, too often practiced, is to use a single procedure that makes sense to the developer and apply it uniformly, thus overgeneralizing it to every instructional situation. Experienced instructional developers may know intuitively which procedures to apply in various settings. However, the neophyte's semantic network of task analysis constructs is not sufficiently developed to allow him to know "intuitively" when to apply different task analysis "scripts" (i.e., procedures). So clarification should help the beginning developer.

3. Recent reviews of task analysis (Foshay, 1983; Kennedy, Esquire, & Novak, 1983) have been useful in identifying the various task analysis procedures and their functions. However, simply knowing what tools are available will not rectify the confusion encountered by inexperienced developers. The confusion results from not knowing which task analysis procedures to use in various situations. Foshay (1983) made some useful recommendations about when to apply which model, but he reviewed only three out of a long list of potential task analysis procedures. What design students need is guidance on when and where to apply the various task analysis procedures.

This article is dedicated to that purpose. We do not intend to review each procedure comprehensively. Nor can we claim a foolproof algorithm for recommending which procedures to apply in all circumstances. Task analysis remains too inexact a science to accomplish that goal. In order to make suggestions about when to apply the various task analysis procedures, we first must clarify what functions are integral to the process. Then, we will briefly discuss some situational variables that affect the task analysis process. From those variables, we shall derive a quasi-algorithm for suggesting alternative task analysis procedures that may be used to accomplish each task analysis function. Those procedures are annotated in the Appendix. Our purpose is to provide a framework for selecting and understanding task analysis procedures and applying them to the task analysis process.

Task Analysis Functions

Much of the confusion about task analysis that frustrates inexperienced instructional developers results from a lack of agreement about what the process of task analysis involves. What exactly do designers do when they conduct a task analysis? That varies greatly among developers.

In some contexts, task analysis is limited to developing an inventory of steps routinely performed on a job. In others, task analysis is functionally synonymous with front end analysis, including all instructional development procedures prior to determining instructional strategies. According to Romiszowski (1981), task analysis procedures pervade the four levels of instructional design. At the course level (Level 1), overall objectives are defined. At the lesson level (Level 2), objectives are refined and sequenced, and entry level requirements are specified. At the instructional event level (Level 3), the detailed behaviors are classified. At the learning step level (Level 4), task state-
Task analysis is an integral part of the instructional development process. A poorly executed task analysis will jeopardize the entire development process.

Development. This inventory may result from a variety of processes, such as job analysis, concept hierarchy analysis, and needs assessment procedures. How we arrive at the list of topics or tasks to be included in our system depends on the instructional context, the sociocultural context, the learners being instructed, the management context, and the goal orientation of the educational or training system.

Describing Tasks
Task description is the process of elaborating the tasks, goals, or objectives identified in the inventory. Task descriptions may include listing (a) the tasks included in performing a job, (b) the steps in performing a task, or (c) enabling objectives for a terminal objective. The procedures for performing the task description function depend upon the nature of the information provided in the inventory. Task description always involves an elaboration of the tasks/goals stated in the inventory to a greater degree of specificity or detail. The emphasis here is thoroughness—ensuring that important instructional components are not excluded.

Sequencing Tasks and Task Components
The task sequence is often implied by the nature of the tasks in the inventory or the components in the task description. However, the task sequence is more than simply a description of the sequence in which the task is performed. It indicates the sequence in which the instruction occurs. The sequence for performing the task implies an appropriate instructional sequence. For example, the training of employees to perform certain jobs implies a temporal sequence of tasks that models the job. This may not always be the most efficient sequence. Instructional sequencing may also be determined by the content/task analysis process or by the design model being used. For instance, elaboration theory (Reigeluth & Stein, 1983) prescribes a specific top-down, general-to-specific conceptual sequence for presenting material, where learning hierarchy analysis suggests a bottom-up, simple-to-complex sequence. According to taxonomies of learning, different content and different tasks suggest different sequences of instruction. So, sequencing varies according to the theory or model on which it is based.

Inventorying Tasks
Task inventory is the process of identifying the relevant tasks that may be considered for further instructional development. This inventory may result from a variety of processes, such as job analysis, concept hierarchy analysis, and needs assessment procedures. How we arrive at the list of topics or tasks to be included in our system depends on the instructional context, the sociocultural context, the learners being instructed, the management context, and the goal orientation of the educational or training system.

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Analyzing Task and Content Levels

Analyzing task and content levels is the function in the task analysis process in which the mental or behavioral performance required to acquire the task or knowledge is described. That is, designers describe the type of mental behavior, physical performance, or affective response required by the task. This usually takes the form of classifying the task statement according to various learning taxonomies.

Table 1 compares a number of these taxonomies, which describe learning in terms of hierarchies of content. Beginning with the lowest level or most fundamental forms of behavior (reflexes), they describe increasingly more complex mental responses or behavior (evaluation, problem solving, or strategies). The purpose of classifying tasks varies with different models. Normally, however, taxonomic classification of objectives and test items ensures consistency between the goals, the test items, and the instructional procedures. Exact instructional procedures for sequences are implied by some models and hierarchies, such as the component display theory (Merrill, 1983).

**Objectives**

Another component of the task analysis process that could arguably be included in the list of functions is the instructional or behavioral objectives. They are the most common component

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*At task level: remember, use and find.
of all instructional development models (Andrews & Goodson, 1980). However, objectives are not a process. Rather, objectives are a product, resulting from task analysis or some other process. Objectives represent specific statements of the tasks being analyzed. Sometimes, objectives are an input to the task analysis process. That is, objectives are often determined by some process (needs assessment, curriculum guide, etc.) prior to the instructional developer being consulted. So the developer begins by inventorying the tasks limited by the objectives. More commonly, however, a list of objectives and enabling objectives are the product of the task analysis process. They are an essential tool of all of the task analysis functions—inventory, description, selection, sequencing, and analysis—but do not constitute a separate function in the process. While they are essential to the process, for our purposes, they are not part of it.

Needs Assessment

The distinction between task analysis and needs assessment is especially ambiguous, since they are complementary, contributory, and often overlapping processes. Needs assessment, like task analysis, is a process. It is a process that entails three or more functions depending upon definition. It is a formal process for determining the present capability of prospective learners, the desired outcomes, and the discrepancies between the two (Kaufman, 1972). It also frequently entails the ranking of those discrepancies in order of priority. In many respects, needs assessment mirrors task analysis. The sequence is often similar, and there is a variety of procedures available for performing needs assessment functions, some of which are often used to conduct task analysis functions. Yet, when it is performed, needs assessment nearly always precedes task analysis, so that it is usually contributory to task analysis. Needs assessment frequently comprises the task inventory and, with less frequency, the task selection functions of the task analysis process. Therefore, they overlap and complement each other. However, task analysis is a larger process that does not always depend on needs assessment.

Functions Included in the Task Analysis Process

Task analysis, as performed in various instructional development models, may include some or all of the previously described functions. The task analysis process varies, so the procedures used during the task analysis process may include only one or all of these functions. However, all task analysis procedures performed using various design models can be described by one or more of these functions. That is, these functions, as represented by most task analysis procedures, are usually distinct enough to be identified. Some procedures may perform two or more functions simultaneously. There is no universal temporal sequence in which these phases are performed. As mentioned earlier, Komisowski (1981) recommends a top-down sequence of inventory, sequencing, analysis, and description. Most designers perform the inventory first, followed by a description. The analysis frequently precedes the sequencing. The functions and procedures used by the developer depend on a large extent on a group of variables to be described next.

Task description always involves an elaboration of the tasks/goals stated in the inventory to a greater degree of specificity or detail.

Task Analysis Variables

The variability in the procedures used to accomplish the task analysis functions results from: (a) the diversity of tasks being analyzed (from psychomotor tasks to complex problem-solving tasks); (b) the instructional situation (from assembly line to laboratory); (c) the characteristics of the learners; (d) the designer's experience and training, and other project constraints, and (e) the instructional development model being applied. The problem is to determine which task analysis procedures are appropriate for accomplishing the task analysis functions. In order to do that, we need to identify the variables that affect the task analysis process and the different functions performed as part of it. These variables can then be used along with the functions as a method for determining the appropriate procedures to be used. A quasi-algorithm is needed for selecting from among available task analysis procedures. In order to do this, we need easily classifiable variables. Some important variables affecting the task analysis process which also lend themselves to classification, are described below.

Micro-Macro

Task analysis procedures are used in different levels of Instructional planning. Micro-level procedures are those that pertain to a relatively small portion of instruction, usually an individual objective, a single idea or a single task. Procedures like Component Display Theory (Merrill, 1983) describe how to classify, test, and present instruction for an individual objective. Many traditional behaviorally oriented task analysis procedures, such as behavioral analysis (Mehrer, 1967), mathetics (Gilbert, 1961), and learning contingency analysis (Guppy, 1974), analyze each objective for the discriminations, generalizations and chains of behavior required to ac-
 sequencings the components of a course. Concept hierarchy analysis (Tiemann & Markle, 1983) is a process for analyzing the conceptual components of subject matter. The most prominent task analysis procedure, learning hierarchy analysis (Gagne & Briggs, 1979) also operates at a macro-level, although not always at a course level. Rather, it is used to identify and sequence the prerequisite skills or performances that lead to course goals. In order to design instruction successful, it is necessary to develop this larger picture on how content is organized. The procedures used to do that are different from micro-level procedures.

Top-Down Bottom-Up

Task analysis procedures vary also in terms of their overall approach to analyzing tasks. Those procedures that are more concerned with content or concept analysis take a top-down approach. That is, they begin at the most general or abstract level of content or with the most general task description and proceed to break it down into its component concepts or tasks. Top-down analysis then is an elaborative process, seeking more detail and specificity. Learning hierarchy analysis (Gagne & Briggs, 1979), for instance, begins with a generic task and analyzes it for its prerequisite tasks, and those for their prerequisites and so on. Information processing analysis (Merrill, 1978: 1980) starts with a task and looks on a micro-level at the specific mental process that produce that performance. Top-down analysis procedures proceed from the general to the specific in a hypothetico-deductive fashion.

Bottom-up task analysis procedures, on the other hand, start at the specific level and build up an instructional sequence. They proceed from the single task or steps in a task and proceed to construct a task sequence from it. This type of analysis is most common in job task analysis (Mager & Beach, 1967) where a designer starts by observing a sequence of steps involved in performing a task. The critical incident technique (Flannigan, 1954; Zemke, 1981) is also a bottom-up process, where analysts begin with describing the critical incidents in job performance. Bottom-up analysis procedures are specific-to-general, inductive types of analysis processes. In most industrial settings, they are helpful in analyzing job task requirements.

The problem is to determine which task analysis procedures are appropriate for accomplishing each task analysis function.

Job Task Analysis vs. Learning Task Analysis

An important distinction to task analysis is the source of the task and the orientation of the agency developing the tasks. Is the task being analyzed a job task or a learning goal or objective? That is, is it a job task analysis or learning task analysis? Is the agency developing training or educational sequences? Job task analysis occurs more commonly in business and industry, while learning task analysis is practiced more commonly in educational institutions.

Job task analysis is normally undertaken to solve a performance problem. Learning task analysis, on the other hand, is undertaken to develop a curriculum. The reasons for conducting task analysis will affect the nature of the process. While the curriculum resulting from a learning task analysis may prepare learners to perform the same jobs or roles for which job task analysis is used to develop training, the goal-orientation of the agencies conducting the analysis is different. Developers who design training sequences seek to develop mastery of specific tasks, whereas developers who design learning sequences usually are more concerned with mastery of subject matter knowledge. These orientations are reflected in processes normally referred to as job task analysis and learning task analysis. Educators foster knowledge acquisition; this approach is proactive. Trainers, on the other hand are more reactive, engaged in an ad hoc attempt to rectify problems. Educators design pre-service instruction, whereas the trainer/developer tend to design in-service training. The focus, orientation, and purpose of these two entities are usually disparate.

This difference in orientation is also reflected in the nature of the knowledge and tasks being analyzed. The job trainer is more concerned with procedural knowledge—how to do something or perform some task. The educator is more concerned with conceptual knowledge—the ideas, concepts and principles and their interrelationships that constitute a field of study. The former usually results in near transfer of training, while the conceptual approach more often produces far transfer (Clark & Voogel, 1985). Job training is not as concerned with getting trainees to apply or transfer their skills to similar problems in different settings. Since educators do not know the specific settings into which their students will go, they must be more concerned with far transfer, that is, the ability of their students to apply knowledge in a broad range of settings. Trainers, therefore, tend to use more behavioral training methods, while educators stress cognitive processes. Behavioral methods promote near transfer; cognitive methods promote far transfer (Clark & Voogel, 1985). While industry and the military rely more on training, there are many educators in their ranks, just as a lot of training is conducted in traditional educational institutions.

These three variables are somewhat global classifications of task analysis procedures. However, when combined with the task analysis functions, they can be used to make recommendations for the task analysis procedures that should be employed. In the next section, these variables are combined to form a quasi-algorithm for making general recommendations regarding selection of appropriate task analysis procedures.

Selecting Task Analysis Procedures

So far, we have described the ambiguity in the task analysis process and provided a scheme for describing and classifying task analysis procedures. The problem of which procedure to use to accomplish each task analysis function remains. We know that the ability to
make informed judgements depends on experience. Experienced developers recommend task analysis procedures for use in different situations based upon their better developed “scripts” for the instructional development process. The purpose of this article then, is to use our organizational scheme to make suggestions about which task analysis procedures may be used for each function. Based upon his review of three task analysis technologies, Foshe (1983) made some informed recommendations about which task analysis procedures would be appropriate under different conditions. For instance, he recommended learning hierarchy analysis for macro-level sequencing, concept hierarchy analysis for discriminating among concepts, and so on. However, his review considered only three of the many task analysis procedures available to developers.

