Integrating Learning Theory with Instructional Design

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EDITOR'S NOTE

This is the second of two articles *JID* is publishing on the implications of cognitive psychology for instructional development. For the first article, see the article by Low in *JID*, winter 1980–81, *4*, 10–18.

Abstract. This paper examines the need for integrating assumptions about learning processes with the decisions typically made when designing instructional systems. Our concern is that the decisions made explicit in each of the commonly accepted components of instructional systems depend to varying degrees on implicit assumptions about the process by which people learn. Consequently, when instructional systems are designed without regard to learning theory, these decisions within components are often inconsistent, resulting in varying degrees of incompatibility among the components. The relationships between learning theory and instructional design are discussed, and suggestions are offered for improving the design process.

Instructional design methodologies have flourished academically in recent years because they have successfully "made sense" of the complex task environment facing teachers and instructional developers in public education, military, and industrial settings. Systems approaches to design of instruction (Briggs, 1970; Davies & Hartley, 1972; Dick & Carey, 1978; Gagné & Briggs, 1974; Glaser, 1966; Merrill & Tennyson, 1977; Skinner, 1968) have made possible a substantial degree of precision and control in handling traditional design tasks and have also created some relatively new tasks for designers and developers (review, for example, the recently expanded growth of need assessment, task analysis, and evaluation technologies). Moreover, the self-correcting nature of design procedures encourages planned systematic improvement of instructional practice, and the use of these procedures has obvious benefits in terms of accountability.

The advantages notwithstanding, the systems approach to the design of instruction has not had a major impact on education outside of the major materials development "shops" (most of which target nontraditional students). Systems approaches have seemed too mechanistic and too complex to receive serious consideration by many within the large and diverse population of public school educators. In fact, instructional designers have often highlighted the complexity and the mechanistic nature of "systems" approaches to their own detriment. It is rarely suggested in the educational technology literature that individual teachers and small teams of public school personnel can conduct, on their own, effective and inexpensive development projects (Gustafson, 1977).

A more serious problem confronting widespread utilization of instructional design principles, however, is that the existing models have very shallow (or nonexistent) theoretical foundations.

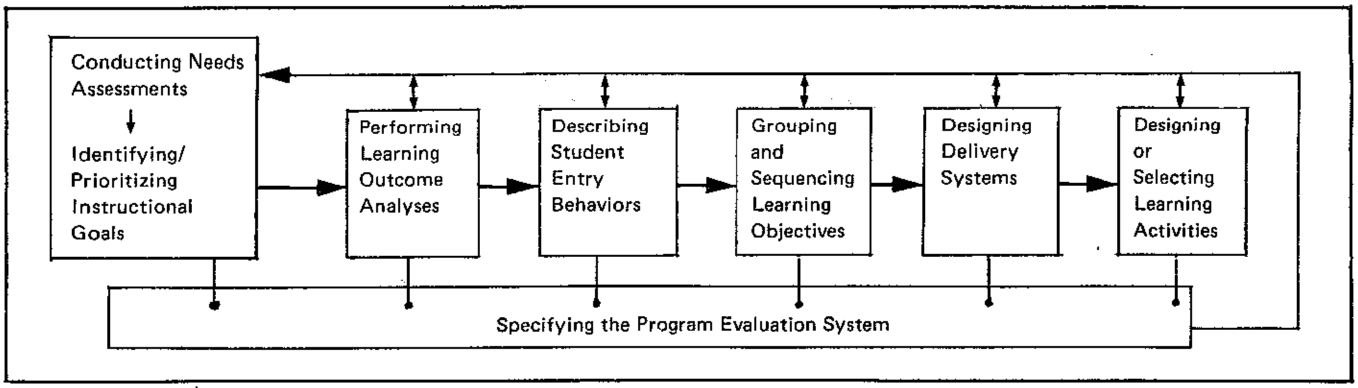

FIGURE 1. A model for the systematic design of instruction.

Very little systematic work has been done in terms of describing the relationships between the assumptions that one makes about the learning process itself and the decisions made necessary by the individual components of instructional systems (Figure 1 gives one example of a systems model). The position taken in this discussion is that the decisions that are made *explicit* in each of the commonly accepted components of instructional systems depend to varying degrees on the *implicit* assumptions the designer makes about what, how, and why people learn. To the extent that instructional systems are designed without regard to a cohesive learning theory (or theories), the decisions within components risk being inconsistent (and arbitrary), resulting in varying degrees of incompatibility among the components. The major purpose of this paper, then, is to explore the possibilities (and problems) of integrating what is known about the psychology of learning with what is known about designing instructional systems, as well as to offer some suggestions for avoiding potential mismatches between the science psychology and the technology of instructional design.

