1 Instructional Design: What Is It And Why Is It?

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CONTENTS

FOREWORD

This chapter discusses why the discipline of instructional design is important, how the discipline relates to the field of education in general, and what the discipline is about. It is argued that instructional design can do much to improve the quality of instruction in public schools, industry, government, and many other contexts. It is shown that instructional design deals with but one aspect of education, and its relationship to some other aspects is discussed.

But most importantly, this chapter is intended to make it *easier* for you to understand and evaluate the instructional theories and models that are presented in Unit II of this book. It discusses such things as concepts, principles, strategies, models, and theories of instruction; it discusses classification schemes; it presents a theoretical framework to facilitate the understanding of theories and models; and it presents a set of criteria for evaluating instructional-design theories. Because all of these topics are intended to facilitate the understanding of subsequent chapters, they are followed by some specific guidelines to follow as you read each of those chapters. Finally, this chapter briefly mentions some of the important contributors to the discipline who are not represented in this book.

C. M. R.

Instructional design is a discipline that is concerned with understanding and improving one aspect of education: the process of instruction. The purpose of any design activity is to devise optimal means to achieve desired ends. Therefore, the discipline of instructional design is concerned primarily with prescribing optimal methods of instruction to bring about desired changes in student knowledge and skills.

PURPOSE OF THIS CHAPTER

The purpose of this introductory chapter is to make it easier for you to read, understand, and evaluate models and theories of instructional design.

The first two sections describe why instructional design is important and how it relates to other aspects of education. The next section helps you to understand and evaluate the following chapters by: (1) clarifying what are the major components of the discipline of instructional design (e.g., what is a theory versus what is a model); (2) presenting a theoretical framework that serves as a "schema" or template for interpreting and understanding the following chapters; (3) identifying

other disciplines that are sometimes confused with instructional design (e.g., learning theory and instructional development); and (4) presenting a set of criteria for evaluating instructional-design theories.

The next section presents procedural guidelines for analyzing the chapters in Unit II of this book. The purpose of the following section is to pay tribute to the three great pioneers who founded instructional design as a discipline. Then a brief reference is made to some other important contributors to the discipline. And finally, several advanced topics are discussed.

WHY INSTRUCTIONAL DESIGN?

What is the point in spending a considerable amount of effort and resources to develop knowledge about methods of instruction? Simply put, it is an effective way to alleviate many pressing problems in education. In his presidential address to the American Psychological Association in 1899, John Dewey (1900) called for the development of a "linking science" between learning theory and educational practice. Ralph Tyler has also stated the need for such a body of knowledge. He has described it as playing a sort of *middleman* role (see, for example, Tyler, 1978). Instructional design is this linking science—a body of knowledge that prescribes instructional actions to optimize desired instructional outcomes, such as achievement and affect.

INADEQUACIES OF INSTRUCTION IN PUBLIC SCHOOLS

But do we need such a linking science? Why do we need to know more about instruction? There is a growing concern that public education is not what it should be and could be. The accountability movement is an indication of increasing concern that instruction is inadequate in many public schools. Many students develop a poor conception of their own learning ability (and hence an often devastating self-image) because of frequent failure to learn what was "taught" (see, for example, Bloom, 1972; deCharms, 1968, 1976; Lynch, 1978). Statistics show that the number and proportion of high-school dropouts has been steadily rising since 1967 (Grant & Lind, 1978). Students seem to be more turned off to learning than ever—precisely when learning is becoming increasingly important to cope in a rapidly changing technological society (see, for example, Toffler, 1970). And the increasing cost of public education is raising concern for more cost-effective methods of educating our children. All of these factors and more are evidence of our need for better methods of instruction in public education.

But there is another, more important reason for learning about instruction. Children have important educational needs besides intellectual ones. Because our methods of instruction are generally ineffective, educators have not been able to devote much time and effort to the whole child. If we can develop highly effective instructional resources (whether in books or in computers), then we can free some (more) of the teacher's time to work on the social, psychological, emotional, and moral development of our children. The field of instruction can also show us how to improve the development of our children in those areas.

It is likely that our schools of the future will entail a vastly different role for teachers: Rather than having primary responsibility for a subject, the future teacher will have primary responsibility for a number of children. The teacher will become an advisor, a motivator, and someone whose major interest is the child—the whole child. The teacher will be liberated from the more routine, boring aspects of his or her profession by well-designed instructional resources (including the effective use of lay tutors), by better testing methods, and by better record-keeping systems. But such improvements in education cannot occur before we improve our knowledge about how to design more effective, efficient, and appealing methods of instruction (nor before we improve our knowledge in such areas as computer-assisted testing and computer-managed instruction).

Instructional Needs in Other Contexts

The need for better methods of instruction does not begin and end with public education. Adult (or continuing) education and distance learning (e.g., correspondence schools) need better methods of instruction to prevent attrition. Businesses and the military need better methods to reduce the amount of money and employee time needed for job training. The medical profession needs better methods of instruction for effective patient education and for professional training. Special education needs better methods of instruction to help teachers cope with mentally and physically handicapped children. The list goes on and on.

All indications are that, as our technological society increases its rate of change, education will become increasingly important, and there will be an increasing need to make our methods of instruction more effective, efficient, and appealing in a wide variety of contexts besides public education. We believe that our present point in the history of education is similar to the point at which agriculture was at the time that McCormack was developing the first automatic reaper. A knowledge base on instructional design is necessary to effect the change.

HOW DOES INSTRUCTIONAL DESIGN RELATE TO EDUCATION?

To understand what instructional design is, it is helpful to look at how it relates to other areas of inquiry within education. On the most general level, the field of education can be viewed as being comprised of knowledge about curriculum, counseling, administration, and evaluation, as well as instruction (Beauchamp, 1968). Although there is some overlap, the primary difference between curriculum and instruction as areas of inquiry is that curriculum is concerned primarily with *what* to teach, whereas instruction is concerned primarily with *how* to teach it (Snelbecker, 1974). In this book we are concerned exclusively with the area of instruction.

Instruction

But how does instructional *design* relate to other disciplines within the area of instruction? On the most general level, the area of instruction can be viewed as being comprised of five major activities: design, development, implementation, management, and evaluation (see Fig. 1.1). Each of these five areas within instruction is a *professional activity* done by people who are concerned with instruction. But there is also a *discipline* associated with each—an area of inquiry that is concerned with understanding and improving the means to perform each activity with optimal results. Following is a brief description of these five major disciplines of instruction. Then the major interrelationships among these five disciplines are briefly discussed.

Instructional Design

Instructional design is concerned with understanding, improving, and applying methods of instruction. As a *professional activity* done by teachers and instructional developers, it is the process of deciding what methods of instruction are best for bringing about desired changes in student knowledge and skills for a specific course content and a specific student population. The result of instructional design as a professional activity is an "architect's blueprint" for what the instruction should be like. This "blueprint" is a prescription as to what methods of instruction should be used when for that course content and those students.