In Figure 1, we present a quasi-algorithm for selecting alternative task analysis methodologies. It is our belief that selecting from the many available procedures is best done through a sequence of decisions. The divisions in this algorithm are based upon the classifications of task analysis procedures previously discussed: (a) functions (inventorying, describing, selecting, sequencing, and analyzing) and (b) variables (micro-macro, top-down/bottom-up, and job vs. learning task analysis). In order to use the algorithm, first decide whether you are conducting a job analysis or an instructional analysis. That is, are you designing training for a specific job or are you developing a general unit of instruction? Next, consider the scope of learning. Are you developing instruction for a single task or objective or a set of course objectives? Are you operating at a macro-level or micro-level? Finally, decide which of the task analysis functions you are performing—inventory, description, selection, sequencing, or analysis. As you make this sequence of decisions and follow the appropriate paths, you are led to one or more numbers, which are key to the task analysis procedures listed and annotated in the Appendix. The numbered procedures shown at the bottom of each decision path in Figure 1 are the appropriate procedures which may be used to accomplish the task analysis function in the setting implied by the decisions. The choice of which procedure to use depends upon the experience and/or preferences of the designer or some organizational design by a design team.

**Conclusion**

It is not our intention to offer a definitive prescription about which specific task analysis procedure should be used for every function in every setting. The knowledge about the task analysis process is too uncertain for us to make specific recommendations about which procedures to use to solve all design problems. Rather, we have tried to impose some organization on the task analysis process. In doing so, we hope to provide some guidance to the

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**Figure 1. Algorithm for Selecting Task Analysis Methodologies.**

![Diagram showing the algorithm for selecting task analysis methodologies.](image-url)

*The suggestions shown here are based on the normal, intended purposes for each method. So, they are not exhaustive. It is possible to innovatively apply each method to a variety of functions.*

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beginning developer in selecting the procedures that could be used to accomplish the various task analysis functions in different settings. Once you have used the algorithm to narrow your choices to a given category, you must familiarize yourself with the alternative procedures in order to make the final selection of task analysis procedures to be used.

References


Rand McNally.


Appendix

Task Analysis Methodologies

1. Behavioral Analysis. Like many other task analysis procedures, behavioral analysis (Mechner, 1967)
grew out of programmed learning. In an attempt to develop systematic methods for sequencing frames of programs, Mechner suggested analyzing the components of each objective. Like Gilbert (1961) and Gropper (1974), he classified these components as discrimination, generalizations, or chains. He developed a set of rules for sequencing chains (procedures) and concepts, such as "never teach a discrimination without simultaneously teaching a generalization" (p. 94). The instructional developer can perform a behavioral analysis by merging the types of questions students might ask about discriminations, generalizations, and chains, such as "What are the steps at arriving at this conclusion?", "Where is all this leading?", or "What are some examples of concepts?" To the extent that we feel comfortable in generalizing programmed learning procedures, behavior analysis provides a useful means for micro-level task analysis and sequencing of instruction.

2. Bloom's Taxonomy. Bloom and his colleagues (Bloom, Krathwohl, & Masia, 1956; Krathwohl, Bloom & Masia, 1964) spent several years developing a taxonomy of cognitive and affective behaviors for purposes of test design. A taxonomy of psychomotor domain was added later (Harrow, 1972). These taxonomies later became the primary means for analyzing learning tasks. They describe in detail increasingly complex forms of cognitive behaviors (from knowledge to evaluation), affective behaviors (from receiving to articulation of a value concept), and psychomotor behaviors (from imitation to naturalization). These remain the most detailed descriptions of learning behaviors, still popular with many educators (see Table 2).

3. Brainstorming. Brainstorming provides a quick route to job analysis (McDermott, 1982). The developer assembles skilled job performers in order to determine the model job performance. All steps and functions are posted on index cards on a large, clear wall. Using different color cards, all contingencies are posted for each step. Then the developer tries to get consensus on the most realistic alternatives to each of the listed contingencies. Finally, the knowledge and skill requirements for each step are stated. This brainstorming procedure is a quick and easy method for analyzing jobs. Its strength lies in the elaboration of contingent behaviors necessary for performing the job.

4. Cognitive Mapping. Understanding concepts is necessary but insufficient for understanding content. Learners must also understand the structural relationships between related concepts. So if we use content or concept analysis procedures for identifying concepts, we will need a method to derive the type and degree of relatedness among those concepts. Cognitive mapping provides a tool for this (Diekhoff & Diekhoff, 1982). Once the key concepts are selected, designers or subject matter experts should form all possible pairs of those concepts and rate each pair for degree of relatedness using a 1-9 scale. The relatedness matrix is treated as an intercorrelation matrix and analyzed using principal components analysis or multi-dimensional scaling. The output of the analysis is a map that spatially relates the inter-concept distances. This process could aid both the sequencing and analysis phases. Sequencing is aided because the clusters that are formed indicate content groups. While not a traditional form of taxonomic analysis, the meaning of concepts is enhanced by knowing relationships among concepts. Further analysis of these relationships adds another dimension of meaning (Jonassen, 1984).

5. Component Display Theory. The component display theory (Merrill, 1983) is a micro-level design strategy for organizing instruction for a single idea or objective in the cognitive domain. The designer begins by classifying each objective to be taught in terms of the nature of the task and the content, a distinction missing from most analysis schemes. An objective can require the learner to remember, use, or find either facts, concepts, procedures, or principles (see Table 1). Component display theory recommends the use of four primary presentation forms (tell or ask generalities or instances) and six types of elaboration (context, prerequisite, mnemonic, mathemagenic help, representation, feedback). It then provides rules that state the required primary presentation forms and elaborators for different types of tasks and content. While component display theory is an instructional design system, much of which is used after task analysis, the task/content matrix is very useful for the analysis phase because of its explicitness.

6. Conceptual Hierarchy Analysis (Tiemann & Markel, 1983; Reigeluth, Merrill & Bunderson, 1978). The sequencing of instruction, according to concept hierarchy analysis, is implied by the structure of the content. Various content structures (description, comparison/contrast, temporal sequence, explanation, definition/examples, problem/solution, cause/effect) may suggest different sequences for different tasks. Concept hierarchy analysis is a macro-level task analysis procedure for identifying, organizing and arranging instructional content in the absence of a specific procedure. It requires identifying and analyzing the network of concepts used in any content area.

7. Criteria for Task Selection. Most of the military task analysis processes include an explicit procedure for selecting from among tasks or objectives those in which training should be provided (Design of courses of instruction, 1973; Job task analysis manual, 1973; Tracy, Flynn, and Legre, 1970). The criteria for determining feasibility and appropriateness include: universality (transferability), difficulty of acquisition, cruciality to the mission, frequency of performance, practicability, achievability by trainees, quality of skill, deficiencies resulting from training, retainability, and need for follow-up training. With limited training resources, a broad range of skills to cover, and a large number of trainees, the military is obviously pressed to develop comprehensive training. These task selection criteria help to rank the importance of each task in order to provide training for the most important tasks first. While these criteria are seldom applied to educational (learning) problems, they could be.

8. Critical Incident Technique. Determining the tasks to be included in instruction is often accomplished by using critical incident analysis (Flannigan, 1954; Zemke, 1981). In this technique, experts identify the critical job incidents and their products. Incidents are edited for redundancy, grouped into similar tasks, and then classified as positive or negative incidents. The incidents are summarized and then validated by the experts for completeness. This is a useful means for obtaining a list of relevant, real-world tasks to be included in instruction. It is a job-related technique, however, and is most useful for converting job descriptions into instructional inventories.

9. Delphi Technique. In selecting the tasks/content to be taught, it is often necessary to place the inventory in priority order. This often requires the informed judgements of subject matter experts. One of the most popular techniques for generating that data is the
Delphi technique (Dalkey & Helmer, 1963), in which sets of comments/beliefs/questions are submitted to an anonymous group of subject matter experts for their judgements. Their responses are analyzed and summarized, and then become the questions for the next round of judgements. This iterative judgment-feedback cycle is continued until the panel reaches consensus. The result represents the convergent thinking of a group of experts. It can be a tedious process, but it is one of the most systematic for collecting judgements.

10. Elaboration Theory. The elaboration theory (Reigeluth & Rogers 1980; Reigeluth & Stein 1983) provides a simple-to-complex approach to organizing instruction in which concepts, procedures, or principles are iteratively detailed and epitomized. It is a macro-level strategy for organizing multiple objectives. For each single objective, component display theory is used to organize instruction. That is, instruction starts at a general level with an epitome; i.e., the organizing of content ideas. These general ideas are then elaborated in progressively more detailed steps. Each level of elaboration has its own epitome (overview), which indicates the content structure of that elaboration, a summarizer (e.g., statement, example, or self-test), and a synthesizer to integrate that level of elaboration to all higher level elaborations. In addition, elaboration theory employs strategy components, such as analogies, cognitive strategies, and learner control. Elaboration theory views task analysis as a form of content analysis; from that point of view, it supports the task inventory, description, and sequencing functions. The analysis steps include selecting the operations to be taught, deciding which to teach first, sequencing the remaining operations, creating the epitomes, and designing instruction on each operation (Reigeluth & Rogers, 1980). Performed in the context of elaboration theory, these represent a comprehensive and systematic top-down approach to learning analysis that is seldom ever used to organize job-related training.

11. Extended Task Analysis Procedure. The extended task analysis procedure (ETAP) (Reigeluth, Merrill, Branson, Beğland, & Tarr, 1980) is a 12-step process for analyzing procedural tasks that combines hierarchical and information processing analysis procedures. It was developed for the military specifically to support job training. The three phases of the process include process analysis (identifying each step using information processing analysis), sub-step analysis (identifying the sub-steps for each step), and knowledge analysis (identifying the knowledge required to perform the task). The result is a multi-dimensional representation of the learning task including a flowchart, a list of sub-steps, and a list of component facts and principles. What is unique to ETAP is the factor-transfer and principle-transfer analysis. In complex transfer tasks that include a large number of conditions or factors, ETAP identifies all the factors and creates decision rules and more general common rules for dealing with those factors in a transfer situation. Where those factors cannot be identified easily, ETAP identifies and sequences into instruction the necessary principles for properly executing the transfer task. Attention to this transfer of training is often absent in instructional design models, especially in the task analysis process.

12. Fault Tree Analysis. Another method for selecting the tasks to be taught focuses on avoiding errors or faults. Fault tree analysis (Russell, Powers & Bennett, 1974) predicts undesired events that may affect the operation of a system and provides the basis for redesigning it to prevent those occurrences. It can be used to select those tasks necessary for preventing undesired events. The result of such an application of fault tree analysis is a priority list of training needs. Working backward from a statement of an undesired event (previously identified), fault tree analysis represents all antecedent conditions that could have caused the event. The same process is repeated for each of those events, with each causal condition represented by an AND or OR logic gate. This process produces a tree of causal events, which shows each of the critical paths that produce the undesired event and the probability of the occurrence of each. Working with this information the designer could select those paths with the highest probability of occurrence as the most important training needs. This is a technical procedure that also requires a thorough knowledge of the operation system by the designer in order for it to be successful (Gentry, 1985).

13. Functional Job Analysis. Functional job analysis conceptually defines worker activity and defines methods for measuring worker output (Fine & Wiley, 1971). All jobs require workers to relate to data, people, and things (machines). Each job can be defined in terms of the workers· interactions with these three elements. Those interactions are actually limited. That is, there are only a few ways the workers can interact with certain types of machines. The job functions related to these three elements are sequential and hierarchical, proceeding from simple to complex. In that sense, it is much like learning hierarchy analysis, which specifies all of the prerequisite tasks to each goal. So analysis of any job task describes how the worker relates to data, people, and things as well as the relative amount of involvement he/she has with each element. This comprehensive analysis of job tasks has been adopted by several private and governmental organizations as their job analysis procedure.

14. Job Task Analysis (Mager & Beach, 1967). In the context of developing vocational instruction, the task analysis procedures focus on job description—what a worker does under the conditions that the job is normally performed, rather than what you would like him/her to do. The procedure requires the designer to list all of the tasks in a job and the steps included in each task: i.e., what a person does when performing the step, the type of performance involved (see Table 1), and the expected difficulty in learning it. From the task analysis, the designer derives course objectives after first determining what the learners already know. Course objectives, then, describe those things that learners should be able to do at the end of the course. Except for the determination of the type of performance required by each step, this is a vocational, behavioral analysis technique that focuses on the inventory function.

15. Information Processing Analysis (Merrill, 1978; 1980; Resnick, 1976; Resnick & Ford, 1982). Similar to learning hierarchy analysis, information processing analysis describes the sequence of cognitive operations required for solving a class of problems. Such analysis usually represents the information processing sequence in algorithmic form. The goal of such analysis is to model the mental operations of a learner while performing a task, rather than modeling the overt behavior exhibited by the learner. While it is normally applied to problem solving, information processing analysis may be used to describe other tasks. Such analysis must be generic so that it may be applied to a range of problems (tasks). It may imply a forward or a backward sequence.
of development, depending upon the problem solving technique employed. (See also Path Analysis, 25).

16. Instructional Analysis. Instructional analysis is a comprehensive set of task analysis procedures intended as a critical link between task analysis and writing instructional objectives (Hoffman & Medsker, 1983). By analyzing the component skills, instructional analysis seeks to identify “New learning,” excluding those skills already known from a list of “instructional” objectives. So, after identifying and sequencing component skills and eliminating extraneous ones, the instructional analyst identifies the type of learning required by the remaining skills using a hybrid taxonomy. This taxonomy includes complex procedures which are pre-defined, interrelated sequences of operations that can be considered a unit. So, starting with a task analysis, the instructional analyst analyzes the type of learning and conducts a traditional hierarchical analysis, a procedure analysis, or a combination analysis which combines the complex procedures. After identifying support skills not integral to the task, a learning map that combines all of the previous analyses is constructed. Instructional analysis is a super-procedure that adds to task analysis. It represents one of the most comprehensive task analysis processes available.