Learning: The Cognitive View

To simplify matters, we have selected one theoretical orientation to serve as an exemplar for unifying instructional decisions. For the complex types of learning that are of primary interest to current educators, the emerging cognitive or information processing orientation is most promising. It has influenced, with its recent maturity, practically all theoretical work in social science, including the traditionally conservative approaches to American education. To date, however, cognitive theories of learning have made only tentative contributions to instructional practice, in part because there is no linking schema for putting its constructs into operation. When instructional design models (e.g., Figure 1) are viewed within the context of such a learning orientation, however, we begin to approximate the required linkage.

Although we focus here on cognitive theory, others are equally available to instructional designers. Besides the several theoretical options that belong under the cognitive/information processing umbrella, the potential contributions of behavioral and humanistic psychology will also be briefly considered in our analyses. It is assumed, however, that *any* theory that has been applied to classroom learning from psychoanalytic theory to transpersonal (Roberts, 1975) to humanistic (Maslow, 1968) to behavioral (Skinner, 1968) could be adopted by the designer of instruction. Yet, because of the limitations each has in terms of explaining a wide range of complex behavior, we believe these additional theoretical approaches ultimately will serve primarily to augment, refine, and extend the application of cognitive theory.

Learning in the cognitive orientation is viewed as an active, generative process where meaning and understanding must be constructed from experiences (Neisser, 1967; Smith, 1975; Wittrock, 1978). The products of such learning are viewed not simply as single behaviors or classes of behaviors, but are described as organized memory "units" for which there are certain known characteristics. Some of these characteristics, for example, are described by Gagné and White (1978) in their recent review of the relationship between memory structures (e.g., networks of propositions, intellectual skills, images, and episodes) and learning outcomes (e.g., rule application and knowledge stating).

To facilitate our discussion of the relationship between learning theory and technology, several major points of cognitive theory are summarized in Figure 2. For substantial planning of instruction to occur, there are certain critical input, process, and output variables that must be considered under the cognitive orientation. There is consensus across many works (DiVesta, 1974; Frijda, 1978; Thorndyke, 1978; Voss, 1978; Wittrock, 1978) that two input variables are critical: one is the existing cognitive structures that students bring to the learning situation; the other is the content structure that may be either contrived or inherent, but in either case, described explicitly for given disciplines. Although methodologies for detecting students' cognitive structures are only just beginning to emerge (Shavelson, 1972, 1975), it is recognized that meaning and comprehension (i.e., learning) is a function of the interaction between the organization of what is to be presented and the characteristics of individual students' own memory units (Ausubel, 1978; DiVesta, 1974; Johnson, 1975; Voss, 1978). Further, the fact that learning requires that students' cognitive structures become, over time, more like the structure inherent in the various content disciplines will have important implications for such instructional tasks as determining initial need and detecting the direction and sequencing of instruction, as well as for conducting final outcome evaluations.

Process variables are those constructs that are used to describe and explain the attainment of competence. Recent theoretical accounts of cognitive learning (Glaser, 1976; Neisser, 1976; Voss, 1978; Wittrock, 1978) have cautioned us that development of competence is a

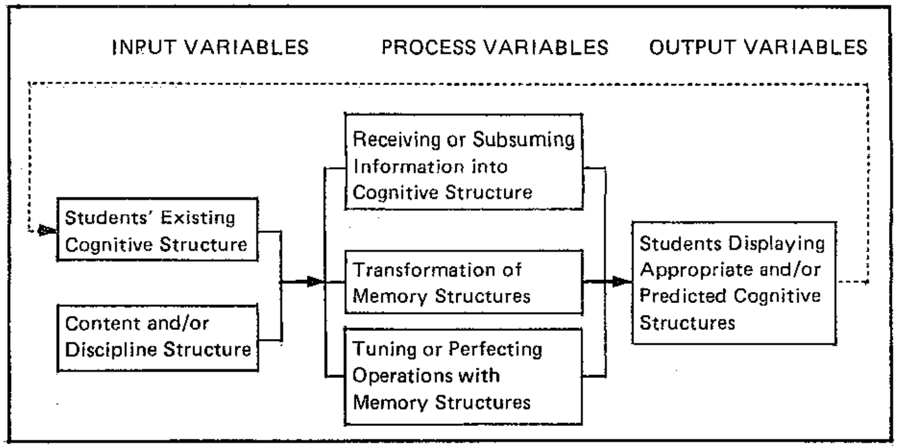

FIGURE 2. Suggested input, process, and output variables of cognitive instructional theory.