On the other side of the coin, instructional design as a *discipline* is concerned with producing knowledge about optimal "blueprints"—knowledge about diverse methods of instruction, optimal combinations of methods (i.e., whole models), and situations in which each of those instructional models is optimal. Some excellent work has been and is being done in this area, and that work is the focus of this book. More is said about this shortly.

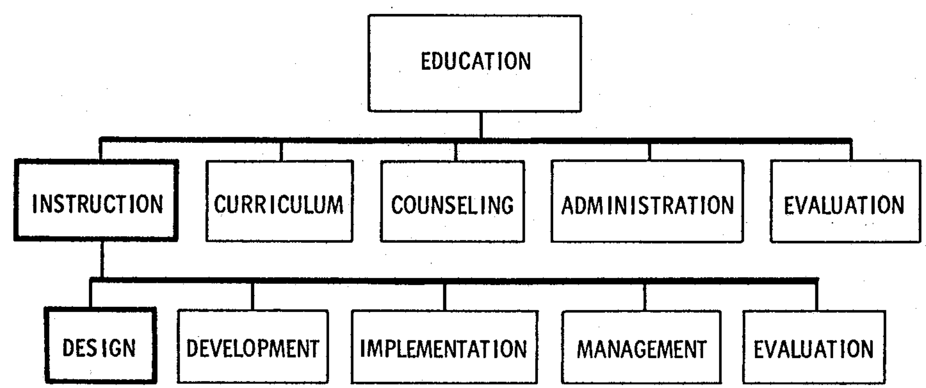


FIG. 1.1 Instructional design's relationship to other areas of inquiry within education.

Instructional Development

Instructional development is concerned with understanding, improving, and applying methods of creating instruction. As a *professional activity,* it is like constructing a building from the architect's blueprint—it is the process of prescribing and using optimal procedures for creating new instruction in a given situation. The result of instructional development as a professional activity is ready-to-use instructional resources, lecture notes, and/or lesson plans (like a ready-to-use building).

On the other side of the development coin, the *discipline* is concerned with producing knowledge about diverse development procedures, optimal combinations of procedures (i.e., whole models), and situations in which each of those development models is optimal. Such models are beyond the scope of this book. The reader is referred to Gustafson (1981) for an excellent review of such models.

Instructional Implementation

Instructional implementation is concerned with understanding, improving, and applying methods of putting some developed instruction into use. As a *professional activity,* it is like a renter's adapting his or her floor of the building to his or her needs and adapting his or her planned operations to the building's constraints. It is the process of prescribing and using optimal procedures for adapting a specific instructional program and/or the instructional institution in which that program is being implemented, so as to enable optimal outcomes from that program in that institution. The result of instructional implementation as a professional activity is an instructional program and/or an institution that has been modified in such a way as to result in the optimal effectiveness of that program.

The *discipline* of instructional implementation is concerned with producing knowledge about diverse implementation procedures, optimal combinations of procedures (i.e., whole models), and situations in which each of those implementation models is optimal. Such models are beyond the scope of this book.

Instructional Management

Instructional management is concerned with understanding, improving, and applying methods of managing the use of an implemented instructional program. It is much narrower than educational administration (mentioned previously) in that it deals only with managing a single instructional program within an institution. As a *professional activity,* it is like maintaining and operating the building—it is the process of prescribing and using optimal time-lines, data-gathering techniques (for data on student progress and on program weaknesses), grading procedures, program revisions and update procedures, and so on. The result of instructional management as a professional activity is the use and maintenance of an implemented instructional program.

The *discipline* of instructional management is concerned with producing knowledge about diverse management procedures, optimal combinations of procedures (i.e., whole models), and situations in which each of those management models is optimal. Such models are beyond the scope of this book.

Instructional Evaluation

Instructional evaluation is concerned with understanding, improving, and applying methods of assessing the effectiveness and efficiency of all of the aforementioned activities: how well an instructional program was designed, how well it was developed, how well it was implemented, and how well it is being managed. It is much narrower than educational evaluation, policy evaluation, and the evaluation of other noninstructional aspects of education. As a *professional activity,* it is like a consultant's giving advice about how the renter can better utilize the building to meet his or her needs. It is the process of prescribing and using optimal techniques for identifying weaknesses. The result of instructional evaluation as a professional activity is a description of weaknesses, consequences, and/or recommendations for improvements.

The *discipline* of instructional evaluation is concerned with producing knowledge about diverse evaluation techniques, optimal combinations of techniques (i.e., whole models), and situations in which each of those evaluation models is optimal. Such models are also beyond the scope of this book.

Summary

In summary, instructional design is concerned with optimizing the process of *instructing*. Instructional development is concerned with optimizing the process of developing the instruction. Instructional implementation is concerned with optimizing the process of implementing the instruction. Instructional management is concerned with optimizing the process of managing the instruction. And instructional evaluation is concerned with optimizing the process of evaluating the instruction.

Interrelationships Among These Disciplines

These five disciplines in instruction are interrelated and interdependent in many ways. For instance, we mentioned earlier that the activity of instructional *evaluation* may deal with evaluating the design, the development, the implementation, and/or the management of an instructional program. Evaluation also draws upon each of the other four disciplines for empirically verified principles and procedures as a sound basis both for identifying specific weaknesses (e.g., see Cronbach, 1963, on "intrinsic evaluation") and for prescribing effective ways to eliminate those weaknesses (e.g., see Merrill, Reigeluth, & Faust, 1979; Reigeluth & Sari, 1980). Also, the activity of instructional *development* is often viewed as encompassing design, implementation, and formative evaluation activities (although in such a view there is still something distinct that happens between design and implementation, and this activity is also what is sometimes referred to as development).