17. Learner Control of Instruction (Merrill, 1975). Learner control describes an instructional strategy rather than a procedure for designing instruction. Essentially, it argues for allowing the learner some degree of self-determination of the content and strategies of instruction (Merrill, 1983). The content may consist of the objectives, lesson, or module selected by the learner. It has the most significant implications for task analysis in the sequencing and selection functions. Giving students the opportunity to select what they will learn as well as the order in which they will complete instruction can preclude some of the sequencing operations normally performed by the designer. To responsibly select instructional content requires some metacognitive skills, which many learners do not possess. Because of this, the research findings related to learner control have been mixed, at best.

18. Learning Contingency Analysis. A task inventory or description provides a set of tasks, or steps in a task, and the ordering of these. Usually performance of one task/step is contingent on another, which is contingent on a prior skill. Since these contingencies have implications for instructional sequences, designers can develop a corresponding progression of steps to be taught. The progression or sequence is dependent on the relationships among tasks/steps. A learning contingency may be necessary, facilitative, or non-existent depending upon four types of relationships: superordinate/subordinate, coordinate input/output, shared elements, or no relationship (Gropper, 1974). The sequence in which behavioral components should be learned in turn depends upon the nature of the relationship. For instance, Gropper (1974) suggests that an output that becomes an input for another performance should be taught first. This type of task analysis describes the behavioral components of an objective, rather than the traditional taxonomies that are used to describe the terminal performance depicted by the objective.

19. Learning Hierarchy Analysis (Gagne, 1965, 1974, 1975, 1977, 1985; Gagne & Briggs, 1979). Learning hierarchy analysis has become so universal that many equate it with task analysis. Based on his own taxonomies of learning (Gagne, 1965, 1977, 1985), Gagne has described a method for developing a hierarchy of learning skills (see Table 1) for organizing learning tasks. While it could be used to organize instruction for job tasks, it is commonly associated with learning analysis. This is a backward chaining technique for elaborating the prerequisite skills for accomplishing an instructional objective. Learning hierarchy analysis has evolved from a behavioral analysis method for describing the structure of a task and the essential prerequisite skills that comprise that task. For any objective, learning hierarchy analysis describes the prerequisite concepts, principles and strategies necessary for acquiring the skill implied by the terminal objective. The optimal sequence of instruction can be inferred from such learning hierarchies.

20. Learning Taxonomy (Leith, 1970). While structurally similar to Gagne’s taxonomy, Leith’s (1970) taxonomy (see Table 1) provides specific instructional suggestions in the form of conditions. Leith devoted as much of his hierarchy to associative processes as Gagne did in his earlier work. The primary difference is at the higher end of the taxonomy, where Leith included problem solving and schemata development. Schemata are general networks of ideas and operations. This reference to schemata reflects the shift in the sixties toward a more cognitive orientation in the psychology of learning.

21. Master Design Chart. One means for using objectives to plan curriculum is to develop a master design chart (Davies, 1976). A master design chart is a matrix, with one axis listing content areas and the other listing specific behaviors (objectives). In designing such a chart, the designer first identifies the objectives along the behavioral axis. Second, the content of subject matter is broken down and displayed along the content axis. Third, each cell in the matrix should be evaluated for the emphasis on each type of behavior that should be manifest for each area of content. The resulting matrix reflects the emphasis of the curriculum and could be used to sequence the tasks in a course. It could also be used in a more top-down way at the front end to inventory the tasks to be included in an instructional unit. The master design chart is an alternative method of matrix analysis.

22. Mathetics. Emerging from the programmed instruction movement, mathetics was promoted by Gilbert (1961) as the technology of education, a complete system for task analysis and instructional design. This behavioral approach diagrammatically represents the task sequence that was established by observing and analyzing a master performer. The task analysis classified behavior as consisting of chains, multiple discriminations, and generalizations. Rather than classifying objectives, this taxonomy describes the processes that comprise an objective (Gropper, 1974). Gilbert’s concern with the stimulus portion of the S-R association resulted in a specific set of instructional procedures based on the task analysis. These procedures include demonstrating, prompting, or releasing the learner. Gilbert also suggested rules for deciding what content to include and the sequence in which it should be presented. While mathetics has not lived up to his prediction as the technology of education, it represents one of the most comprehensive behavioral task analysis systems available.

23. Matrix Analysis. Like many task analysis procedures, matrix analysis (Evans, Glaser & Homme, 1962; Thomas, Davies, Orens, & Bird, 1963) emerged from the programmed instruction literature as a means for sequencing program frames. In designing programs (or other forms of instruction), designers first identify the important concepts and convert those into
a set of specific rules. The rules should then be sequenced in some order. In order to adequately communicate knowledge, the interrelationships among rules need to be understood and taught. In order to identify all of the pertinent interrelationships, a matrix is created. The matrix, which shows all possible interrelationships, requires that the designer do a pairwise or cell-by-cell assessment of the relatedness between each possible pair of rules. Each pair is classified as an association (the rules are related and similar) or discrimination (the rules are related but different). The sequence of instruction is reflected in the matrix, so that by observing the matrix, the designer can quickly discern omissions, inverted or misplaced rules, or any other sequencing problem. From the matrix, a flow diagram describing the different types of frames is developed, showing the final sequence of instruction. Matrix analysis could be used to help sequence any form of instruction.

24. Methods Analysis. Methods analysis is a micromotion analysis of any job based on detailed motion studies (McCormick, 1979). These often use operation charts that describe in detail the actions of workers at a single location, using standardized symbols to depict each motion of the worker. Micromotion studies analyze videotapes of workers performing jobs in terms of basic motions and develop a simultaneous motion cycle chart that describes the motions of each hand and the body. This type of micro-level analysis is useful for deriving the description phase for psychomotor tasks.

25. Path Analysis (Merrill, 1978, 1980). Path analysis is the second phase of information processing analysis. In conducting a path analysis, the designer identifies the unique paths through an information processing flow chart. This is especially important when a process contains iterative sub-processes. Paths are depicted by listing the numbers of all the operations on a flow chart that the learner executes going from start to stop. Comparing the sequence and inclusiveness of different paths provides a meta-level analysis of the information processing that occurs. This analysis shows the superordinate/subordinate relationships among various paths. That is, some paths may be embedded hierarchically in other paths. Those paths (representing skills) that are subordinate to others are also prerequisite to them, so that learning hierarchy analysis (Gagne, 1965, 1977, 1985) can then be used to analyze the skills. These hierarchical paths are then converted into task sequences for orienting instruction. (See also Information Processing Analysis, No. 15).

26. Pattern Noting. Pattern notes were originally conceived as a notetaking method (Buzan, 1974; Fields, 1982) for summarizing the content of notes in a network map form. To construct a pattern note, you box the key issue or item in the center of a clean sheet of paper. You begin to free associate related topics and write those on lines connected to the box. Sub-issues are written on lines linked to the initial lines. You continue to elaborate the lines until the related topics are complete, and then interconnect any related topics on the map with lines. Pattern notes are excellent organizational and retrieval strategies (Jonassen, 1984) that reflect a person's cognitive structure (Jonassen, in press). They can assist the task analysis process most in terms of the inventory and description functions when the content of instruction is being identified. They are conceptual in nature, so they could support concept hierarchy analysis. Pattern noting, as a measure of cognitive structure, is also a useful measure of prior learning. Pattern noting can depict interrelatedness of prior knowledge, rather than a unidimensional, single score on a pretest. It is similar to, though distinctly different from, concept mapping (No. 4).

27. PROBE Model. The PROBE model (Gilbert, 1982a, 1982b) is a performance analysis procedure that consists of eight sets of questions that analyze the capabilities of workers and the environments in which they work. These individual difference and environmental questions concern the inspiration and instrumentation available to employees as well as the motivational contingencies that result in performance. The questions are used to analyze any performance problem situation in terms of employee skills and motives, knowledge and training, adequate information and feedback, proper tools and responses, and appropriate incentives. The PROBE model is a conceptually sound and practical performance analysis process. It was not designed as a task analysis procedure; it is broader in scope. It could, however, yield useful information to anyone performing a task analysis. The questions related to knowledge and training function as a needs assessment procedure that would supply the basis for task analysis. So, the PROBE model is a useful strategy supporting the task analysis procedure.

28. Syntactic Analysis (Stone, Dunphy, Smith, & Ogilvie, 1966). One of the most difficult parts of task analysis is organizing a large number of tasks that have been inventoried. Syntactic analysis reviews each task statement syntactically, i.e., looks for statements with similar terms, performing the same syntactic function. For instance, task statements can be analyzed for common direct objects. Those with common direct objects, indicating various performances on the same object, cluster together (Martin & Brodt, 1973). Syntactic analysis can also search for synonyms of objects or other syntactic elements. It is used primarily to order task statements.

29. Task Description (Miller, 1962). A task description specifies the sequence of stimulus-response associations required to complete a task (Miller, 1962). This includes specification of the cues or indicators perceived by the performer, the task activities, and the conditions surrounding each performance required for accomplishing each task. Task analysis further clarifies the behavioral requirements of the task where the designer looks for some behavioral structure in the task. The task description and analysis process, according to Miller (1962) is a molecular process concentrating, only on the behavioral aspects of performance.

30. Vocational Task Analysis. Hershbach (1976) proposed a three-step task analysis model that includes a task inventory, a task description, and a task analysis. In the task inventory, the designer identifies the steps, or task elements and sub-elements, using observation and interview techniques. Analysis of tasks qualifies the task description and analyzes the behavior using learning hierarchy analysis (Gagne, 1965, 1977, 1985) or Bloom's taxonomy (Bloom, Krathwohl, Masia, 1956). No explicit technique is described for sequencing tasks, except those implied by the task analysis step. Hershbach essentially applies classic task analysis procedures to industrial education.
The Acceptability and Effectiveness of Textbook Material Revised Using Instructional Design Criteria

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Abstract. If instructional designers are to achieve widespread success by reaching large numbers of students, they have to develop learning materials that are not only effective in producing the desired learning outcomes but are also accepted and used by teachers. In this study, a list of standard instructional design revisions (techniques that are frequently used by designers) were identified. The effects a number of these standard revisions (applied to a chapter from a commercial textbook) had on teachers' adoption attitudes and student performance were investigated. Teachers who reviewed the modified chapter were no more or less willing to use it than teachers who reviewed the original version. However, the instructional design revisions did significantly improve student performance. The implications of the results of the study for instructional design practice and future research are discussed.

Introduction

There are two basic approaches to the design of print instructional materials: the traditional method and the instructional design method. The traditional approach is the one commonly used by commercial publishing companies. In this method most of the author's attention is paid to the content of the book. Assumptions about what content should be presented are the textbook writer's guidelines. The standard editing and graphic design procedures of the publisher determine how the content will be communicated. These procedures usually take the form of "tried and true" principles that are based on artistic judgments and marketing considerations rather than on scientific knowledge about the learning process. Most print materials used by teachers are developed in the traditional way.

Unlike the traditional approach used in the design of most commercial textbooks, instructional design focuses on the characteristics of the material that produce learning. Typically, a development team is guided in its work by the instructional designer's knowledge of instructional design principles derived from learning theory and research and also from data collected from learners who have used the material. In general, instructional designers consider learner data the primary source of information on which to base the design of instructional materials.

Will a traditional textbook that is revised using instructional design criteria (design principles derived from learning theory and research) be used by teachers? If so, what will be the effects on student performance? Commercial publishers have not shown much interest in either question. While instructional designers strive to find answers to the question of improved student performance they too have not shown much interest in the first question. Yet, designers should be concerned about teachers' adoption attitudes because if designers' revisions affect teachers' attitudes negatively, the materials may not be adopted by teachers and used by students. Either designers will have to find alternatives that are both instructionally effective and acceptable to teachers, or teachers attitudes must be changed. On the other hand, if instructional designers' revisions have neutral or positive effects on teachers' attitudes any problems associated with adoption may be beyond the designer's control. In this case, instructional designers, confident that their efforts do not have a negative effect on teachers' willingness to use their materials, can continue to focus most of their attention on improving student performance.

Purpose of the Study

The major purpose of this study was to answer the following questions:
1. Do teachers who review traditional textbook material that was revised using instructional design criteria have significantly different attitudes toward adopting the material from teachers who review the original, unrevised version?
2. Is traditional print instructional material that was revised using instructional design criteria more effective with learners than the original, unrevised version?

The effects of student reading ability on posttest performance, the amount of time it took to complete each chapter, and the posttest were also examined.

Method

Subjects

The teacher and student participants in the study were from St. Petersburg Vocational-Technical Institute in St. Petersburg, Florida. Fifty-six teachers were in the teacher sample. Seventy four students participated in the study; they represented most of St. Petersburg Vo-Tech's 45 vocational programs, and all read at an eighth grade level or higher. Most of the teacher and student subjects were involved in classes characterized primarily by self-paced instruction.

All of the teachers were expected to teach entrepreneurship, the subject of the instructional material selected for the study. Seventy-seven percent of the teachers reported that they had spent no time teaching entrepreneurship, and only eight percent reported spending more than 20 hours. None of the teachers had ever reviewed or used the version of the material he or she was assigned in the study.
Each teacher participant was asked to provide at least one student who met two criteria: (a) not be enrolled in a business management program and (b) be able to read at an eighth grade level or higher. Forty-five students had worked in a small business, 13 in their families' businesses. Since the students were randomly assigned to the two versions of the material, any effects of previous knowledge of the subject on the results were controlled.