complex process that involves more than simply breaking expert behavior into discrete tasks or steps that students subsequently reassemble in prescribed and clear-cut ways. Rather, it seems that successive inputs from instructional environments are initially transformed by students according to existing memory structures (or plans, sets, schemas, etc.) and that these structures in turn may be transformed later via generative processes that teachers can facilitate but never completely control. Norman (1978) gives an appealing account of three process variables that Rumelhart and he (Rumelhart & Norman, 1979) have used to describe the attainment of competence. We have used these variables to complete the process portion of the model shown in Figure 2. First, a great deal of learning requires students to simply add or subsume (Ausubel, 1978) new information into existing memory units. This process is relatively easy to understand and control given certain minimum information about students' entry characteristics. Ausubel, in fact, has described methods for putting appropriate structures or "organizers" in place as part of standard instructional practice.

At some point in the development of competence, however, existing memory units are restructured or replaced with more efficient and powerful units. It is these important restructuring operations that constitute insight into a body of content and that (depending on the power of the structure [Bruner, 1966]) allow knowledge to be used in a generative rather than prescriptive fashion. It is not well understood how such restructuring activities occur or what one can do to influence the process. Rumelhart and Norman (1979) have suggested that most new schemata are patterned on analogies from existing ones with perhaps some modifications included. They also consider inductive processes, however, and it is the detection or invention of new categories or structures from systematic observations of recurring data patterns that is the foundation of several inductive approaches to learning from instruction (Weil & Joyce, 1978).

Finally, performance improves systematically in the absence of either additional information or of new ways of organizing knowledge. Rumelhart and Norman have described this third process or type of learning as "tuning," which suggests that intact cognitive performances, with practice, become smooth and automatic in a manner similar to improvement of intact motor capabilities. Repeated use of cognitive capabilities is a logical requirement for "tuning" to occur, and the effectiveness of such training may be measured by tests involving accuracy, speed, breadth of generalization, smoothness, and the like.

Although each of the above processes may be occurring simultaneously during a given learning episode, Norman (1978) hypothesizes that attainment of knowledge within content areas involves rather distinct phases where, over time, humans alternate between the first two processes (adding new information and restructuring) with "tuning" activities becoming more important as the information structures begin to stabilize.

The educational importance of these notions is that appropriate instructional interventions must be available at the appropriate time to ensure optimum learning. Determining appropriate strategy at any point, however, will involve several options since there are a variety of instructional "models" that have appeared out of the general cognitive movement (see, for example, Ausubel, 1978; Bruner, 1966; Suchman, 1966; Taba, 1967). Because these approaches or "models" can vary from inductive to deductive in nature, one's particular choice(s) may have considerable impact on the design process.

The third category shown in Figure 2 involves those *outcome variables* that are expected, given a cognitive orientation to learning. As shown here, learning evaluations should yield evidence that students have personally "replicated" those knowledge structures that were established as input variables. Considerable research needs to be conducted to create testing technologies that detect learner outcome structures. Generally, we expect the best results might be obtained through evaluation devices that simultaneously assess the efficiency and generative power of one's memory structures.

Integrating Learning Theory with Design Technology

Needs Assessment

Needs assessment is a logical first step when planning any service program—educational or otherwise. Generally, the major goal of performing needs assessments on a routine basis is to ensure that more instructional time is available especially for those few "needs" that have been empirically validated and have survived a rigorous process whereby priorities among needs are identified. In the educational technology literature, at least, the methodologies for conducting needs assessments are well known (Burton & Merrill, 1977; Kaufman, 1972). Typically, the procedure involves measuring empirically (for some target group) the discrepancy between existing conditions (e.g., skills, attitudes, achievement patterns) and some predetermined required conditions. These differences or discrepancies are subsequently restated in verbal form (i.e., as goals) and placed in some order of priority.

Our concern is that existing needs assessment methodologies are essentially independent of theory, with established procedures having only logical rather than psychological foundations. Since education is a tool of the general social order, we should reinforce those technologies that ensure wide participation in determining "what ought to be." At one level then, need refers to social expectancies, and these may develop independently of particular theoretical orientations. Yet, even in this social context, participants in the needs assessment process respond to questions and instruments that could reflect certain "biases" of given conceptual notions about learning. We would expect a behaviorist, a humanist, or an information processing enthusiast to elicit different kinds of needs assessment data through the form and substance of their respective assessment tools. Given this possibility of theoretical "bias" we would prefer assessment methodologies that make those orientations explicit in much the same way that they should be made explicit within other design components. For example, needs assessments derived from cognitive theory should be designed to gather data from each of the major categories of variables shown in Figure 2. The major discrepancy data would involve differences between student information structures and the various content or discipline structures described by experts. Process information would also be highly valued under cognitive orientations and these data are also not generally available through current needs assessment methodology.