The interactions and interdependencies that are of most interest to us are those involving instructional *design* (see Fig. 1.2). Because design is usually viewed as a part of the development process (broadly defined), design theories and models are usually viewed as an essential component of *development* models. Design is also an important input for the *implementation* process because different kinds of

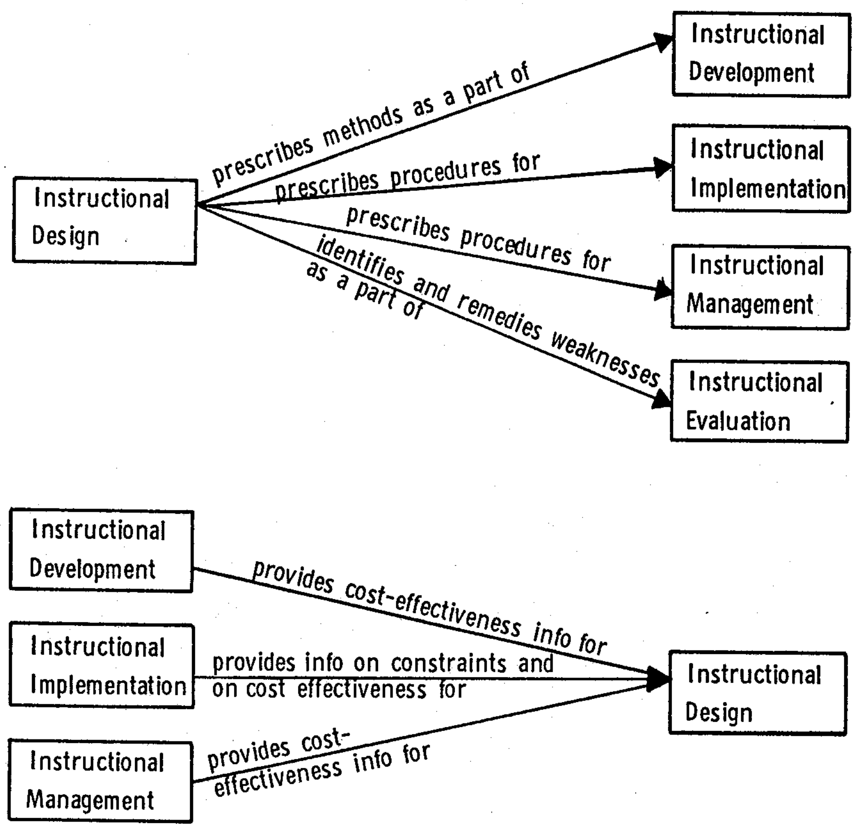


FIG. 1.2 Instructional design as an input for other disciplines in instruction (top), and the other disciplines as inputs for instructional design (bottom).

instructional designs may require different procedures for implementing the instructional program. Thirdly, design is an important input for the *management* process because the best way to manage an instructional program may be different for different kinds of instructional designs. And finally, design is an important input for the *evaluation* process for reasons mentioned previously: instructional design's empirically verified principles are a sound basis for both identifying and remedying weaknesses in an instructional system.

But design is not just an input for other processes; it is also dependent on other processes (see Fig. 1.2). *Implementation* should usually have the greatest impact on instructional design. Design must take into account implementation needs whenever possible because innovative programs of instruction are usually very poorly implemented in existing institutions (e.g., see Cooley & Lohnes, 1976). In

a recent evaluation study of the follow-through program, it was found that many "experimental" classrooms did not use individualized teaching methods even though they were supposed to (Cooley & Leinhardt, 1980). The indication is that, because teachers and administrative systems are accustomed to carrying out and supporting instruction in a "usual" way, instructional-design innovations that require substantial changes in the "usual" way often are not implemented. The discipline of instructional implementation may indicate that some designs are incompatible with some characteristics of an existing institution. For instance, it is likely that classrooms with all desks facing forward and attached to the floor are incompatible with designs that call for active classroom discussion among students; and an institution that requires each course to be completed in one term or semester is probably incompatible with a design that is based on self-pacing and mastery learning. If such institution characteristics cannot be changed by the implementers, they become important inputs into the design process in that they constrain the selection of methods. The disciplines of instructional implementation and instructional design should interact to provide the key as to which institution characteristics significantly constrain which instructional methods and which institution characteristics it is possible to change.

Design is also dependent on *development* for important cost-effectiveness information on the design process—some designs may be more expensive to develop than they are worth. The disciplines of *implementation* and *management* may provide similar cost-effectiveness information—some designs may be more expensive to implement or to manage than they are worth. *Evaluation* has no direct input into instructional-design models and theory, but it does provide a basis for validating and/or revising instructional-design prescriptions. For example, a program may have been designed according to a set of instructional-design prescriptions. An evaluation of that program might identify certain weaknesses that require revision of those prescriptions. On the other hand, it might find no weaknesses in the instruction itself, in which case the prescriptions would be validated to some extent.

One final distinction of interest on this subject is that each of the just-described disciplines has *models* that are used by practitioners and processes that are used on those models. The models are of the five kinds previously described: design, development, implementation, management, and evaluation. To confuse the issue, the processes that are applied to each of those kinds of models are: design, development, implementation, management, and evaluation. For example, instructional-design models can be designed, developed, implemented, managed, and evaluated. Such is the case for the four other kinds of models, too.

Having now looked at why instructional design is important and how it relates to other disciplines within education, let us move on to what instructional-design theories and models are and some useful background knowledge for understanding and evaluating them.

WHAT IS INSTRUCTIONAL DESIGN LIKE?

This section of this chapter is intended to help you understand and evaluate the instructional theories and models presented in Unit II of this book. It discusses such topics as concepts, principles, strategies, models, and theories of instruction; it discusses conceptual and theoretical frameworks; and it presents a set of criteria for evaluating instructional-design theories.

The discipline of instructional design (which is often called instructional science) is concerned with producing knowledge about optimal "blueprints"—knowledge about what methods of instruction will optimize different kinds of desired outcomes. This knowledge has two components: concepts and principles. *Concepts* are human-made and hence are arbitrary, whereas *principles* exist naturally and hence are discovered. Concepts are categories of phenomena (such as "trees" or quadratic equations" or "sonnets"), whereas principles show change relationships—they show how one change (or action) is related to another change (or action)—usually by describing causes and effects (such as "the law of supply and demand" or "the law of gravity" or "the pendulum principle").[1]

Concepts (Classification Schemes)

When we say that concepts are human-made and arbitrary, we mean that phenomena can be conceptualized (i.e., grouped or categorized) in *many alternative ways*. Trees can be classified according to their age (e.g., saplings), their leaves (e.g., deciduous), their genus (e.g., oak), their climate (e.g., tropical), or many other characteristics; and each of these categories cuts across a number of other categories (e.g., saplings may be oaks, maples, etc.; seedlings may be oaks, maples, etc., and so on). In a similar way, the instructional world can be conceptualized in different ways. Methods of instruction can be classified according to the subject matter on which they are used (e.g., methods for teaching mathematics), the students with whom they are used (e.g., methods for special education), the philosophical orientation with which they are associated (e.g., behaviorist methods), or many other characteristics.

Practically all classification schemes will improve our understanding of instructional phenomena, but concepts are not the kind of knowledge for which instructional scientists are looking, except as a stepping stone. Instructional scientists want to determine *when* different methods should be used—they want to discover principles of instruction—so that they can prescribe optimal methods. But not all classification schemes are equally useful for forming highly reliable and broadly applicable principles (see Fig. 1.3). Some classifications of trees and diseases will

[1]All principles show "change" relationships: They show that one change is related to another. However, not all change relationships are causal relationship—for instance, they may be correlational (nondirectional).