**Instructional Materials**

Two sets of instructional materials were used in this study. One was a chapter taken from a commercial textbook entitled *Small Business Management* (Pickle & Abrahamson, 1981). The other was a modified version of the chapter which incorporated standard instructional design revisions.

A panel of nine instructional designers was formed to review the original version of the instructional material and to recommend revisions that would make the chapter more effective in teaching the objectives of the lesson. The recommended revisions were selected from a list of 94 standard instructional design techniques that had previously been identified by the same instructional design panelists as effective ways to supply Gagne’s (1977) events of instruction. The panelists consisted of four professors/practitioners and five practitioners. All panelists were experienced in using Gagne’s events of instruction to design print material. The revisions were made in the original textbook chapter by the researcher and validated by the panelists. A comparable page from the original textbook and the modified version can be seen in Figures 1 and 2.

**Instrument**

A five-point Likert-type scale, the Instructional Materials Acceptance Questionnaire (IMAQ), was developed to measure the degree to which teachers agreed or disagreed with 25 statements describing behaviors that reflect teachers’ willingness to use or not use instructional material. The face validity of the IMAQ was established by asking teachers from the target population to review every item on the questionnaire and indicate whether it represented an adoption, rejection, or information-seeking behavior. Coefficient alpha was used to estimate the reliability. Alpha was .95 (n = 25).

A criterion-referenced (objectives-based) test was developed to measure student performance on the verbal information objectives and the intellectual skills objectives of the instruction. The test was validated by a professor of measurement evaluation and two instructional designers. Coefficient alpha was used to estimate the reliability of the 90-item test. Alpha was .96 (n = 79).

**Procedure**

The Instructional Materials Acceptance Questionnaire was completed by the 56 postsecondary vocational instructors. None of the teachers had ever reviewed either version of the instructional material before participating in the study. All of the teachers convened at one time in a large classroom. Twenty-seven teachers were randomly assigned to the group that reviewed the revised version, and 29 teachers were randomly assigned to the group that reviewed the original, unmodified chapter.

The 74 vocational students convened...
in two sessions held one day apart. Half of the students met the first day, and the other half met the next day. Thirty-six students were randomly assigned to the group given the revised chapter, and 38 students were randomly assigned to the group given the original, unmodified chapter. The two groups were homogeneous in reading ability. The students were allowed as much time as they needed during the day to read and study the chapter and take the test. They were not allowed to view the other version of the chapter during the experiment.

**Statistical Analyses**

A series of t tests were used to test the hypotheses on teachers' adoption attitudes, student time spent on the book, and student time spent on the test. A t test was also used to determine whether the two groups differed significantly in reading ability. The students' scores on the Gates-MacGinitie Reading Tests were used in this test. As Table 1 indicates, the variance estimates for the groups were homogeneous.

A two-way analysis of variance was used to test the hypotheses concerning student performance on the posttest.

The independent variables were: (a) version of the book (original or modified) and (b) reading ability (high or low). The students were divided into two ability groups: learners with high and low reading abilities. Students who scored above the mean for the total sample on the Gates-MacGinitie Reading Tests were assigned to the high group; students who scored at or below the mean were assigned to the low group. Three separate ANOVAs were run for the three dependent variables: total posttest score, verbal information subscore, and intellectual skills subscore.

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**WHAT PERSONALITY CHARACTERISTICS CONTRIBUTE TO SMALL BUSINESS SUCCESS?**

A great deal of research has been conducted to try to identify the personality characteristics that contribute to small business success. So far, there is no general agreement. One research study of 97 small business managers, however, showed that success is related to five general characteristics: (1) drive, (2) mental ability, (3) human relations ability, (4) communications ability, and (5) technical knowledge. *(See Fig. 1-2.)*

![Entrepreneur](image)

**Figure 1-2** Personality characteristics that contribute to small business success


**Drive**

In general terms, drive is a person's motivation toward a task (how much the person wants to do it). Drive includes such personality traits as responsibility, energy, initiative, persistence, and ambition. An entrepreneur must work hard to start and manage his/her small business. A manager who works hard planning, organizing, coordinating, and controlling his/her small business is more likely to have a successful business than a manager who is casual and careless.

Of course, many entrepreneurs work long hours at menial (low level) tasks, such as cooking in a restaurant, and still do not succeed because they fail to perform the more difficult management functions: planning, organizing, directing, and controlling. In fact, some small business managers perform menial chores in order to avoid managerial tasks because they feel inadequate or don't know how to be effective managers. By staying busy at menial tasks, they convince themselves they don't have time to perform management functions. It is not unusual to hear such comments as "I know I should be doing that, but I just don't have time."

**Mental Ability**

Mental ability consists of overall intelligence (IQ), creative thinking ability, and analytical thinking ability. Small business managers must be fairly intelligent, able to change their actions to meet various situations (creative
### Table 1

Means, Standard Deviations, and t Values for Reading Ability

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>SE</th>
<th>F*</th>
<th>2-Tail Prob.</th>
<th>t</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revised</td>
<td>35</td>
<td>45.26</td>
<td>5.60</td>
<td>.95</td>
<td></td>
<td>1.27</td>
<td>.49</td>
<td>26</td>
</tr>
<tr>
<td>Book</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Original</td>
<td>35</td>
<td>44.89</td>
<td>6.31</td>
<td>1.07</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Reading scores were not available for four subjects, one in the revised group and three in the original group.

**F** test for homogeneity of variance

### Results

**Teachers' Adoption Attitudes**

Teachers in Group 1, the group that reviewed the modified chapter, scored a mean of 55.52 on the Instructional Materials Acceptance Questionnaire, while teachers in Group 2, the group that reviewed the original version, scored a mean of 59.90. On a 25 item scale with item response values ranging from positive (1 point) to negative (5 points), a mean of 50 points indicates that teachers had a slightly positive attitude toward using the material. The difference between the two groups' ratings was not statistically significant. An analysis of teachers' open-ended responses to the question asking what features of the material particularly influenced their feelings about using it or not using it revealed that teachers paid more attention to the content and the visual appearance of the chapter than the features supplying the instructional events.

**Student Performance**

As indicated in Figure 3, students who received the modified version of the chapter scored higher on the total post-test as well as on the verbal information and intellectual skills subsections, than did students who received the original chapter. The results of the three ANOVAs, as shown in Table 2, indicate there were main effects for version of book and reading ability on all three dependent variables (p < .001). There were no significant interactions. As indicated in Figure 3, on all three dependent variables, the low readers assigned to the modified version attained means very close to the high readers assigned to the original version.

The time students spent reading the book and doing the test was measured in minutes. There was a significant difference (p < .001), for time on book but no significant difference for time on test. Students completing revised version took an average of 19 minutes longer than students reading the original chapter.

### Discussion

The main purpose of this study was to determine what effect standard instructional design revisions of traditional print instructional material had on teachers' attitudes toward adopting the material. Another important purpose was to verify that the instructional design revisions resulted in a product that was more effective in teaching students the objectives of the instruction. Based on the results of this experiment, the following conclusions are made.

An analysis of teachers' responses to the open-ended question concerning what features influenced their adoption decisions shows that content was the most important factor. Teachers tended to pay attention to the same characteristics in both books and for the most part they did not consider the presence or absence of the standard instructional design revisions or their intended effects as especially important to their decisions.

In this study teachers were not made aware of the differences in the two versions of the materials. It would be interesting to determine whether instructional design revisions influence teachers' choices of materials when teachers are asked to make a comparative evaluation. Another worthwhile line of inquiry would be to investigate whether providing teachers with feedback on student performance, attitudes, and time it took students to achieve mastery would produce significantly different degrees of acceptance of the two versions of materials. If teachers' decisions are influenced favorably by raising their awareness of the instructional design revisions and their effects, or by providing feedback on student performance and attitudes, then designers could increase the use of their products by promoting instructional design features.

The focus of this study was limited to the effectiveness and acceptability of a group of instructional design revisions.
### Table 2
Analysis of Variance for Total Test, Verbal Information, and Intellectual Skills Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Test Scores</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main Effects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B_1</td>
<td>1</td>
<td>3846.79</td>
<td>3846.79</td>
<td>19.38*</td>
</tr>
<tr>
<td>R_1</td>
<td>1</td>
<td>3802.86</td>
<td>3802.86</td>
<td>19.16*</td>
</tr>
<tr>
<td>Interactions</td>
<td>1</td>
<td>234.12</td>
<td>234.12</td>
<td>1.18</td>
</tr>
<tr>
<td>B_1 x R_1</td>
<td>70</td>
<td>13895.41</td>
<td>198.51</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>73</td>
<td>21583.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Verbal Information Subscore** |    |      |      |      |
| Main Effects     |    |      |      |      |
| B_1              | 1  | 788.75 | 788.75 | 19.80* |
| R_1              | 1  | 826.32 | 826.32 | 20.74* |
| Interactions     | 1  | .62 | .62 | .02 |
| B_1 x R_1        | 70 | 2788.59 | 39.84 |
| Error            | 73 | 4362.88 |      |
| Total            | 73 |      |      |      |

| **Intellectual Skills Scores** |    |      |      |      |
| Main Effects     |    |      |      |      |
| B_1              | 1  | 1151.78 | 1151.78 | 14.48* |
| R_1              | 1  | 1083.83 | 1083.83 | 13.63* |
| Interactions     | 1  | 258.85 | 258.85 | 3.25 |
| B_1 x R_1        | 70 | 5568.47 | 79.55 |
| Error            | 73 | 8005.62 |      |
| Total            | 73 |      |      |      |

*p < .001

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Figure 3. Mean test scores for the total test, verbal information subpart and intellectual skills subpart.
on a particular set of print materials. Having established that the revisions did result in higher student performance scores, the next step in examining the effects of the revisions should be to determine how much each of the changes contributed to differences in student performance. It is important for the instructional designer to know this because: (a) some of the revisions may not have had much of an effect and (b) some revisions cost more, in time and/or dollars, to implement than others. Knowing which revisions were more cost effective would help designers choose techniques that are not only effective but also fit the constraints of tight time lines and limited budgets. In addition, if student performance or teacher acceptance is equally affected by several different revisions, the designer should take into account how much a revision costs in time and dollars in comparison to other equally acceptable and effective alternatives before implementing it.

The instructional designers in this study did not use empirical data on student performance as the basis for their revision decisions. Instead, they relied on their own informed judgments and experience. Carrying the question of the cost-effectiveness of design decisions one step further, it would be informative to know whether the differences in performance attributed to the designers' expert judgments would be equal to, or significantly less than, differences when revisions were based on formative evaluation of student performance data. Do the outcomes of one or more cycles of formative testing and revision justify the additional costs? The answer depends on how much better the results would be using student feedback in addition to expert judgment as the revision criteria.

Instructional designers are in the business of producing effective learning materials. Yet, if designers are to achieve widespread success by affecting large numbers of students, they have to produce materials that will be used by teachers. In addition, more often than not, designers have to produce quality instructional materials within the constraints of limited budgets and time lines.

This study demonstrated that the extra cost and work involved in preparing the revised version of a chapter from a traditional textbook had no effect on teachers' adoption attitudes, but the revised chapter did significantly im-

prove student performance. Although designers may be able to improve the instructional effectiveness of materials, it still remains to be seen whether they can promote teacher adoption of those materials.

References
Training Interactive Videodisc Designers

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Abstract. This article describes a model for training instructional designers who will work as members of a videodisc development team. The model develops and integrates a complex set of skills that range from planning and design to programming and production. Its purpose is to train designers who can envision the many facets of disc development—designers who can converse intelligently, creatively, and efficiently with other specialists. The model is implemented, over a 15-week period, through a sequence of intense and highly coordinated activities. These build rapidly from relatively simple tasks that omit many aspects of disc development to a complex collaborative undertaking that includes, in simplified form, all of the major elements involved in creating a disc from scratch.

Introduction

There may be a shortage of videodisc designers on the horizon. Miller and Sayers (1985) forecast that by 1990, the installed base of videodisc players used in education and training could exceed 124,000. They project that about 65% of all videodiscs will be educational or instructional. Several hundred companies now design and produce videodiscs.

A rough estimate of the future demand for instructional videodisc designers can be derived as follows: Assume that total production expenditures will exceed $1.5 billion (Miller & Sayers, 1985) and that 15% of these costs are for instructional design; if 80% of design costs are allocated to salaries and benefits for instructional designers (at an average of $40,000 per designer, including benefits), the number of designers required would exceed 4,000.

We may already face a shortage of trained disc designers. Industry experience is currently limited to a small cadre of self-taught experts who paid their dues as pioneers. Thus, disc design is an expensive trial-and-error process in many organizations. It is characterized by conceptual backing and filling; it is not particularly efficient; it does not exploit the real power of the technology; and the industry produces only a small trickle of quality products.

The long, pioneering phase of interactive video is coming to an end. During this innovative period, designers acquired their knowledge primarily by participating in various research and design projects and small-scale commercial projects. Training was informal, dominated by collegial exchanges and mentorships. Using the technology in an orderly and efficient manner now requires a more systematic and formal approach.

How can we train good disc designers? What skills should they possess? To put these questions differently, what would a formal training program look like? This article describes a model for training instructional designers who will work on videodisc development teams—a model that could be adapted to a variety of educational and industrial organizations.

Based on a course offered by the San Diego State University Educational Technology Program as part of its master's degree curriculum, the model has been developed over a four-year period. The model is not designed to train production specialists or computer programmers. Rather, it aims to train students who can function as instructional designers on a videodisc development team.