The humanistic movement in psychology and education has often harshly criticized both behavioral and cognitive approaches because they have allegedly ignored certain of the "higher level" characteristics of human nature, namely the ability to recognize and control one's own feelings, beliefs, and general growth toward self-fulfillment. Regardless of the accuracy of such criticisms, we tend to agree with Snelbecker (1974) that the humanistic approaches can at least have a corrective or "fine tuning" influence on instructional development. This influence might well begin by systematically including in needs assessment methodology (regardless of the major theoretical orientation) some collection of data concerning those growth needs that are consistent with humanistic psychology.

The basic generalization we want to propose here is that a needs assessment will be significantly affected by the theoretical orientation within which it is conducted. We see no way, for example, to perform a post hoc transformation of discrepancy data generated within a behavioral framework to make it serve design models based on cognitive learning theory. Theory and practice must initially merge at the needs assessment phase.

A major source of frustration for teachers (and students as well) is that learning activities and classroom tasks performed daily often do not "add up" to, or result in, the predicted final behavior or competency. Although many of these failures involve the technical quality of the activities themselves, of more concern here is the possibility that certain sequences of learning activities are not even potentially successful because designers and/or teachers do not understand the terminal outcome (or task) in terms of the logical relationship between/among component behaviors involved. For too long it has been incorrectly assumed that teachers' personal expertise in particular content areas is sufficient to allow one to make useful curriculum and teaching decisions regarding that content. Educators apparently fail to recognize that competent performance is *qualitatively* different from the behavior of novices and that the route between the two is complex. Our earlier discussion of Norman's hypotheses makes it clear, for example, that the learning act itself may vary over time depending on whether information is simply being added to existing structures, whether structures themselves are being transformed, or whether operations *with* structures are being refined. Thus, even though educators may have specified (Resnick, 1976) certain smaller steps that are the result of being competent, often there is little or no sensitivity to the operations required *during* novice, intermediate, or final learning phases. Lack of sensitivity often results in students being placed in learning activities that are not only technically inadequate, but are unrelated to the "mode" of learning (or dominant process) that is in operation. One major purpose of task analysis, then, is to suggest both the "route" *and the processes* students must use to progress from naiveté to competence.

More specifically, understanding the development of competency within disciplines (e.g., math, science, English) requires some specification of the structure of that discipline. Certainly, much of what is taught within any content area is amenable to some structural analysis that can be displayed in the form of hierarchies, taxonomies, or other framework. Yet, in spite of the fact that learning is increasingly described as the process of building or obtaining organized memory structures, we have not seen large-scale attempts to make these target structures known through either instructional materials or classroom practices. This is one reason why such importance is attached to the task analysis process: It is the component initially responsible for making explicit the major variables shown in Figure 2.

Once task structures have been outlined via the initial stage of task analysis, designers should proceed to describe, within levels of the structure, the precise operations that students must perform. These operations will depend on the mode of learning that might reasonably be in operation as well as the instructional model (e.g., deductive or inductive) that has been designed or selected to facilitate particular learning processes. Certainly, one serious problem with recently described task analysis procedures (Gagné, 1962, 1977) is that once a hierarchy has been created, designers and/or teachers still face, with insufficient information, the task of teaching facts, concepts, and rules that have been arrayed in some fashion via the analysis. Required student operations or processes at all levels need to be "discovered" and made explicit within the task analysis steps since most existing school materials are notoriously efficient in concealing this critical information within complex and obscure prose statements too difficult to decipher. We are encouraged by the possibility of using Landa's (1976) work to improve this aspect of task analysis methodology. His apparent success with the use of algorithms in learning and instruction gives a viable methodology for accomplishing at least three important things: detecting the critical attributes of concepts or rules, devising a correct and unambiguous statement of those attributes, and generating a procedure to follow that results in successful processing of learning tasks using those rules and concepts.

Task analysis essentially "gives birth" to cognitively based instructional methodology. During this process the goal statements that are typically derived through needs assessment procedures must be "transformed" into statements consistent with theory relevant variables such as those shown in Figure 2. We should mention here that only cognitive theory creates such a workload for task analysis. Behavioral approaches are essentially satisfied with establishing learning hierarchies that Gagné (1962, 1968) has pioneered during recent years, and humanistic psychology is insufficiently mature to suggest clear functions for task analysis.