Classification Schemes

- are arbitrary
- may categorize phenomena in many alternative ways
- have different degrees of predictive usefulness
    - -due to the way that the phenomena are categorized
    - -due to the level of generality of the categories.

FIG. 1.3 Characteristics of classification schemes.

have little value for predicting which trees are likely to come down with which diseases (e.g., classes of trees based on their ages), whereas other classifications will have high predictive value (e.g., genus—only elms are attacked by Dutch Elm disease). The same is true of classes of instructional phenomena: Some will have high *predictive usefulness* and some will not. The challenge to our discipline is to find out which ones are the most useful.

Besides the grouping of phenomena (in ways that may or may not be useful), another factor that will influence the predictive usefulness of a classification scheme is the *level of generality* of the concepts, especially of the methods. Many methods that have been investigated in the past are not very useful because they are too general (and often too loosely defined). For instance, "lecture" versus "discussion group," "inductive" versus "deductive," and "discovery" versus "expository" often vary more within each category than between categories. If progress is to be made in improving our methods of instruction, then it is essential to break down such general methods into more elemental *strategy components*—which are more precise and clearly defined—and to build one's models and theories with those more precise, clearly defined, elemental, building blocks. (Strategy components include such parts of methods as definitions, examples, and practice; but even more elemental characteristics of each of these can also be identified, such as visual versus verbal representations of each, formating of each, ways in which the examples can differ from each other, and many more. See Chapter 9 for more information about and examples of these strategy components.)

As you proceed to analyze the instructional models and theories presented in the remainder of this book, keep in mind that concepts are arbitrary, that categories of phenomena (such as methods and the conditions under which those methods are used) will vary from one model or theory to another, that some categorization schemes may be too general to be useful, whereas others, although precise enough, may just group phenomena in a way that is not useful, and that classification schemes (concepts) can ultimately only be evaluated on the basis of their predictive usefulness—the reliability of the cause-and-effect relationships into which they enter (see Fig. 1.3). (Categorization schemes can be evaluated on the basis of a number of internal characteristics, such as whether or not every phenomenon fits into one, and only one, category of a single scheme. However, for our purposes, such internal characteristics are of minor importance in relation to their predictive usefulness.)

Principles

A principle describes a relationship between two actions or changes. This relationship may be *correlational*, in which case it does not state which action influences the other, or it may be *causal*, in which case it does state which action influences the other (see Fig. 1.4). It also may be *deterministic*, in which case the cause always has the stated effect, or it may be *probabilistic*, in which case the cause sometimes (or often) has the stated effect. Finally, the term *principle* is used here regardless of the degree of certainty of the relationship. Hence, it includes everything from pure conjecture or hypothesis (having little or no evidence for its truthfulness) to scientific law (having much evidence for its truthfulness).

A Theoretical Framework

Several people who have written about the process of theory construction have advocated the use of paradigms or metatheories as useful for providing a framework within which to build one's theory (e.g., Snelbecker, 1974; Snow, 1971), and such frameworks can be very useful for both understanding and evaluating a theory or model as well. A *paradigm*, according to Snelbecker (1974), is "a basic building block or basic theme which occurs frequently in articulation of the theory or model [p. 33]." A *metatheory*, according to Snow (1971), "provides a kind of syntax or grammatical structure within which a particular theory can be developed and stated [p. 80]." For our purposes, we use the term *framework* as synonymous with both paradigm and metatheory. We propose that the following framework (from Reigeluth & Merrill, 1978, 1979) is a particularly useful one for understanding and analyzing instructional theories and models.

In contrast to Glaser's (1965, 1976) four components of a *psychology* of instruction (analyzing the subject matter, diagnosing preinstructional behavior, carrying out the instructional process, and measuring learning outcomes), Reigeluth and Merrill (1978, 1979) have proposed that there are three major components of a *theory* of instruction: methods, conditions, and outcomes. Instructional *methods* are the different ways to achieve different outcomes under different conditions. An instructional designer or educator must be able to manipulate them in order for them to be method variables. Instructional *conditions* are defined as factors that influence the effects of methods and are therefore important for prescribing methods. Hence, conditions are variables that both (1) interact with methods to influence their relative effectiveness and (2) cannot be manipulated in a given situation (i.e., they are beyond the control of the instructional designer or educator).[2]

[2]Instructional conditions are not the same as *conditions of learning* (Gagné, 1977, and Chapter 4 of this book). Conditions of learning may be factors internal or external to the learner. *Internal conditions of learning* include such things as mastery of prerequisite skills and knowledge. Any internal conditions

Instructional *outcomes* are the various effects that provide a measure of the value of alternative methods under different conditions. Outcomes may be actual or desired. *Actual* outcomes are the real-life results of using specific methods under specific conditions, whereas *desired* outcomes are goals, which often influence what methods should be selected.

The identification of instructional conditions, methods, and outcomes as the three major components of principles and theories of instruction is akin to the distinction drawn by Herbert Simon. Simon (1969) has stated that all design sciences have three major components: (1) alternative goals or requirements; (2) possibilities for action; and (3) fixed parameters or constraints. He has also stated that these three components provide a framework for devising functional prescriptions for goal attainment. These three major components are equivalent to instructional outcomes, methods, and conditions, respectively. And the functional prescriptions for goal attainment are prescriptive principles and theories of instruction.

It should also be noted that the notion of ATI (Aptitude-Treatment Interaction; see, for example, Cronbach & Snow, 1977) is a special case of the conditions–methods–outcomes framework. "Aptitude" in this context means "student characteristic," and "treatment" is synonymous with method. Hence, the term *ATI* refers to prescribing methods on the basis of student characteristics. (Note that ATI is a metatheory, not a theory of instruction, and hence it is not included in this book.) The major problem with the ATI metatheory is that it ignores other important kinds of condition variables that are necessary to prescribe optimal methods of instruction.

Conditions and methods are not fixed categories. Something that is a method variable in one school (because the teacher can change it) may be a condition variable in another school (because the teacher cannot change it). For example, "medium of instruction" may be a method variable in School A because the teacher has a choice of lecture, discussion, or film for presenting instruction on a topic. On the other hand, "medium of instruction" may be a condition variable in School B because lecture is the only available way of presenting the instruction—films are not available and the class is too large for discussion.

If a "method" cannot be changed in a given situation, then it is no longer a method: It is a condition (assuming that it interacts with methods). And, if a "condition" can be *manipulated* in a given situation (e.g., being able to select only students who are highly motivated, as opposed to being forced to take students who are at all levels of motivation), it has become a method—assuming that it influences outcomes. Also, "conditions" that do not *interact with methods* (e.g., the color of the ceiling) are not considered as conditions even if they influence outcomes, because they have no value for deciding when to use different methods.

of learning that interact with methods of instruction are instructional conditions. *External conditions of learning* include such things as examples and generalities. Because they can be manipulated by an instructional designer or teacher, they are instructional methods. Internal and external conditions of learning are discussed in some detail in Chapter 4.