General Description of the Model

DeBlois (1982) argues that computer-based interactive video instruction (CBVI) is not merely a combination of previously existing media delivery systems, but a new medium with unique properties. DeBlois also contends that effective use of interactive video technology requires a radical reconceptualization of the way we design and produce instructional products. Therefore, competent design of interactive video instruction requires a new synthesis of diverse skills.

CBVI development requires efficient coordination of many specialists. An instructional designer is only one member of a team that may include project managers, subject-matter experts, writers, actors, directors, video production specialists, video editors, computer programmers, and representatives of disc mastering facilities.

This model is not intended to teach students to be fully competent in any of the other specialties. Yet it allows students to become aware of the problems faced by other team members, even as they master skills specifically associated with design. It assumes that competence in designing discs requires the ability to converse with other team members and to assist them with their roles when necessary. The model represents those competencies as seven skill strands. They are:

* Instructional design  
* Project management  
* Interpersonal skills  
* Storyboarding and flowcharting  
* Computer programming  
* Video production  
* CBVI systems knowledge

Prerequisite Skills

Before taking the interactive video course, students should have completed
Figure 1. Model for Training Interactive Videodisc Designers.

This model develops and integrates seven skill strands. As students progress through the three projects, the skills represented by each strand become more complex and the strands become more interdependent.
The model is designed to train students to function as instructional designers on a videodisc development team.

designers represent algorithms as flowcharts which they can cross-reference with storyboards, which in turn serve primarily to represent message detail. Flowcharts and storyboards are not only tools for the individual designers, but also serve as a vehicle for communication with other team members. Designers must, therefore, adhere to (and create when necessary) flowcharting conventions that can do the following: represent the logic of instructional algorithms, designate media subsystems, and describe the instructional functions of message components.

Project Management
As Glasgow and Edmondson (1985) note, "The success or failure of an ISD (instructional systems design) project often depends on the actions of the people managing it. Any manager who embarks upon an ISD effort to develop interactive videodisc training better have highly-developed management skills to bring off a successful project (p. 23)."

Project management techniques help ensure efficient development. It is not uncommon for disc designers to develop specifications that substantially exceed available project resources. In addition, optimal scheduling of CBIVI projects involves parallel development activities undertaken by separate teams. Thus, the model provides training in the use of Gantt and PERT charts to allocate project resources and to monitor and control progress.

Interpersonal Communication Skills
Successful orchestration of team activities requires that designers be able to communicate with other team members about plans, roles and functions. They must be able to do the following: give and accept criticism, adjust to and negotiate differences with others, adapt to strengths and limitations of others, and assume leadership roles when necessary. The model does not attempt to teach the kind of interpersonal wisdom that requires years of learning; yet it provides numerous opportunities to experience the differences in interest, skill and perception that result from specialization. More importantly, it gives students a chance to refine previously acquired interpersonal skills with instructor guidance in the context of specific problems that typify CBIVI development.

CBIVI Capabilities
The development of interactive video technology has been tumultuous and is only now making strides towards standardization of equipment and software. The model provides for exposure to a range of equipment and emphasizes potentials and limitations for delivery of instruction. Course content focuses on how CBIVI can be used to control and represent instructional messages.

Computer Programming
Students use BASIC to transform instructional algorithms (represented by flowcharts and storyboards) into computer displays and a program that controls videodisc functions. Students who take this course are already familiar with BASIC. However, since the projects focus on instructional design, programming is not emphasized. Instead, students use subroutines developed by the instructors and draw on a library of program shells created by former students. Students who are especially well versed in BASIC develop new or unusual programs when necessary.

Video Production
All students taking the course have had at least one semester of television production; the course usually contains one or two students who possess undergraduate degrees in telecommunications. Introductory projects rely exclusively on existing videodisc material. Only the final project requires original video production. Options for this project are...
deliberately constrained to reduce complexity and save time.

Projects

Course activities revolve around three major projects of increasing difficulty. As the students progress through the projects, the skills represented by each strand become more complex; the strands also become more interdependent.

In the first project, individual students develop a simple Level 2 program that controls playback of an existing commercial disc. For the second project, students work in pairs to develop software for an external computer linked to a disc player. These programs incorporate computer-generated text and graphics but rely on an existing commercial disc for video content. For the third project, the entire class produces a complete videodisc from start to finish.

Project I

Project I does not deal with instructional design issues; the focus is on controlling the disc player and on systematic documentation. Students are introduced to videodisc capabilities, videodisc programming logic, and flowcharting conventions. Students use standardized template symbols to identify motion sequences, still frames, step frames, and decisions made by the learner or the control program. They also use a standardized system for numbering video or computer segments. Flowcharting conventions are adapted from those developed by Sony Corporation and Pioneer Video, Inc., for Level 2 program dumps.

Designing a Control Program

Before the project begins, students review the differences between Level 1 and Level 2 systems (see authors note) and they critique the effectiveness of representative instructional discs. With this background, each student designs a program to demonstrate important functions of a videodisc player: still frame, step forward, search, alternate use of audio tracks I and 2, user input and branching. Each student selects a short section of an existing disc and develops a simple flowchart to represent the control program. The student then converts the flowchart into a series of Level 2 commands that are laid out on codelsheets. Working informally with a partner, each student verifies the logic of the code and enters it into the videodisc player’s onboard computer using a remote control unit. The program is debugged and a sample run through is recorded on a VHS videotape.

Deliverables

Project I provides an introduction to the capabilities of disc players; students are advised to focus on the player’s capabilities and to de-emphasize message design issues. However, they are required to design a hypothetical single still frame that would request user input and to use this information to execute a simple program-branch. Deliverables for Project I include: a flowchart with appropriate designators, a program codelsheet, and a sample run through. Criteria used to evaluate Project I include: use of all the player’s capabilities, accuracy of the flowchart, and match between flowchart and code.

Project II

The second project extends knowledge acquired by students in previous instructional design courses to videodisc systems. The goal is to “interactivate” a short linear segment of video instruction using the capabilities of a Level 3 videodisc system.

Interactivation

Allen (1986) defines interactivation as “a process in which linear, fixed-pace media (including audiotapes, videotapes, and films) are transformed so as to allow the selection, pacing and sequencing of messages to be based on the responses of the learner” (p. 102). Project II allows students to extend their instructional design skills to interactive video without requiring that they develop original video footage.

Students work in teams of two. The original video material consists of excerpts from a commercially produced video disc on 35-mm photography, The Creative Camera (Holzmann & Benz, 1981). This disc uses the constant angular velocity (CAV) format. In theory, CAV discs support true interactive designs. However, the organization of The Creative Camera is linear. The information is also extremely dense; it is not uncommon for a one-minute segment to present two or three new concepts or a complex procedure. Audio track 1 contains introductory narration, while audio track 2 presents advanced information for more experienced photographers. The high information density of this videodisc makes it especially appropriate for an interactive-exercise exercise.

Project II requires extensive collaborative use of the tools and conventions introduced in Project I. Students employ a 15-step model for interactivating the videodisc (Allen, 1986). The model contains three stages: (a) specifying outcomes, (b) analyzing and designing instructional strategies, and (c) producing new components.

Analysis of Existing Video

Stage One requires students to determine the instructional goals and objectives of the video and to specify additional objectives if necessary. In Stage Two, they subject the continuous structure of the linear video to a detailed four-phase analysis.

Students log four separate phases or structures against an absolute time scale, measured in seconds and in disc frame numbers. They analyze video cinematic structure as a set of components (e.g., scenes, shots and camera angles). They analyze audio cinematic structure in terms of music, narration, dialogue, and field sounds, etc. The other two phases of the analysis are concerned with the instructional function of audiovisual representations. Video and audio channels are each assumed to carry a sequence of more or less discrete instructional messages; each message is seen as a component in an overall instructional strategy. Merrill’s (1983) component

Designers must be able to negotiate differences with others and assume leadership roles when necessary.
display theory (CDT) provides a set of descriptors for identifying these components and for describing their relationship. As modified by one of the authors (Allen) for use in the four-phase analysis, CDT provides about 40 descriptors ranging from "motivator" and "expository generality" to "directions" and "learning strategy."

The four-phase analysis helps students to catalogue existing pictorial and audio representations, to determine the structure and function of the existing instructional strategies, and to locate points where the continuous structure of the tape can be interrupted without damaging cinematic continuity. The four-phase analysis also provides students with a basis for deciding how additional components might enhance the existing instruction or adapt it to new purposes. The students must consider the extent and nature of the learners' interaction with the program; when to use still frame and when to use motion; what additional graphics are appropriate; and what kind of feedback and remediation could or should be added.

Algorithm Development

Once the four-phase analysis is complete, students develop a flowchart that incorporates existing video as part of an instructional algorithm. Flowcharts for Project II are more complex than those in Project I since they include computer-generated text and graphics. Flowchart symbols representing instructional components include a brief content description and a CDT descriptor that explains the function of the component within the instructional algorithm strategy (see Figure 2).

Flowcharts serve as instruments for communication among team members. They permit preliminary evaluation of instructional strategies and verification of program logic during informal reviews within the team as well as with other teams.

Message Design

The next step is to develop the instructional messages in more complete detail. A storyboard frame is developed for each message contained in the algorithm. A standardized storyboard form (see Figure 3) includes space for describing video, audio, and computer displays, indicating programming branches, and specifying subroutines. Frames are cross-referenced to corresponding flowchart symbols. Since Project II relies on existing video, un-

Figure 2. Portion of a flowchart used to interactivate an existing linear video presentation on 35-mm photography.

Flowchart symbols contain a designator (lower left corner) that denotes the form in which a message will be represented, e.g., VM = video motion, VF = video freeze, CT = computer text, etc. (Each flowchart designator is cross-referenced to a storyboard form. See Figure 3.) Notation modified from Merrill (1980) describes the instructional function of the message, e.g., EG = Expository generality, Eg = Expository instance, Eg/h = Expository instance with help, di = Directions. Flowchart symbols also contain a brief description of content. A rectangle with squared corners signifies that messages will be generated by computer; a rectangle with rounded corners indicates that source of message will be videodisc. Combined use of both forms specifies that computer text and/or graphics will be superimposed over video source. Based on a student project by J. Duffield and M. Weiner.
modified video segments and audio content are transferred to storyboards.

Message Design
The next step is to develop the instructional messages in more complete detail. A storyboard frame is developed for each message contained in the algorithm. A standardized storyboard form (see Figure 3) includes space for describing video, audio, and computer displays; for indicating programming branches; and for specifying subroutines. Frames are cross-referenced to corresponding flowchart symbols. Since Project II relies on existing video, unmodified video segments and audio content are transferred to storyboards.

Project Management
A coordinating instructional designer monitors the early phases of development to ensure consistency in screen formatting. A coordinating programmer conducts a parallel effort to ensure that variables and subroutines are used consistently by separate teams. The coordinating programmer also works with the instructors as necessary to develop new subroutines and program shells. When team efforts are completed, the coordinating programmer links each program to a main menu and record keeping system. Teams and coordinators use a simple Gantt chart to monitor progress and to ensure adherence to deadlines.

In the final phase of Project II, students develop computer code to control the disc player and to drive text and graphic displays. Working with a library of shells and subroutines developed by the instructors and other students, they write and debug programs in BASIC.

Deliverables
Deliverables for Project II include the following: goals and objectives for the interactived video, a four-phase analysis of the videodisc segment, a narrative description of the instructional strategy, flowcharts and storyboards, computer code, and computer diskette. The entire class critiques each team's final product. The lessons developed in
Project II from *The Creative Camera* videodisc are used to teach students basic 35-mm camera skills in an introductory audiovisual course. A menu allows learners to select different modules. The program keeps a record of each student's performance.

**Project III**

In the third project, videodisc development is a team effort. No individual student is expected to have the expertise or the time to accomplish this project alone. Just as all seven skill strands (see Figure 1) overlap and intertwine in earlier projects, so do the responsibilities of the team members overlap and intertwine in the third project.

**Scope**

Projects I and II build a framework for creating and communicating CRIVI designs. They introduce students to a systematic development process. They also establish—through small teams and class critiques—a collegial environment in which CDT notation, flowcharts, storyboards, and other tools become vehicles for resolving conflicts. Project III is far more complex and demanding than its predecessors. It involves a team of over twenty people and requires development of a complete Level 3 disc from start to finish in eight weeks.

The instructors determine the general concept for the production, which is usually centered on procedural skills. They solicit informal support from a local company or agency in the form of subject-matter expertise and equipment. Past projects have resulted in discs to teach simple medical procedures to Navy medical corpsmen and food preparation techniques to restaurant workers.

**Management**

The class is divided into four module-development teams. Each module deals with a different aspect of procedural content: (a) parts, functions, and principles of operation; (b) demonstration of the procedure; (c) remediation of common errors; and (d) guided practice. Module team members assume roles as instructional designers, computer programmers, or video producers. Team efforts are managed by coordinating designers, coordinating programmers, and coordinating video producers.

*MacProject* (Willrett & Young, 1984), a computer-based project planning tool, is used to coordinate the project. Project III is broken into about 30 separate sub-
tasks (see Figure 4). These subtasks are often collaborative efforts involving as many as six individuals. Students spend about 50 hours on the project; distribution of workloads during the eight-week period depends on the role assumed by the individual. Certain tasks on the critical path, such as video editing, may generate peak loads of 20 hours in one week.

Analysis

The initial phases of Project III focus on analysis of the instructional problem. Working with a subject-matter expert, the coordinating instructional designers perform a task analysis of the procedure. They also analyze the target population’s age, educational background, subject-matter knowledge, attitudes, and motivation. They then base instructional goals and objectives on this information.