Entry Behaviors

As cognitive theory has evolved during recent years, our view of the learner as a passive recipient of information has changed to one where the learner is seen as an active processor of information. This change also recognizes the major responsibilities that students have for their own learning and, consequently, has forced us to consider more carefully the entry capabilities needed to engage a particular "chunk" of instruction. Several aspects or dimensions of entry characteristics now seem important. To begin, we know that where active processing is required, we need to look for a certain motivational state, a kind of tension, which in its elementary form simply may be a readiness to attend to the relevant attributes of some instructional problem. For most younger children this motivation, or tension, seems to be "built in" almost as if it were a natural drive. However, for older students at all levels, particularly those who have not done well in schooling, this motivation may be lacking, perhaps destroyed by long-term failure of schools to respond to and be sensitive to the natural curiosity found in young children. It also seems advisable, from a cognitive view, to eventually conduct analyses that measure the finer motivational determinants of student performance. These include dimensions such as locus of control, reflectivity, and anxiety as well as a host of variables identified as cognitive styles.

Additionally, routine learning episodes involve the ability or inclination to take risks, to work under conditions involving conceptual confusion, to propose and/or generate meaningful relationships and structures, and to evaluate one's own behavior. Students exhibit a great deal of variability across these dimensions and, to date, much of this variability is essentially meaningless. The recent book by Cronbach and Snow (1977), however, as well as other related aptitude, treatment, interaction (ATI) research, has demonstrated how to use variation within these and other dimensions to instructional advantage.

Developmental differences also are critical in terms of assessing students' entry characteristics, and these are specified both in cognitive and humanistic psychology. Clearly, as children move through preschool, elementary, and secondary levels we find tremendous quantitative and qualitative changes in terms of the cognitive technology that students bring to instructional situations. These changes are documented in the works of Piaget and Bruner and, in some cases, have been woven into instructional theory (Bruner, 1966; Case, 1978). Adult learners present a somewhat different situation. For them, we are not as concerned with the possibility of broad developmental changes. However, it will be important to determine, even for adult learners, exactly what processing capabilities are available. For example, certain students may have only poorly developed or practiced symbolic capability and/or may be unable to use certain complex logical operations. Instruction that requires these symbolic or logical competencies thus may be largely unsuccessful. Unfortunately, there is relatively little attention to adult developmental stages in the research literature (Fozard & Popkin, 1978; Kidd, 1973; Knowles, 1970; McClusky, 1971).

Gagné's work in developing the notion of learning hierarchies has had perhaps the greatest success in fully operationalizing the concept of examining entry capability prior to instruction. His idea is that the best way to determine suitability for instruction is to determine which of the required prerequisite skills have been mastered by each student. Although this work has been conducted essentially within the behaviorist tradition, the basic idea is easily transportable. Within the cognitive orientation Gagné's work is extended to include specification of memory units or structures as well as skills hierarchies. Essentially, then, the work done in the prior task analysis phase provides the capability to conduct the appropriate entry assessment. The key question, of course, is whether students have cognitive *structures* (as opposed to cognitive styles) sufficiently similar to that of the instructor and/or the materials to ensure good communication.

Grouping and Sequencing Learning Objectives

Since instructional programs are operationalized as series of events that occur over time, one practical design problem is to arrange some reasonable grouping and sequence of learning objectives. Historically, learning theory has contributed only minimally to this instructional task. In fact, it was only when Gagné (1962) applied the notion of learning hierarchies that any real conceptual advance was made regarding sequencing. This section describes briefly the additional requirements necessary if cognitive learning theory is applied to this aspect of the design process.

The prior analysis of discipline or content structure that was completed in the task analysis phase offers some initial help. However, a simple bottom-to-top sequencing, such as suggested in Gagné's learning hierarchy approach, is not sufficiently complete to serve all variations of cognitive methodology. For one thing, different teaching models within the cognitive framework will require somewhat divergent sequences of instructional activity (compare, for example, Ausubel, 1968; and Bruner, 1966). While Ausubel and Bruner both appreciate that meaningful learning involves attainment of organized memory structures, they each propose different sequences of events for attaining those goals. Ausubel's methodology essentially requires students to subsume or "chunk" information into structures that are initially presented (via advance organizers) as part of the instructional episode. Ausubel does not, however, describe these processes as purely deductive since the initial structures or propositions tend to acquire new meanings through a transformational process he calls progressive differentiation. Yet, these essentially top-down sequences are substantially different from the primarily inductive approaches (Weil & Joyce, 1978) that involve students in collecting data, generating hypotheses, testing hypotheses, collecting additional data, etc. The primary point to be made here is that sequencing is intimately related to both general theoretical orientations and to variations within broad theoretical frameworks. We should also mention that decisions made here may require reexamination of entry behavior requirements. In fact, instructional design methodology probably will involve constant checks for compatibility among all components, hence the bidirectional linkages among components shown in Figure 1.