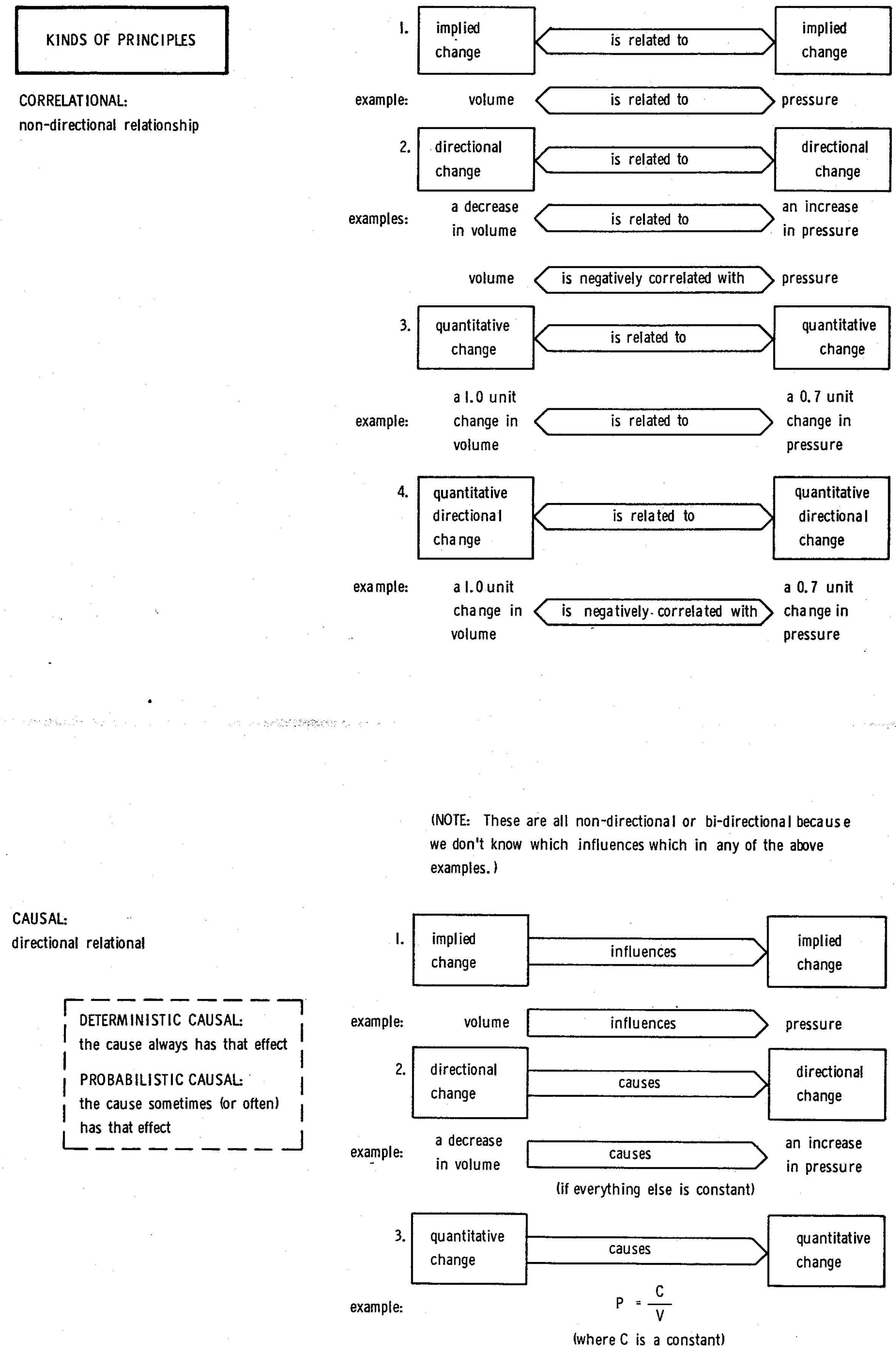


FIG. 1.4 Two major kinds of principles and varieties of each.

For example, in instructional design there is a concept called "alternative representation," which is a different way of communicating something that has already been said or shown. It might be a paraphrase of an earlier statement, or it might be a diagram that says the same thing visually as was just said verbally. In any instruction, you can classify parts of that instruction as to whether or not each is an alternative representation. Now, in instructional design there is also a *principle* that goes by the same name (alternative representation): If what is being taught is relatively difficult for the student (a condition), then you should use an alternative representation (a method variable) if you want the student to be able to acquire and retain the knowledge better (the desired outcome). It is useful to think of all principles of instruction as having a method variable (e.g., alternative representation), at least one outcome variable (e.g., better acquisition and retention), and often one or more condition variables that delimit the validity of the principle (e.g., only for relatively difficult content).

A principle is fundamentally the same in all disciplines—it can always be expressed in the same conditions–methods–outcomes format. For example, in physics, the following is a statement of a principle whose degree of certainty (i.e., validation through experimentation) places it in the category of "law":

Conditions:	If there is no wind resistance and you are relatively close to the surface of the earth, . . .
Method:	. . . dropping any object . . .
	. . . will cause . . .
Outcome:	. . . it to accelerate at the rate of 9.8 meters per second squared (9.8 m/sec^2).

An Extension of the Theoretical Framework

Instructional models and theories should be as comprehensive as possible. This means that they should include all kinds of method variables that have an important influence on outcomes. Reigeluth and Merrill (1979) have extended the conditions–methods–outcomes framework in an attempt to identify all of the important kinds of method variables that should be included in a comprehensive model or theory of instruction. This extended framework (see Fig. 1.5) should also prove very helpful for analyzing the instructional models and theories that appear in Unit II of this book.

Instructional Methods

First, instructional-method variables (for instructional design) are classified as three types: organizational, delivery, and management.

Organizational-strategy variables are elemental methods for organizing the subject-matter content that has been selected for instruction. They include such things as use of examples and diagrams, sequence of content, and formating. (For more detail refer to the following list.)