Design

Coordinating designers and module designers develop instructional strategies and represent strategies as algorithms. The algorithms are evaluated by the entire class. This is a critical step in terms of disc development and student experience. Designers often develop specifications that exceed the resources and capabilities of programmers and producers. A rigorous critique at this stage ensures that all “specialists” have a chance to express reservations and doubts about the soundness and feasibility of the designs. Properly managed class discussions serve not only to negotiate differences, but to build consensus.

Once the flowcharts have been revised, the instructional designers develop detailed storyboards. They then write simple, conversational-style scripts for the video segments. Coordinating instructional designers, producers, and programmers then meet with module designers and instructors to review the storyboards. Coordinating designers, programmers, and producers make final revisions and freeze the design.

Production and Programming

The coordinating producers, in conjunction with the instructors, now begin planning the logistics of the video shoot. They organize actors, scenery and props, and schedule rehearsal time. Module producers develop shot sheets, and coordinate their efforts to eliminate duplicate shots.

Meanwhile, programmers begin drafting the computer code. Since flowcharts and storyboards provide detailed specifications, programming is relatively independent of other project activities. With the help of the instructors, coordinating programmers develop specialized subroutines for controlling the disc player and for superimposing computer text and graphics onto videodisc images. Copies of the subroutines are supplied to each module programmer. Team programmers meet to help revise and debug each others’ code. Programs are tested and debugged using a “dummy disc.” Any standard optical laser disc can serve this function. The primary concern is to ensure that the program generates computer text and graphics as specified and that it controls the disc player properly.

Post-production

The coordinating programmers review the completed computer code and determine the precise order in which video segments must be laid out on the finished videodisc. (Unlike conventional linear videotapes, the sequencing of segments must be optimized to reduce access time during frame searches.) They relay the tape-sequencing specifications to the coordinating producers for use during editing sessions. The coordinating producers and programmers also work together to configure computer text and graphic overlays. This is a joint effort since it involves positioning of actors and props during the video shoot as well as placement of computer-generated screen displays.

Module producers are responsible for videotaping, editing, and post-production. Production techniques are deliberately constrained; shooting is usually completed in a single day. The procedure is shot as a table-top demonstration. Voice-over narration is used in lieu of live sound whenever possible and two cameras shoot all scenes simultaneously. The tape is edited in conformity with storyboards and specifications of coordinating programmers. Music and narration are dubbed and the final tape is sent to a disc mastering facility for conversion to disc.

Disc Production

The final phase of the project awaits production of the videodisc. Since the disc is not intended for commercial distribution, low-cost production technologies are used. One option is a 30-minute/54,000 frame DRAW (Direct Read After Write) disc available from several disc-oriented post-production services. A single copy costs about $300. DRAW discs have a limited life span, are not as durable as commercial discs, and the video image quality is poor.

A second option, the Lasermaster, is available from Laservideo Inc. of Chicago. This proprietary process is suitable for small runs. As with DRAW technology, each disc is mastered separately in real time. However, the Lasermaster process yields a durable disc with an indefinitely long life span, and high video image quality. The cost for one 15 minute/25,000 frame disc is about $600.

Program Completion

When the disc is received, frame numbers for all critical segments are logged on flowcharts and storyboard forms. Frame numbers are then inserted into the control program code by module programmers, who replace frame numbers used with the dummy disc. Module programmers test the separate module programs again and adjust the configuration of any text or graphic overlays to the actual videodisc images. They then link the separate module programs to a master menu/record keeping system and test the entire program again.

Documentation

One incentive for the high level of involvement and commitment required by Project III is the value that it adds to a student’s portfolio. Students are encouraged to make videotape copies of a sample run through of the final CBIV program. Project documentation is also important as portfolio material. Students use this documentation in their portfolios because it gives future

Although this model was designed for a specific audience, a number of its features will be useful to others engaged in training designers of CBIV products.
employers a summary of their CBIVI design experience. It is also used by
students as a reference on future projects.

Two students assigned the role of writers compile and polish storyboards and
flowcharts, write introductions for the documentation, and compose the ex-
decutive summary. Coordinators meet with the writers to review and revise
the project documentation and to ensure that it corresponds with the completed
master videotape and computer code. At this point the documentation is finalized
for printing.

Deliverables

Project III deliverables include an ex-
ductive summary of the project, an analysis of the subject matter and the
target audience, instructional objectives, narrative descriptions of proposed in-
structional strategies and lessons, flowcharts and storyboards, computer
code, videodisc, and computer diskette.

Evaluation is based on the quality of
instructional strategies, accuracy of
flowcharts and storyboards, clarity and
layout of text and graphics, and, use of
interactive capabilities. The production
guality of the video, audio and graphics
as well as the accuracy of the computer
code is also assessed. Assessment of in-
dividual student performance is based
on the quality of the product as
evaluated by the instructors and peer
evaluations of individual contributions.

Discussion

This model describes a complex set of
integrated skills that range from plan-
ing and design to programming and
production. The model is implemented
through a sequence of intense and highly
coordinated activities. These build
rapidly from relatively simple tasks that
omit many aspects of disc development
to a complex undertaking that includes,
in simplified form, all of the major
elements involved in creating a disc from
start to finish. The projects described
here incorporate specialized protocols
for planning, designing, commu-
nicating, and managing in a highly
collaborative framework.

How generalizable is this model? The
answer is unclear. The model is closely
articulated with other courses in a
master's degree program. Students in
this program are typically mature in-
dividuals in their late twenties or thir-
ties. Most are highly committed to the
program. By the time they take the
course on which this model is based,
they have completed most of their
degree requirements. Many are actively
pursuing new employment. In short, this
course was designed for a specific group
of students with a specific academic
background. In spite of this, we suspect
that a number of features of the model
will be useful to others who are engaged

in similar efforts to train future designers
of CBIVI products.

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Equipment Notes

We have taught the course on which
this model is based for four years.
Equipment capabilities and course
content have been interdependent: and have
evolved together. For the first two years,
we used an interactive videotape system
consisting of an Apple II+ computer, a
Whitney interface card, a Panasonic
soliond-operated VHS tape system. A
menu-and-prompt-driven authoring
system supplied with the Whitney card
was used to generate Apple soft
BASIC code for the CBIVI programs.
The Whitney authoring system was cum-
bersome, simplistic, and full of bugs. In
the second year, we substituted Apple
Superpilot and had much better results.
For the third and fourth years, we
purchased a new system consisting of an
Apple IIE, a Pioneer LD-V1000 player,
and VMI interface; we used a
Microkeyer graphics card to superim-
pose text and graphic overlays. Costs for
the total system were about $4000. In
our experience, the Microkeyer card was
not well supported by its manufacturer.
Since Superpilot did not allow sufficient
room for Microkeyer drivers, students
wrote their code in BASIC.

During the third year, our videodisc
was mastered by Spectrimage, Inc. of
Burbank, CA for a cost of $300 using
DRAW (Direct Read After Write)
technology. Video was recorded on half-
inch VHS tape using light industrial
equipment and then transferred to
3/4-inch tape during editing. DRAW
discs are currently suitable only for tem-
porary ("check disc") use. While the disc
was functional, it had a high signal-to-
noise ratio. It began to degrade even fur-
ther after about nine months.

During the fourth year, we significantly
improved the quality of our video
production, relying on assistance from
our university's television station,
and its Telecommunications and Film
Department. We also sought and receiv-
ed help from a local corporation
which lent us its studio. We used an inex-
ensive, high-quality mastering process of-
fered by Laservideo, Inc. of Chicago
($600 for a 25,000 frame, 8" disc) with
excellent results.

We are planning to switch again to a
new interactive video system next year
and anticipate using it for at least two or
three years. It will link a Macintosh Plus
and a Pioneer LD-V6000 player via a
straightforward RS-232 cable. We have
recently negotiated a site license with
Edudisc, Inc., of Nashville for use of its
CBIVI software products including its
authoring system, Mentor; a videodisc
clip editing utility, called MacVideo,
and an image management system, Port-
folio.

Author Notes

Teaming Tomatoes, this years' class
project, won a silver "Cindy" award for
excellence in Level 3 video disc design
from the Association of Visual Com-
municators.

The authors wish to express their
thanks to Dr. David M. Sharpe of the
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collaborated extensively with Allen in
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the course on which it is based. Thanks
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taught each other as well as their instruc-

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tors about the complexities of developing computer-based interactive video projects.

A Level 1 system allows a viewer to determine the pace of information delivery. The user can freeze the action, step frame by frame in forward or reverse, scan the disc, or proceed in slow motion. Level 2 players possess an on-board, programmable microcomputer. This allows a videodisc to be programmed to respond to a user's input. Level 3 systems link a videodisc player with an external computer, allowing complex branching patterns and computer text and graphics overlays.
Supplementing Traditional Instruction with Objectives-based Instructional Development

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Abstract. A teacher guide incorporating objectives, learner practice, and assessment was developed for use with an existing instructional booklet on electricity. Eight classes of fourth graders were randomly assigned by class to one of two conditions: the booklet taught by teachers using their own teaching styles or using the objectives-based guide. Mean pretest scores of the two groups were comparable. Posttest means were 15.28 (76 percent) for objectives-based subjects and 10.29 (51 percent) for those under the more traditional instruction, t(126) = 8.11, p < .001. The objectives-based program took longer to complete but yielded a faster learning rate and more favorable student attitudes.

Introduction.

Most instructional development models and several models of teaching stress an objectives-instruction-assessment approach in which the latter two components are closely tied to the objectives (e.g., Gagne & Briggs, 1979; Popham, 1973; Sullivan & Higgins, 1983). Yet, well-designed instructional programs using this approach are not common in the schools. Textbooks rarely incorporate tightly integrated objectives, instruction, and assessment. Nor do school curriculum guides. Teacher-directed instruction based on the textbook and the teacher's own teaching style remains the dominant form of classroom instruction.

Factors limiting use of the objectives-based approach are not hard to identify. Many educators reject it out of hand. They oppose the notion of instructional objectives and of objective, as contrasted with subjective, assessment of students. Among textbook publishers and authors, the tradition is to produce works that are packed with information but lack carefully thought-out objectives and assessment. Further, development of effective objectives-based instruction requires hard work and specialized knowledge and skills that many educational professionals do not yet possess.

Still another limiting factor may be the scarcity of research evidence that objectives-based instruction really makes a difference. Evaluation in systematic instructional development focuses mainly on field testing a program during its development. Investigations of the effects of a program using an objectives-instruction-assessment approach with those of a non-objectives-based program that covers identical learning content are rare. Instruction over precisely the same content seldom exists in both forms.

The present study was a comparative evaluation of the effects of traditional and objectives-based instruction. The learning content, which was identical for both groups, was contained in a 24-page commercially developed instructional booklet on electricity. Under traditional instruction, teachers received a booklet for each student and taught its content according to their individual styles without further guidance. Under objectives-based procedures, teachers were given the student booklets as well as a teacher guide developed to enable them to teach the learning content of the booklets using an integrated objectives-instruction assessment approach.

Student learning was assessed with a 20-item pretest and separate 20-item posttest keyed to the instructional objectives derived from the booklet. Data were also collected on student and teacher attitudes and on instructional time.

Method

Subjects

Eight fourth-grade classes, four from each of two schools in separate school districts in the Phoenix, Arizona, metropolitan area participated in the study. One school is located in a low socioeconomic area; the other in a lower-middle area. Two classes within each school were randomly assigned to each treatment, to control for possible school effects.

A total of 128 students who were present for the entire instructional period, including the pretest and posttest, constituted the final sample. Students absent for one or more days continued in the instructional program but were not included in the data analyses.

Materials

The instructional material for the classes receiving traditional instruction was a 24-page colorfully illustrated, professionally printed, 8 1/2" x 11" booklet entitled Faster than an eyeblink: How electricity gets to you (Anders and Lindstrom, 1982). The Eyeblink booklet was written for a large electric utility company in the Midwest. In 1984 it was being used by more than 30,000 fourth graders in the utility's service area.

No teacher guide was prepared for Eyeblink at the time it was written, nor were instructional objectives written for it. However, the booklet is organized into four major topics (What Is Electricity?; How Do We Get Electricity?; How Does The Electricity Get to My House?; Electric Safety) with straightforward textual instruction covering each topic. The booklet also includes a vocabulary list and three pages of experiments, activities, and written exercises related to its textual content.
Four readability levels, each computed using a different readability formula, are reported in *Eyeblink*. They range from 3.0 to 4.0.

The materials for the objectives-based classes consisted of the *Eyeblink* booklet and a teacher guide written in 1984 to accompany *Eyeblink* and to provide an objectives-instruction-assessment approach for teaching it. The utility company sponsored the development of the guide in response to requests from teachers using the booklet. Four instructional objectives were inferred from *Eyeblink* as the basis for the objectives-based approach, one for each of its four major topics. Each objective encompassed the majority of the text and learning content for its section.

Five printed exercises providing student practice on the four objectives, one for each of the first three objectives and two for the more complex final objective that requires application of rules to new situations, were developed and incorporated into the teacher guide. A 20-item pretest, containing five items assessing performance on each of the four objectives, and a parallel 20-item posttest were also developed and included in the guide. Only a single copy each of the tests and exercises is in the guide, but the teacher can reproduce them for students. For purposes of this study, each teacher was supplied with enough copies for his/her class.

The teacher guide also includes a lesson sequence that organizes the instruction into the pretest, five lessons (one per exercise), and the posttest. This section contains teacher-directed oral practice and feedback to supplement the written exercises and an answer key to provide feedback for each exercise.

In summary, the teacher guide used by the teachers of objectives-based classes contained the information, directions, and materials for an objectives-instruction-assessment system for use with the *Eyeblink* booklet. The booklet was the core instructional content for both groups, but only the teachers of the objectives-based group received the teacher guide.