Long-term sequencing (i.e., a year or

more) will involve a somewhat more complex set of variables. On the one hand we need to consider developmental theory that suggests, for example, that humans progress through "stage-like" phases where information processing ability evolves from a very concrete and egocentric state to the point where the environment can be manipulated hypothetically using a variety of abstract symbol systems. In this regard, Bruner's spiral curriculum notions are relevant and can be used to sequence learning activities. We are also interested in the potential application of Rumelhart and Norman's (1979) "modes" of learning to the question of determining sequence. Again, there is at least some implicit understanding that humans tend to cycle through episodes involving (a) simple accumulation of information within structures, (b) restructuring or "progressive differentiation" of structures, and (c) the fine tuning of intact and mature structures. It seems relevant, at least in the context of our model shown in Figure 2, to plan actively for this cycling or sequencing of learning behavior.

Delivery Systems

This component deals with the broad environmental framework within which instructional activities are presented. Within this single component, we are interested in at least two major decision categories: selecting and/or developing instructional materials and designing and/or selecting a teaching or delivery model. Again, it is important to remember that these categories are interrelated and that the entire component must be considered in terms of its relationship with other components.

With regard to materials selection, it should be apparent by this time that the time-honored strategy of letting textbooks and other materials dominate instructional decision making is completely inappropriate. Materials should be selected on the basis of decisions made within and among the various components of an instructional system. The task analysis procedure, for example, not the textbook, will determine the way content and process are organized. Likewise, texts and other commercial material cannot be allowed to dominate decisions concerning required student entry skills, sequencing of activities, evaluation procedures, and the like. These decisions are all a function of the complex design process.

We are particularly concerned that teachers become better consumers of both instructional materials and intact instructional programs. Improvement of commercial materials will happen only through widespread insistence by teachers who understand the powerful theoretical notions of cognitive and behavioral psychology that materials must conform with the relevant principles and constructs. The recent works of Hayes-Roth (1978) and Thorndyke (1978), for example, demonstrate the connection between text structure and the processing of studied material into memory. In many cases not only is inherent structure not made explicit within text, but the tendency of experts (i.e., authors) to produce good (artistic) writing may not be consistent with learner needs. We simply cannot afford to spend valuable resources on materials that need extensive reorganization and rewriting to be useful within a selected theoretical context.

Decisions concerning the actual delivery of instruction are clearly more involved than simply choosing a technique (e.g., lecture, lecture-discussion, discovery) that may have some particular appeal. Within the cognitive orientation there are a number of options, or models, that have been described in sufficient detail for practitioners to understand and implement (see, for example, Eggen, Kauchak, & Harder, 1979; Weil & Joyce, 1978). Both Weil and Joyce and Eggen et al. have provided an excellent service for teachers in making explicit and concrete the operation of both inductive (Bruner, 1966; Suchman, 1966; Taba, 1967) and deductive (Ausubel, 1968) systems of instructional delivery. Generally, these models are consistent with mainstream cognitive theory and have given sufficient attention to the tasks of explicating both student and teacher roles and of dealing with individual student characteristics. What they have not attended to, however, is the problem of integrating the models within a total instructional system such as we are describing in this paper. At this time the major point we want to make about delivery systems is that they should be consistent with the major theoretical framework employed (which the models we have referenced tend to be), and that they are compatible with the outcomes of other major components, viz., task analysis, student entry behaviors, individual learning activities, and evaluation procedures.

Learning Activities

It may seem awkward to place the specification of learning activities at the end of the design process. This placement makes a good deal of sense, however, when we consider the several advantages. Generally, the sequence shown in Figure 1 reduces considerably the risk of putting together a series of learning activities that fail to add up to desired outcomes. The results of task analyses and subsequent assessments of student entry behaviors, for example, allow designers and teachers to place students within appropriate learning activities and to move students through more efficient sequences of activities. Moreover, learning activities designed at this point in the design process are more likely to be consistent with already established evaluation procedures. Finally, our prior attention to selection/generation of appropriate materials and delivery mechanisms increases the probability that all learning activities will fit together and will receive needed support from the entire system.