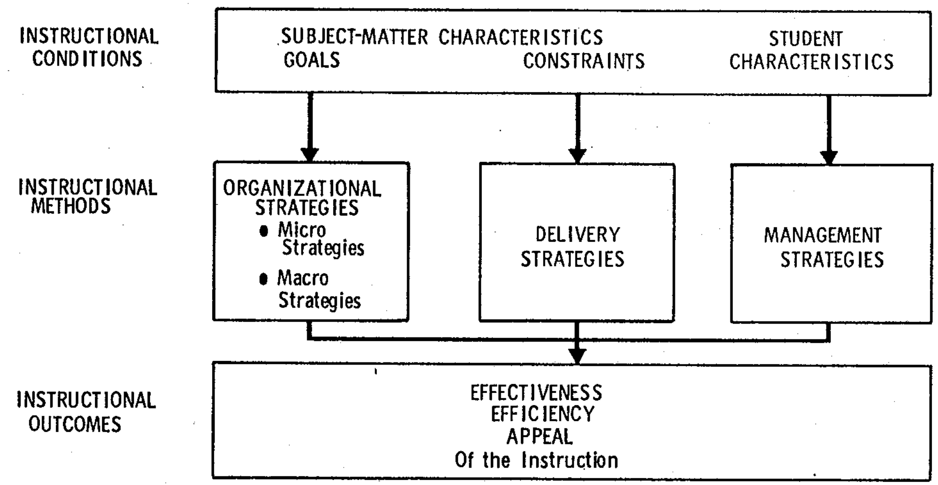


FIG. 1.5 A framework showing classes of instructional-method variables and the major condition variables that influence each. The classes of condition variables are *not* a complete list. Rather, they represent the conditions that are likely to have the strongest influence on each class of method variables.

Delivery-strategy variables are elemental methods for conveying the instruction to the learner and/or for receiving and responding to input from the learner. Media, teachers, and textbooks (and their characteristics) are the major part of delivery-strategy concerns.

Management-strategy variables are elemental methods for making decisions about which organizational- and delivery-strategy components to use when, during the instructional process. They include such concerns as how to individualize the instruction and when to schedule the instructional resources.

It is also useful to further conceptualize organizational strategies as being of two kinds: micro strategies and macro strategies.

Micro-strategy variables are elemental methods for organizing the instruction on a *single* idea (i.e., a single concept, principle, etc.). They include such strategy components as definition, example, practice, and alternative representation. (See Chapter 9 for additional examples of micro-strategy variables.)

Macro-strategy variables are elemental methods for organizing those aspects of instruction that relate to *more than one* idea, such as sequencing, synthesizing, and summarizing (previewing and reviewing) the ideas that are taught. (See Chapter 10 for more specific examples of macro-strategy variables.)

Instructional-design theories and models must take all of the just-described types of instructional strategies into consideration in order to be broadly useful.

Instructional Outcomes

It is also important that instructional theories and models identify the different kinds of instructional outcomes for which each set of method variables is prescribed. Some of the models or theories in this book are intended to optimize entirely *different kinds* of outcomes, and this accounts for the major differences among those models. Like other instructional phenomena, instructional outcomes can be classified in many different ways. On a very general level, they are often categorized in three classes:

The *effectiveness* of the instruction, which is usually measured by the level of student achievement of various kinds (see following);

The *efficiency* of the instruction, which is usually measured by the effectiveness divided by student time and/or by the cost of the instruction (e.g., teacher time, design and development expenses, etc.), and

The *appeal* of the instruction, which is often measured by the tendency of students to want to continue to learn.

(Notice that instructional outcomes focus on the instruction rather than on the learner; learner outcomes are but one aspect of instructional outcomes.)

The *effectiveness* of the instruction can then be broken down into various kinds of student achievement, from such *generic* knowledge as the ability to solve problems, being able to discover relationships, and being able to reason logically, to such *content-specific* knowledge as being able to recall a certain fact, being able to classify examples of a specific concept, and being able to follow a specific procedure. As you read the instructional theories and models in this book, be sure to identify and keep in mind the kind(s) of outcomes that each is intended to optimize.

Also, it is useful to know that *methods* of instruction can be classified and labeled by the kind of *outcome* towards which they contribute. For example, strategy components that are intended primarily to increase the appeal of the instruction are usually called *motivational-strategy components*. Of course, different motivational-strategy components may be further classified as organizational-, delivery-, or management-strategy components. Chapter 11 of this book is dedicated solely to this fledgling yet extremely important part of instructional-design theory.

Instructional Conditions

In addition to identifying and classifying precise method and outcome variables, it is important that instructional theories and models specify the conditions under which each set of method variables should or should not be used. For example, a certain strategy component may be very important for desired outcomes if students are poorly motivated but it may be detrimental for those desired outcomes for students who are already highly motivated. Figure 1.5 shows the major classes of condition variables that are likely to have the strongest influence on each class of method variables. But other condition variables are likely to be important, too, and many condition variables are likely to have an important influence on more than one class of method variables.

Models and Theories

Instructional scientists are not just interested in knowing that one method variable has better results than any other under given conditions—we are not just interested in single strategy components and isolated principles of instruction. What instructional designers and teachers need to know is what *complete set* of strategy components has better results (for desired outcomes) than any other set under given conditions: We are interested in complete models and theories of instruction.

People use the term *model* in many different ways. However, what is referred to as an instructional model (not to be confused with *instructional development model*; see following discussion) is usually an integrated set of strategy components, such as: the particular way the content ideas are sequenced, the use of overviews and summaries, the use of examples, the use of practice, and the use of different strategies for motivating the students. An architect's blueprint should show what many different aspects (preferably all different aspects) of the building are to be like. So also should an instructional model show what *many* different aspects (preferably *all* aspects) of the instruction are to be like in order to best achieve the desired outcomes under the anticipated conditions. Hence, an instructional model is merely a *set of strategy components*; it is a complete *method* with all of its parts (elementary components) described in detail.

Instructional models may be *fixed*—that is, they prescribe the same method variables regardless of what the student does (see, for example, Chapter 4)— or they may be *adaptive*—that is, they prescribe different method variables depending on student actions or responses (see, for example, Chapter 8).

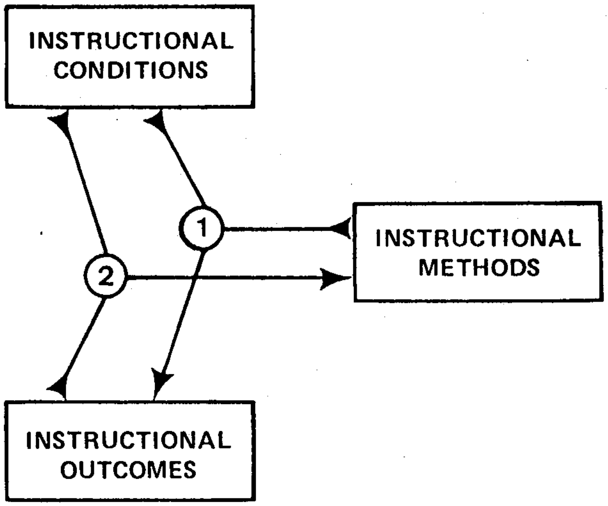
People also use the term *theory* in different ways. But an instructional-design theory (often referred to simply as an instructional theory) is usually thought of as a *set of principles* that are systematically integrated and are a means to explain and predict instructional phenomena. Just as conditions and outcomes are integral parts of a principle, so also are conditions and outcomes integral parts of a theory. In fact, a theory is to a model what a principle is to a single method variable; and hence a theory is to a principle what a model is to a single method variable:

$$\frac{\text{theory}}{\text{model}} = \frac{\text{principle}}{\text{method variable}} \qquad \frac{\text{theory}}{\text{principle}} = \frac{\text{model}}{\text{method variable}}$$

This means that a theory can be viewed as a set of statements that take the form conditions–model–outcomes, just as a principle takes the form conditions–method–outcome. These distinctions are valuable to keep in mind for understanding and analyzing subsequent chapters, and they are further clarified in the next section.