**Procedures**

Preliminary orientation meetings were held by the experimenters with the teachers from both groups at their respective schools to introduce them to the procedures and materials for the study.

Teachers in the traditional instruction group were given copies of the *Eyeblink* booklet, pretest, and posttest for all of their students. They were oriented to the booklet and were instructed to teach its content according to their own judgments and individual teaching styles. They also were asked to administer the pretest and posttest at the appropriate times.

Teachers in the objectives-based group were given copies of the *Eyeblink* booklet, pretest and posttest, and the five practice exercises from the teacher guide for all of their students, as well as a copy of the teacher guide. They were oriented to the booklet and guide, and were instructed to follow the teaching procedures and sequence described in the guide.

Teachers from both groups were asked to complete the unit within two weeks. All teachers were given copies of the student and teacher attitude surveys to administer upon completion of the unit. Teachers were also asked to keep a simple log on which they recorded the time and content covered for each session.

All instruction was carried out by the classroom teachers under their normal teaching schedules. The fourth-grade science curriculum in both districts includes the study of electricity, and the unit was taught as a part of regular science instruction.

**Data Sources**

Student learning under the two conditions was assessed with the unit pretest and posttest. Each test consists of 20 items: five items covering each of the four objectives derived from the four major topics in the *Eyeblink* booklet. The pretest and posttest are parallel forms that are identical in number and type of items, but the individual items themselves are different across the two tests. Both tests were administered by the classroom teachers as a part of the unit.

Student attitudes were assessed with a seven-item questionnaire with three response choices. The classroom teachers administered the questionnaires at the end of the unit. Teacher attitudes were assessed with a nine-item questionnaire containing five response choices.

Data related to time on program and progress through it were obtained from a brief daily log provided by the experimenters and completed by each teacher. Individual experimenters also observed selected lessons in each classroom during the study.

All tests and questionnaires were scored by the experimenters.

**Design and Data Analyses**

The evaluation design was a Pretest-Posttest-Control Group Design (Campbell & Stanley, 1966). According to Fitzgibbon & Morris (1978), this is a strong evaluation design that permits a powerful test to be made between alternative programs.

The data on student learning were analyzed by means of a two-tailed t-test of the means of independent samples. Student attitude data were analyzed by a chi-square test of the difference in response choices between groups on each attitude item.

**Results**

**Student Learning**

The means and percentage scores on the 20-item pretest and posttest are shown in Table 1 for both groups.

It can be seen that the traditional instruction group averaged 6.23 and the
objectives-based group 6.58 on the pretest, a difference between groups of only .35 of an item. Mean posttest scores were 10.29 (51 percent) for the traditional group and 15.23 (76 percent) for objectives-based subjects, a between-group difference of 4.99 items. Mean scores improved 4.06 items from pretest to posttest for traditional instruction and 8.70 items for objectives-based instruction.

The t-test of the difference between means on the posttest revealed a highly significant difference favoring objectives-based instruction. \( t(126) = 8.11, p < .0001 \). The t-value of .91 for the difference between pretest means was not statistically significant.

**Student Attitudes**

Student attitudes and judgments about the unit, as reported on the seven-item questionnaire, were generally favorable. Seventy-nine percent of the objectives-based subjects and 72 percent of the traditional subjects reported that they learned a lot, and 63 percent of objectives-based and 49 percent of traditional subjects responded that they liked the unit a lot.

Attitudes of objectives-based students were more favorable than those of traditional subjects on six of the seven items, but the chi-square analyses yielded a statistically significant difference on only one of the items: "How much did you share the activities with your family or friends?" Non-significant differences favored the objectives-based approach on test difficulty, liking for the unit, amount learned, helpfulness of the exercises, and amount students thought they would remember. The non-significant difference on ease of reading favored the traditional approach.

**Teacher Attitudes**

The ratings of the teachers on the nine-item teacher questionnaire were favorable and were similar across the two groups. On a five-point scale with one representing "agree strongly" with positive statements and five representing "disagree strongly", the overall mean ratings were 1.63 for objectives-based teachers and 1.80 for those using traditional instruction. All teachers in the objectives-based classes either agreed strongly or agreed with all nine positive statements about the unit. All teachers in the traditional classes, as well as in the objectives-based ones, agreed strongly or agreed that the skills taught were important, the unit was effective, the students liked it, and they (the teachers) would use it as a regular part of their curriculum.

**Time in Program**

The objectives-based groups spent considerably more time on the unit than those under traditional instruction. Mean times computed from the individual lesson times reported by teachers on their daily logs were 252 minutes (3 hours 22 minutes) for objectives-based classes and 137 (2 hours 17 minutes) for traditional instruction classes.

Analysis of gain scores per unit of time reveals a faster learning rate for the objectives-based group than for traditional subjects. The 8.70 item gain from pretest to posttest for objectives-based students represents an improvement of one correct answer every 27 minutes for their 232 minutes of time. This contrasts with one additional correct response every 39 minutes for the traditional group's gain score of 4.06 in 157 minutes.

**Discussion**

The overall evidence from the study favors the objectives-instruction-assessment approach incorporated through development of the objectives-based teacher guide over traditional teacher-directed instruction relying on the Eyeblink booklet and individual teaching styles. Not only did students learn more under objectives-based instruction, their overall attitudes and judgments were also more positive about the unit.

Despite their greater time on the unit, the learning-rate data also favored the objectives-based subjects. Their faster learning rate is particularly impressive because the more typical finding is a slower rate for groups spending considerably longer on a learning task. With extended time it is not uncommon to encounter a ceiling effect or simply to experience diminishing returns on more difficult learning content and test items.

The most feasible explanation for the better performance of the students who received the objectives-based instruction is their greater amount of practice and associated feedback on the learning task. The daily logs and classroom observations revealed that objectives-based teachers did in fact consistently follow the lesson sequence as described in the guide. This sequence provided specified oral practice and feedback led by the teacher, plus written practice and feedback in the form of the prepared learning exercises.

Under traditional instruction the typical pattern was for classes to read and discuss the booklet with no strong focus or structure to the discussion or to learning activities introduced by the teachers. Consequently, while both groups read the same basic learning content, those under traditional instruction spent a much lower amount and proportion of time receiving direct practice and feedback over this content. Reading and discussing textual information, with little related practice, simply are not enough to produce mastery of most learning content.

A potential problem in basing instructional objectives relates to possible differential learning of the other content of the unit or program. That is, an objectives-based approach may result in a heavier focus and better learning related to the content subsumed under the objectives, whereas non-objectives-based instruction may yield greater learning of the other, more incidental, content of the unit. This study did not investigate that issue directly by identifying and assessing performance on non-objectives-related content from the booklet and classroom activities. However, it appeared unlikely from careful examination of the Eyeblink booklet that differential incidental learning favoring the traditional group would have occurred. The content of the booklet is centered heavily on its four major topics, and the instructional objectives are quite comprehensive in subsuming this content.

Teachers had positive attitudes toward both forms of the program. They rated traditional instruction favorably even though it resulted in low posttest scores. Further, their responses reflected none of the negative attitudes that teachers sometimes express toward instructional objectives. On the contrary, all four teachers using the objectives-based approach responded positively to all nine items about the unit, and their overall ratings were slightly more favorable than those of teachers using traditional instruction.

Student attitudes were also positive toward both approaches but more favorable toward the objectives-based one. Support for objectives-based instruction was reflected in the statistically significant finding that students shared the activities more with their family or friends and in non-significant differences.
favoring this approach on five of the other six items.

The study suggests at least two avenues of further research. One would involve assessment of both objectives-based and non-objectives-based instruction to determine whether incidental learning may be greater under the latter approach. A second would include a detailed, minute-to-minute observation and recording of activities under the two methods in an attempt to isolate the factors most responsible for improved student learning. Research along these lines should provide greater insight into the overall effects of objectives-based and traditional instruction and the reasons for these effects.

References


As indicated by the title, the purpose of this book is to demonstrate how the affective and cognitive domains can be integrated for instruction and research. Leslie Briggs died shortly after the manuscript was completed. The forward by Robert Gagne is a eulogy to his former colleague. The authors rely heavily on the work of Gagne in the cognitive domain, but have expanded his ideas into the affective domain, and made significant contributions of their own.

Chapter 1 describes the separation of the affective and cognitive domains and presents an approach for integrating the two. A new taxonomy of the affective domain, which appears in the last chapter, also helps clarify the concepts in Chapter 1 and should be read at this point. In Chapter 2, the authors look at the instructional design process, beginning with needs assessment through the formulation of objectives and day-to-day instruction. They approach the process by means of a new concept—the "audit trail." An audit trail is a list of goals and objectives arranged in a descending order of complexity—roughly a hierarchical order.

Chapter 3 reviews the various taxonomies of the affective and cognitive domains and the research related to them. It provides an important distinction between "attitudes" and the "affective domain." Chapters 4 and 5 deal with values, attitude change, and developing moral and ethical behavior. About twenty attitude change theories are summarized in an excellent five-page table. The educational implications of these theories are addressed.

Chapter 6 covers self-development which is the personal dimension of the affective domain including self-concept, self-esteem and personality theories. The chapter contains a selected review of the literature and its instructional implications. Chapter 7 reviews emotional development and feelings, interest and motivation, social development and group dynamics, and attributions.

Chapters 8, 9 and 10 provide examples of instructional situations involving affective and cognitive content from elementary, secondary, undergraduate, and professional education.

Chapter 11 is one of the key chapters in the book. It describes the purposes and procedures of audit trails. The book provides a 14-step process for constructing an audit trail. The explanation is good, but more specific instructions would have helped. More examples should have been included than the three that were provided throughout the entire book.

Chapter 12 describes industrial and military training. The chapter traces the origins of instructional technology, noting the contributions of both industry and the military. Chapter 13 focuses on education for the professions with emphasis on health, medical and nursing education. The authors rightly point out that there is a shift in emphasis in the professions from strictly cognitive learning to both cognitive and affective learning.

Chapter 14 provides an excellent listing of 230 external conditions of learning which are most directly under the control of the teacher and the designers of instructional materials. Chapter 15 discusses delivery systems, media, and lesson design. It provides four examples of lesson designs incorporating conditions of learning and instructional events. The chapter also incorporates 20 principles for integrating instruction from the affective and cognitive domains.

In Chapter 16 the authors look back to what has been done and look to the future to see what needs to be done in this area. In the book they have reviewed and interpreted the existing literature from over 300 authors.

The purpose of the book (to integrate the affective and cognitive domains in instructional situations and to close the gap between need, curriculum, and instruction) is adequately covered. However, the authors assume much knowledge of instructional development and lesson design, especially the work of Gagne, Briggs and others from Florida State University.

The book is research-based and an excellent reference for all major topics discussed. Tables and figures are used to graphically summarize relationships. In fact, the book is an encyclopedic reference rather than a textbook. It condenses a huge amount of literature into 300 pages.

The chapters are well organized with an outline followed by an introduction at the beginning of each chapter and a summary at the end. This contributes to the redundancy within the book, but facilitates reading the chapters in any sequence. The authors use the old adage—"Tell them what you are going to tell them, tell them, and tell them what you told them." This technique works very well with oral instruction, but gets overwhelming with text material.

Some of the reviewer's concerns include the following items. The level of sophistication and depth varies throughout the book. No techniques are presented for writing or evaluating affective objectives and there is some confusion in the use of the terms formative and summative evaluation.

Since formative and summative evaluation relate both to lessons and to
students, this distinction should have been made clear, but was not. Interpersonal skills are dealt with only in the chapter on medical education. This is an important topic and should have received more attention in the book since it involves both affective and cognitive objectives.

Despite these concerns, the strengths greatly outweigh the weaknesses. The book is a "must" for professionals in the instructional development field. It is currently the best resource on the affective domain and a strong contender to become a classic in the field.—Reviewed by James D. Russell, Professor of Education, Purdue University, West Lafayette, IN 47907.


In reviewing the work of a former colleague and personal friend, it is our goal to be as objective and fair as possible to the authors, the publisher, and to you, the reader. As with any publication, the book has its strengths and weaknesses. We will first describe the content of the book, next discuss its contributions to the field, and then, finally, its weaknesses.

Briggs (1984) has commented in the Educational Technology column: "So what am I going to do about the neglect of motivation and the affective domain by instructional designers? I am now working with Barbara Martin Hurst on this problem. You may see something about this work in the pages of Educational Technology in 1985 (p. 34)." Their work has turned out to be a five hundred page book entitled The affective and cognitive domains: Integration for instruction and research.

The authors observe that the field of instructional design and development is not making as much impact as it could on educational and training practices. They then identified two neglected areas of research that deserve more attention in order to solve this problem: (a) integration of cognitive and affective domains in lesson design, and (b) direct linkage of lesson objectives to the lifelong goals of instruction. By addressing the areas that have not received enough attention, the authors propose ways for the field of instructional design and development to contribute to overall educational practices.

The first problem area that the authors have attacked is the identification and structure of the affective domain. Whereas the theories and models of instructional design have treated the cognitive domain extensively, little, beyond the work of Krathwohl, Bloom, and Masia (1964), has been done with the affective domain. In order to integrate the two domains in lesson design, the authors first thoroughly reviewed taxonomies and research concerning the affective domain. The review looks at such psychological constructs as attitudes, values, morals and ethics, self-development, emotions and feelings, interest and motivation, social development and group dynamics, and attributions.