Within the present framework a designer is given considerable direction in terms of constructing and selecting activities that are consistent with the dominant theoretical position. Yet, the complexity of the cognitive approach suggests that a great variety of different activities might be planned to run concurrently across students. We will expect, for example, to find individual students who require, within a small time frame, a variety of activities that correspond to one or more modes of learning (i.e., subsuming, transforming, tuning) that occur simultaneously across different content areas. A task of considerable importance is simply to manage and keep track of the varied activities across students. Success here is largely a function of the data made available through the program evaluation system. One possibility is to develop and maintain a cumulative record for each student that, instead of simply tracking discrete behaviors, will track growth and modification of memory structures. Such a record would be used both as a formative record of progress and as a management technique to cue designers/teachers to needed modifications within or transitions among learning activities.

In addition to the mainstream activities actually designed into instructional programs, we also expect to see de-

TABLE 1. Examples of key questions or issues that arise when instructional design occurs under theoretically different conceptualizations of human learning.

	Conducting Needs Assessments	Performing Task Analyses	Assessing Student Entry Behaviors	Grouping and Sequencing of Learning Objectives	Designing Delivery Systems	Designing Learning Activities
Behavioral Theory	Are descrepancy analyses presented in behavioral terms? Are routine needs assessment techniques generally followed? Are needs assessments routinely updated?	Can terminal outcomes be subdivided into appropriate enabling or prerequisite behaviors? Has the task analysis product been verified empirically?	Can existing levels of behavior be pinpointed and charted? Is reinforcement history known?	Does sequencing follow established rules of shaping and chaining? Do sequencing patterns follow from task analysis?	General questions in delivery include the following: Are learners informed of objectives? Do materials actually elicit desired behavior? Are provisions made for reinforcement? Is progress based on mastery?	Do activities meet standard behavioral requirements (i.e., small steps, active responding, frequent feedback)?
Cognitive Theory	Does assessment procedure express desired and existing conditions in terms of cognitive structure characteristics? Does assessment procedure seek information processing needs? Does assessment procedure stress "learning how to learn" skills? Are needs assessments routinely updated?	Does analysis yield a task or information structure? Are information processing requirements noted throughout? Does the task analysis process make explicit the difference between novice and expert behavior? Is the task analysis suitable for the targeted variation of cognitive instruction (e.g., inductive vs. deductive)?	Can structural aspects of memory be identified? Have processing skills required for relevant variations of cognitively based instruction been assessed? What prerequisite intellectual skills and information are present? Have developmental concerns (such as the mode in which material is represented) been considered?	Is sequencing consistent with targeted theoretical variation (i.e., inductive vs. deductive)? Are grouping and sequencing decisions sensitive to hypothesized periodic variations in learning behavior (such as shown in figure 2)?	Has conscious choice been made from among the several cognitively based instructional options currently available? Has above choice been made in context of decisions made within previous components Are materials adequate for model chosen?	Are specific activities consistent with theoretical option chosen? Are specific activities consistent with all decisions made within previously considered components?

signers systematically using supportive teaching/learning activities. Good behavioral techniques, for example, will obviously continue to play a significant role within any instructional framework. During the tuning phase described earlier, it seems likely that the process of stimulus control could be used to refine, focus, and make automatic already acquired performance patterns. In fact, a great deal of the social behavior associated with all learning activities in classrooms might well occur in the context of either reinforcement theory or humanistic theory, or both.

Summary

To summarize briefly, we have generated one additional display (Table 1), which gives at a glance some examples of questions and issues that arise when theory interacts with instructional design procedures. The questions associated with cognitive theory have emerged only recently and have been discussed in some detail above. Questions associated with behavioral theory have not been treated extensively here but are generally well known to designers. As can be seen from Table 1 and from the above discussion, cognitive theory places demands of greater breadth and complexity on the designer than does the more familiar behavioral orientation. Yet, however broad and complex, these and other issues not included in Table 1 (such as the particular questions that arise within variations of cognitive theory) must be taken up by designers. Designers, no doubt, will satisfactorily answer some of these questions as well as discover others of interest to theorists. Progress in education is thus seen as a cooperative venture between theory and design technology.

Theory and Design: Additional Caveats for the Designer

The task of matching all the available theoretical approaches to learning with the many permutations of instructional design sequences is beyond our time, knowledge, and inclination. We have described the integration of cognitive theory with a general design model. The larger task could probably be accomplished in a general manner, but to the extent that each teacher, designer, etc. chooses a single theory and adapts it to his or her own phenomenological needs and beliefs, such an "accomplishment" may be overprescriptive. It is appropriate, therefore, to mention some general principles or strategies we believe should guide the process of integrating design and theory.