Descriptive versus Prescriptive Principles and Theories

Instructional design is a prescriptive science (Glaser, 1976; Reigeluth, Bunderson, & Merrill, 1978; Simon, 1969; Snelbecker, 1974) because its primary purpose is



1. For descriptive theories, the condition variables and the method variables are independent variables and their parameters may interact to produce fairly consistent effects on the outcome variables, which are dependent variables.

2. For prescriptive theories, the desired outcomes and the conditions are independent variables that may also interact and their parameters are used to prescribe good methods of instruction, which are dependent variables.

FIG. 1.6 Three categories of instructional variables, and two sets of interrelationships among those categories.

to *prescribe* optimal methods of instruction. (In this sense, it is very different from learning science, whose primary purpose is to describe the processes of learning.) But principles and theories of instructional design may be stated in either a descriptive or prescriptive form (see Fig. 1.6). *Descriptive* principles and theories take sets of conditions and methods as givens (constants) and describe the likely outcomes as the variables of interest. In contrast, *prescriptive* principles and theories use sets of conditions and desired outcomes as givens and prescribe the best methods as the variables of interest. This distinction between descriptive and prescriptive principles and theories is summarized in Fig. 1.6.*

Prescriptive principles and theories are goal oriented, whereas descriptive ones are goal free (the former is intended to achieve a goal, whereas the latter is intended

*Editor's note: For more about the distinction between descriptive and prescriptive theory, see Chapter 2, p. 51, and Chapter 3, p. 59.

to describe the outcomes); and prescriptive principles have optimal methods as the variables of interest, whereas descriptive ones have outcomes as the variable of interest. Also the outcomes in prescriptive principles and theories are desired outcomes, whereas in descriptive principles and theories they are actual outcomes (usually in a probabilistic sense—that is, they are likely outcomes) and may or may not be desirable. A prescriptive theory is concerned with prescribing whole models that will be "optimal" for given sets of conditions and desired outcomes. A descriptive theory, on the other hand, is concerned with merely describing the likely outcomes of using whole models under different sets of conditions.

Hence a theory is: (1) a set of *models*; and (2a) in the case of a prescriptive theory, a set of *prescriptions* as to which model will optimize given desired outcomes under given conditions; or (2b) in the case of a descriptive theory, a set of *descriptions* as to which outcomes occur under given conditions for a given model.

Things Often Confused with Instructional Design

There are two things that are often confused with instructional design: learning theory and instructional development. The major difference between a theory of instructional design and a theory of *learning* is that the former focuses on methods of instruction, whereas the latter focuses on the learning process. Instructional-design theory is concerned with what the teacher does, whereas learning theory is concerned with what happens to the learner. Like instructional theory, learning theory may be descriptive or prescriptive. But prescriptive learning theory is *not* instructional theory.* Note the following example:

Prescriptive principle of learning	To increase long-term retention, ensure that knowledge is organized into stable cognitive structures.
Prescriptive principle of instruction	To increase long-term retention, begin instruction with an overview that epitomizes the content rather than summarizes it. Then gradually elaborate on each aspect of that overview, one level at a time, constantly relating each elaboration to the overview.

Instructional-design theory must include specific instructional *method* variables. If it does not, it is not. This is important because much of what is called instructional theory is really learning theory. Instructional-design theory is relatively easy to apply in the classroom because it spells out methods of instruction. Learning theory is usually difficult to apply in the classroom because it does not spell out methods of instruction; at best it spells out "conditions of learning" (Gagné [1977] and Chapter 4 of this book), for which a teacher must then develop his or her own methods of instruction.

*Editor's note: For more about this distinction, see Chapter 3, p. 62.

Instructional-design models are also often confused with instructional-*development models*. The major difference here is that the former indicate *what* the instruction should be like, whereas development models indicate *how* to make it that way. Instructional-design models are "blueprints" of the instruction itself, whereas development models describe the steps that developers should follow in order to make the instruction. This is a very real and important difference.

Criteria for Evaluating Instructional-Design Theory

There are two important aspects to evaluating instructional-design theory: whether it is and how good it is. *Whether it is* an instructional-design theory depends on two things: (1) whether it is *instructional* rather than learning; and (2) whether it is a *theory* rather than a model or a list of propositions. To be an *instructional*-design theory, its focus must be on methods of instruction—specific ways to manipulate the instructional environment—rather than on learning processes. Knowledge of learning processes may be useful in developing an instructional theory, but it does not constitute any part of an instructional theory.

To be an instructional-design *theory* it must include three things: (1) one or more instructional *models*; (2) a set of *conditions* under which each model should be used; and (3) the *outcomes* (desired or actual) for each model under each set of conditions. A descriptive instructional theory describes the *actual* outcomes that result from using each model under each set of conditions. A prescriptive instructional theory prescribes the models that should be used to achieve *desired* outcomes under different conditions. Hence a theory can be viewed either as an integrated set of principles or as a set of models that are related to conditions and outcomes.

How good it is as an instructional-design theory is the second important aspect to evaluating it. The Association for Supervision and Curriculum Development (ASCD) formed a commission on instructional theory in 1964. This commission established criteria for evaluating theories of instruction (Gordon, 1968). The following are its criteria that we believe are most valuable for judging "how good it is": (1) it should have internal consistency (i.e., it should not contradict itself); (2) its boundaries and limitations should be explicit; and (3) it should not be contradicted by empirical data (although we caution that apparent contradictions may disappear in the light of reinterpretation of such data).

To these criteria we add Snelbecker's (1974) criterion of (4) parsimony: It should be simple—the fewer the variables, the better. Also we add Snow's (1971) criterion of (5) usefulness: "The primary criterion for the evaluation of theory is usefulness, not truthfulness [p. 103]." This is reminiscent of Hebb (1969): "A good theory is one that holds together long enough to get you to a better theory [p. 27]." Snow (1971) states that theory should be useful for organizing existing data meaningfully and for producing useful hypotheses.