Finding no adequate affective taxonomy for their purpose of creating an instructional design model, the authors propose a new taxonomy of the affective domain. While the best known and most prescriptive of the affective taxonomies by Krathwohl, Bloom, and Masia (1964) uses an organizing principle closely related to learner strategies (responding, valuing, etc.), the proposed new affective taxonomy is based on affective constructs. Self-development is placed at the apex of the taxonomy, representing the most inclusive of the affective components. Attitudes are treated as a central component of the taxonomy, which links as the subordinate component directly to morals and ethics and values, and indirectly to social competence and continuing motivation. Five other psychological constructs are also included in the taxonomy.

For each of the components of the affective domain, the authors provide internal and external conditions of learning (Cagney, 1985), as well as the capability verb (Cagney & Briggs, 1979) for writing instructional objectives. They state that "we have done for the affective domain what Cagney did for the cognitive domain..." and acknowledge that "we have basically followed the instructional design model of Cagney and Briggs, greatly expanding their work on attitudes (p. 436)." The internal and external conditions of learning have been derived from the authors' extensive review of literature that contains a limited research base and their interpretation of it.

Identifying the internal and external conditions of learning in both cognitive and affective domains has led the authors to the solution of what they call the problem of "domain isolation." It has become apparent that cognitive conditions play an important role in facilitating affective learning, which suggests that designers must consider this integration in their development of curriculum. The authors derive affective conditions which support the acquisition of cognitive skills as well as cognitive conditions supporting affective learning. A total of 230 external conditions are listed for cognitive and affective domains, many of which describe interactive effects of one domain on the other. The authors attempt to diagram the relationships in the form of a taxonomy.

The second problem area the authors have addressed is isolation of lesson design from broader goals of instruction. They see existing conventions of discontinuity among needs, curriculum, and instruction as an ineffective practice. A means to establish a connection between each level of planning is presented as a technique called "audit trail." An audit trail is defined as "a series of objectives, listed in descending order of generality and complexity, which are to be achieved by instruction and incorporated into the subsequent life and behavior of the learner (p. 279)." Since an audit trail contains both cognitive and affective objectives, the authors claim that the use of an audit trail will also facilitate the design of instruction which integrates the two domains. The authors' first attempt at deriving audit trails is presented for various educational settings ranging from elementary and secondary education to industrial and military training.

One strength of the book lies in the authors' review of the behavioral, cognitive, and social psychology research related to the affective domain. From basic constructs they derive "conditions of learning" to facilitate change in affective behaviors. These conditions of learning serve as the foundation for prescriptions in designing instruction aimed at affective outcomes. The literature review and derivation of implications for instructional design alone make this book a major contribution to the field.

Another strength of the book can be found in the authors' proposal of a new taxonomy for the affective domain. From their study they determined that existing taxonomies are not sufficient to describe the complexities of affective domain, and they develop their own taxonomy, which they stress is incomplete, but which might, they hope, provide a
foundation for future development and research. The strength of their taxonomy is that it recognizes the cognitive component of affective behaviors, and it attempts to relate these cognitive behaviors to the various kinds of affective behaviors in the taxonomy. In addition, it describes the "prerequisite" or facilitative conditions of one type of affective behavior on another. Again, if the authors did nothing else, their development of an inter-domain taxonomy is a major contribution to the field of instructional design.

Finally, the "audit trail" technology provides a way to use the integrated taxonomy. An audit trail is a loosely organized "top down" analysis of the component behaviors of a desired affective outcome. Much like the development of an intellectual skills hierarchy, the developer develops the audit trail through the application of the taxonomy and a process of asking the question, "What skills would the learner already have to have to develop a new, more complex skill?" The process for developing audit trails is described by a set of guidelines and illustrated with examples.

The weaknesses of the book, in our opinion, lie in its length and organization. The authors, as the title indicates, cover a great deal of content in the area of the cognitive domain, with which most readers of this book would already be familiar. The rehash of this cognitive domain information, at least for us, detracts from the importance of the information on the affective domain. However, we realize that the book will be read by persons without our familiarity with former Gagne/Briggs publications.

The organization issue is, perhaps, a consequence of the length of the text and the problem of integrating information about the cognitive domain with that of the affective domain. In any case, a great deal of the text is spent explaining what was just read, what will be presented next and how they relate. This seems unnecessary for the potential audience. As a result the reader may find him or herself skimming the text to get to the real meat of the information.

We would have preferred a smaller, more concise work, modeled on the Gagne/Briggs (1979) text, Principles of Instructional Design. However, our expectations aside, we feel that the Martin/Briggs text is a very valuable addition to the literature in our field. It is certainly a "must" reference for any designer working with objectives in the affective domain. It also contains a lot of "hunches" for further research that deserve more attention. Hopefully, it will be adopted by instructional design programs as a foundation of theory and practice for the affective domain, just as the earlier Gagne/Briggs text was for the cognitive domain. The Martin/Briggs effort is certainly a good start at an analysis of a domain of learning outcomes that has had little development since the work of Krathwohl et al. (1964). In this respect this book represents the most recent major contribution to our field.--Reviewed by Walter Wagner and Katsuaki Suzuki, Florida State University, Tallahassee, FL 32306.

References


This is a book for anyone who has ever asked for a job analysis and found themselves looking at the result and wondering, "Now what am I supposed to do with this?" It is also a book for anyone who has ever been asked to do one and wondered, "Where do I begin?"

Carlisle states that many job analyses fail as a result of two major errors. First, they are often reported before they are actually complete; and second, analysts tend to use only the techniques with which they are "comfortable," rather than ones which are particularly appropriate for the activities and purposes at hand. In Analyzing Jobs and Tasks, Carlisle defines the characteristics and structure of a truly useful job analysis, and describes 33 job analysis techniques.

In his first chapter, "Getting Ready to Analyze the Job", Carlisle presents some useful guidelines for drawing up an "Analysis Agreement", a contract between an analyst and client which defines the purposes, processes, and outcomes of the analysis activity. He describes the structure of a complete analysis as being composed of at least three steps:

1. Describe the component parts of processes of performance.
2. Describe the results of the processes.
3. Restructure the processes to match "correct" performance.

In Carlisle's view, this last step includes a description of how an employee will learn to perform the job or task. This helps to ensure that the results of the analysis will be implemented to achieve its ultimate purpose, which is to improve performance on the job.

The next four chapters provide comprehensive descriptions of a wide variety of techniques which can be used to achieve the goals of job and task analysis. Carlisle presents a total of thirty three different techniques which vary from the familiar card-sort, flow-chart, and critical incident techniques, to more esoteric ones such as risk assessment, man-machine time chart, and performance-probe. He also describes the types of performances for which each technique is most appropriate. While many of the techniques described are familiar, each is presented from the point of view of its utility for achieving one of the four goals of complete job analysis. They are:

- to write task statements,
- to detail and sequence task statements,
- to identify and solve inadequate task performance, and
- to identify learning requirements.

By describing each of the 33 techniques within the context of these goals, Carlisle presents even familiar data collection techniques in a new perspective and expands the scope of what many have previously understood to be job and task analysis. In achieving the final goal, "to identify learning requirements", the role of the job analyst clearly merges with that of the curriculum developer.

In his final chapter, "Completing the Analysis", Carlisle describes a reporting procedure which is, in effect, a job aid for those who will be responsible for implementing the results. Its connection to the "Analysis Agreement" described in the first chapter clearly brings the process full circle, and places a complete job analysis document in the hands of the client ready to be put to use.

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Analyzing Jobs and Tasks is an excellent reference book for both beginners and more experienced analysts. It has been written and designed to be used as an on-the-job resource. Writing in a clear, conversational style, Carlisle makes good use of diagrams, tables, and algorithms, rather than detailed text to support and illustrate concepts and procedures.

Sometimes this requires a bit of back-and-forth-page-flipping, but the book is very well designed and the diagram references are usually on the pages immediately adjacent to the text. Each chapter concludes with a brief summary, a feature which further enhances the book's use as a desk-top resource. Although I found myself occasionally wishing for references listed at the end of some of the chapters, Carlisle has included a very comprehensive bibliography. Anyone wishing further information on any of the techniques will find this an excellent representation of the job and task analysis literature.

Detailed information about each technique is presented in a simple job-aid format which includes: (a) the purpose of the technique, (b) its advantages and disadvantages, (c) a complete description of the technique, and (d) an example of its application. The examples, all drawn apparently from Carlisle's personal experiences as an analyst in business and industry, are particularly useful in bringing the techniques to life, as well as being fascinating in their own right. He has selected tasks from a variety of interesting jobs which include hotel desk clerk, training manager, control room operator at a nuclear plant, gas station attendant, and paleobotanist, to mention just a few. The job-aid format, which Carlisle introduces in the first chapter and uses consistently throughout the book for every technique, simplifies the comparison of techniques and makes it very easy to locate information.

Anyone with the responsibility for planning and/or conducting a job analysis will find Carlisle's book an excellent source of information. Analyzing Jobs and Tasks presents not only the techniques or "tools" you need to do the job, but also a well built "tool-box" for organizing and storing 33 different analytical techniques to help you select the best one for the job at hand.

This useful book is the first of ten in the series planned by Educational Technology Publications, Inc., "Techniques in Training and Performance Development". It has certainly left me anxious waiting for the next release.—Review by Judith Fidler, Manager of the Educational Resources Group, British Columbia Telephone Co.

The intended end product of the research project described is an intelligent multimedia tutoring system for procedural tasks, in particular, the repair of physical objects. This paper presents the data structure that will be used, i.e., a graph with five types of nodes (mental, abstract, motoric or action, visual, and verbal) and two types of links (subconcept and pointer). The graph examples given in the paper are knowledge representations of conceptualizations that people might have for a simple object such as a flashlight. Use of the representations is shown for choosing actions, planning strategies, making inferences, and designing instructions. The plan for computer implementation of the tutoring system is also given, as well as a report on applications of this knowledge representation, including how it can be derived from experimentally observed behavior. Finally, this knowledge representation is compared with others such as KRL, Pavio, and linguistically based theories.—Microfiche 75 cents, paper copy $5.40, plus shipping, as document ED 260 693.


A study of 60 elementary and secondary math and science teachers nominated by their peers as effective microcomputer-using teachers was conducted to describe how peer-nominated teachers use microcomputers for instruction, and how these uses vary as a function of teacher characteristics (e.g., knowledge and attitudes) and other background variables (e.g., learning environments). The primary method of data collection was personal, semi-structured interviews. However, observational techniques were also used to note the physical context of microcomputer use and to examine courseware used during the observation period. In addition, biographical data were obtained from the teachers through a self-administered questionnaire, which provided information on their educational and teaching background and their attitudes toward computers. Homogeneous clusters of teachers were formed on the basis of their patterns of microcomputer-based instruction, revealing four characteristic patterns of use: orchestration, enrichment, adjunct instruction, and drill and practice. Analysis of the data indicated that teachers’ attitudes toward microcomputers were unrelated to the patterns of microcomputer-based instruction that were identified; there were no systematic differences between patterns of use according to the average percent of coursework taken except for teachers in the drill and practice cluster; patterns of microcomputer-based instruction were unrelated to teachers’ experience in using microcomputers, to teaching other teachers about them, or to their facility with computer languages; patterns of instructional microcomputer use were unrelated to district and school policies regarding their use; and patterns of computer-based instruction were unrelated to organizational variables such as the number and location of microcomputers. It is suggested that data on student achievement and motivation would help to determine whether these different styles of teaching with microcomputers produce different outcomes. A list of references completes the document.—Microfiche 75 cents as document ED 264 839; paper copy from The Rand Corporation, 1700 Main Street, PO Box 2138, Santa Monica, CA 90406-2138 ($4.00).

This two-year study, which took a multidisciplinary approach to the problem of discovering principles for designing effective multimedia instruction, focused on the effects of the materials and the coordination of multiple instructional media on instructional effectiveness. The task domain was a logic box used to control an irrigation system. Fifteen different stimuli were prepared, each including an explanation of how the box works. Each was shown to a group of approximately 25 California community college students. The stimuli were videotapes of a professional actor following a carefully prepared multimedia script involving use of verbal explanation, diagrams on a blackboard, and the box itself. The stimuli comprised two series, the first using a fully-crossed design with three binary independent variables, and the second exploring seven variants of a single explanation type. Separate objective tests devised for each series shared several questions to permit cross-series comparisons. Analyses relied chiefly on 1-and 3-way ANOVAS, tests to evaluate between-group differences, and correlations between individual items and total test scores. The major findings suggest that the choice of discourse type can strongly affect comprehension; comprehension can be improved by gestural coordination between visual and verbal material and use of suitable visual icons; both cognitive level, and manipulation of the internal structure of discourse units have significant and systematic effects on comprehension; and inclusion of summaries, particularly initial summaries, seems to assist comprehension. Eight guidelines for media production are included, and scripts and test materials used in the experiment are appended. A reference list is also provided. —Microfiche 75 cents, paper copy $5.40 plus shipping, as document ED 261 6889.

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This paper identifies situations in which the use of nonprint media is effective in library instruction programs. Two points are emphasized throughout the document: (a) the use of sophisticated and expensive media is not crucial to the success of a library instruction program, and (b) effective use of media in library instruction involves careful planning and preparation. Some advantages of using media effectively are identified, including the ability to reach a large audience, the extension of influence of quality instruction, the ability to overcome time and space limitations, and the ability to create special effects to enhance learning. A general discussion of the use and advantages of media is followed by discussions of each of the ten steps involved in the instructional development process: (a) needs assessment, (b) solution selection, (c) analysis of task and content, (d) development of instructional objectives, (e) selection and sequencing of instructional strategies, (f) selection of media, (g) development and location of necessary resources, (h) tryout and evaluation, (i) revision/revise, and (j) social aspects. A 26-item reference list is included. —Microfiche 75 cents, paper copy $5.40, plus shipping, as document ED 261 6889.

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