First, the process of planning the instructional enterprise can begin only after the planner meets the dual requirements of understanding both the systematic nature of the design process as well as particular theoretical orientations that explain how learners do learn, might learn, can be motivated to learn, etc. Without these prerequisite understandings, it is difficult to "plan" or "design" effective instruction to meet the individual needs of the client. Obviously, in team enterprises this requirement will have to be articulated in a rather formal manner such that all those involved have an understanding from the outset what the basis of their efforts will be. A classroom teacher, on the other hand, would probably not need to do more than outline the requirements. In either event, these understandings will probably have to be committed to paper.

Second, the instructional design situation should be approached as one of hypothesis testing. Although space has not allowed discussion of any specific formative or summative evaluation strategies, the entire design enterprise should be viewed as amenable to change based on feedback. This would include not only specific design steps or theoretical concepts, constructs, etc., but also the entire design model or learning theory. Treating the process as an hypothesis-testing exercise further delineates the need for stable design technology and learning theory. To the extent that this need is not met, the ability to test becomes meaningless as random decisions and variables intrude on the process.

Third, we agree with Snelbecker (1974) that a single learning theory should be selected as the starting point for entering the planning process. After it is used in some consistent fashion and testing reveals it to be inadequate for certain needs, *then* it is appropriate to modify and refine by adding, subtracting, or supplementing with additional theories. Related to this line of reasoning, it is suggested that the simplest model of a given theory be utilized initially. This simplifies decision making and testing and allows for elaborations to be made easily as experience progresses. Within this paper the cognitive model outlined (see Figure 2) may be considered to be the theoretical "bare bones," yet it easily permitted the generation of some rather complex design questions.

Fourth, allow the design model to ask the questions and allow the learning theory to answer. When the theory selected cannot answer questions, modification is necessary; if the theory cannot answer a majority of the questions, it is inadequate and should be replaced. This may be a particularly troublesome aspect of integrating design and theory—losing a "pet" learning approach (similar to what Abramowitz, 1978, has labeled "heart-potheses" as opposed to hypotheses). If a theory cannot answer the questions required in instructional planning, however, it is not useful, no matter how intuitively appealing.

Finally, it should always be remembered that the system must be internally consistent. Use of a theory will not always guarantee that a decision in step 4 of the design model will be consistent with a decision made in step 2. Thus, a certain amount of checking back and forth is essential to ensure that the parts "add up" in a holistic manner. Naturally, the more internally consistent one's learning theory or framework is, the less of a problem this becomes.

Conclusions/Recommendations

We have approached this work essentially because of our frustration with the absence of a paradigm or framework for linking learning theory with instructional practice. In daily work with teachers, teacher trainees, and doctoral students, we have seen the difficulties of trying to comprehend instructional practice without theory, and theory without clear conceptual understanding of practice. The literature in education and psychology is sometimes sensitive to these conditions, but little is done to remove them. We have taken a preliminary step in what we hope is a fruitful direction.

The field of educational psychology, particularly, needs to engage in work of this nature. It seems to us that too much time and effort have been spent on systems approaches to the design of instruction without knowing whether these approaches can have widespread utility in the public education sector, or whether they have utility as a device for transforming theoretical statements into practical applications. Tentatively, we believe the answer is yes in both instances, but this has not been demonstrated.

Instructional technologists need to be more honest and open in the promotion and dissemination of instructional design (ID) products and processes. Reiser (1978) has appropriately cued us to a major problem of instructional design: The users of ID products often do not understand the product, how it was developed, or how it should be used. We suspect this problem lies more with designers (who should know better) than with clients who (a) have little or no formal training in instructional design and (b) have not been given adequate directions from designers. We also believe that designers and practitioners should reach some common understanding of the major theoretical notions about learning (if any) that underly design products. These principles should be made explicit in much the same manner that consumers of other products (e.g., food and clothing) are now given details concerning ingredients and appropriate care and use instructions. It may be that those who design and market ID products have avoided such explicit details to avoid "scaring off" potential customers who react negatively to certain theoretical positions. By not stating theoretical frameworks, a more "mass appeal" of the product is guaranteed.

Finally, there needs to be more emphasis on external evaluation of what has already been developed in educational technology and in learning theory. The tendency to produce increasingly refined paradigms has taken on, in both areas, the aura of an exercise in logic rather than research. It is hoped that future efforts will be directed, not just toward research but towards cooperative research between technologists and theorists.

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