A. Whether it is:
1. Instructional rather than learning.
2. Theory rather than model or list.

B. How good it is:
1. Internal consistency.
2. Explicit boundaries and limitations.
3. Not contradicted by data.
4. Parsimony (i.e., simplicity).
5. Usefulness.
6. Comprehensiveness (number of relevant classes of methods).
7. Optimality.
8. Breadth of applicability (percent of conditions).

FIG. 1.7 Criteria for evaluating theories of instruction.

In addition to these criteria for evaluating "how good it is," we propose the following. (6) Comprehensiveness: For how much of the total variance does it account? This may be influenced to a large extent by the number of classes of method variables that it includes: organizational/delivery/management, effectiveness/efficiency/appeal, and so on. (7) Optimality (which is related to usefulness): It is not enough to be valid, is it better than anything else available? In the case of a prescriptive theory, does it present the best models for achieving desired outcomes under given conditions? In the case of descriptive theory, do the models have the best outcomes for the given conditions?[3] (8) Breadth of applicability: For what percent of conditions is it optimal?

All of these criteria are summarized in Fig. 1.7. For more about evaluating instructional-design theory, see Chapter 2.

HOW SHOULD YOU READ THIS BOOK?

The following suggestions may be helpful for understanding and evaluating the theories and models that are described in this book. As you read each chapter, do the following:

1. Search for and label conditions, methods, and outcomes.

— Put a *C*, *M*, or *O* in the margin by each.

— Remember that the classifications are *arbitrary* and hence vary from one chapter to another. (Caution: Sometimes the same lable is used with different

[3]In descriptive theories, "optimality" would be replaced by "precision": Does it merely indicate that a relationship exists, or does it state the directionality of the (causal) relationship, or does it quantify the relationship, or does it quantify the directional relationship?

meanings by different theorists, and sometimes different lables are used for the same concept by different theorists.)

— Remember that the methods must be methods of *instruction*, not methods of developing or designing instruction.

2. ***Search for and flag all principles of instruction.***

— Remember that they must be principles of *instruction* rather than of learning—each must include a specific method variable.

— Remember that they are more useful if they are stated in a *prescriptive* way rather than a descriptive way.

3. ***Evaluate the classification scheme.***

— Remember that *predictive value* is the criterion of importance—the reliability of the cause-and-effect relationships into which they enter.

— Remember that predictive value can be low for two reasons:

- The methods are *too general*—too much within-method variation.
- Phenomena are *categorized* in a poor way.

4. ***Search for instructional models.***

— Remember that each of these is a "blueprint" of what the instruction should be like.

5. ***Evaluate each instructional model for:***

a. Comprehensiveness.

— Remember that this is determined by the percent of total variation that can be accounted for. It can be estimated by considering whether or not the model includes strategy components from all major classes of methods—organizational (both micro and macro), delivery, and management. Boundaries and limitations should be spelled out by the theorist.

b. Optimality or Usefulness.

— Try to decide whether or not any other model could do a better job of achieving the desired outcomes under the specified conditions. If the model is not optimal, try to assess whether or not any parts or aspects of the model are novel and thereby represent a useful advance that should be integrated into the better model.

c. Breadth of Application.

— Remember that this is determined partly by the number of conditions under which the model is optimal and partly by the number of desired outcomes for which it is optimal.

6. ***Search for instructional theories.***

— Remember to look for conditions–models–outcomes. This means that there must be:

- more than one model and
- a basis (i.e., conditions and/or desired outcomes) for prescribing which model to use when.

7. ***Evaluate the theory (if any).***

— Remember these major criteria:

- Comprehensiveness (same as 5a).

- Optimality or usefulness (same as 5b, except that the *bases* for prescribing each model may also represent useful advances that should be integrated into a better theory).
- Breadth of application (same as 5c, except that you should consider the breadth of all the models collectively rather than consider the breadth of each individual model).
- Parsimony: Is its degree of complexity warranted? Is it cost effective?

HISTORY OF INSTRUCTIONAL-DESIGN THEORY*

Aspects of instructional design have developed out of two major areas: (1) psychology, or more specifically, learning theory; and (2) media and communications. However, the media/communications tradition's contributions to instructional design have been in the form of isolated strategies and principles rather than integrated models and theories (see, for example, Fleming & Levie, 1977). The major portion of instructional design's antecedents comes from the learning-theory tradition, and all of the theories and models described in this book have grown out of that tradition.

Instructional design's conception can be primarily attributed to John Dewey and Robert Thorndike, but its birth as a discipline must be credited to B. F. Skinner, Jerome Bruner, and David Ausubel. More than anyone else, *Skinner* motivated the scientific investigation of instruction as something different from the scientific investigation of learning, and he integrated strategy components and principles into the first real empirically tested model of instruction (Skinner, 1954, 1965). In contrast to Skinner's behavioral orientation to instructional design (whose initial conception can be traced back to Thorndike), both Bruner and Ausubel developed cognitive orientations (whose initial conceptions can be traced back to Dewey). *Bruner* developed a model of instruction based on discovery methods and stages of intellectual development (Bruner, 1960), and he was among the first to talk about forming a "theory of instruction" (Bruner, 1966). On the other hand, *Ausubel* developed a model of instruction based on expository methods and cognitive structures (i.e., the way knowledge is organized within one's memory). He also developed a theory of learning, from which he derived most of his instructional-design model (Ausubel, 1968).

Contributions of Others

In addition to the three pioneers just discussed, many other people have had important roles in the history of instructional design. Stimulated by Bruner's work on instructional theories, the Association for Supervision and Curriculum Develop-

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*Editor's note: For more about the history of instructional theory, see Chapter 12 of this book; Merrill, Kowallis, and Wilson (1981); and Snelbecker (1974).

ment (ASCD) formed a commission in 1964 (Snelbecker, 1974) "to delineate scientifically based instructional theories from the more intuitively based and somewhat speculative 'theorizing' which had been so characteristic of education previously [p. 141]." This commission did much to focus attention on the need for "scientifically based" instructional theories, and it provided guidelines as to the chracteristics of such theories in the form of its *Criteria for Evaluating Theories of Instruction* (Gordon, 1968).

Robert Glaser also contributed much to the early development of the discipline. Not only did he contribute to the development of the "ruleg" (rule-example) model of instruction (Evans, Homme, & Glaser, 1962), but he also contributed on an even higher level by: (1) collecting much of the relevant work of that time into edited volumes (Lumsdaine & Glaser, 1960; Glaser, 1965); and (2) describing and drawing attention to areas that were particularly in need of investigation—his "four components of a psychology of instruction" (Glaser, 1965).

Robert Gagné is another important early contributor to instructional design. His early work on a number of models of instruction and a basis for prescribing each (see Chapter 4) helped to establish the discipline and to attract talented people to it.

Perhaps the most complete of the early models of instruction was that developed by Maria Montessori (1958, 1964). However, her valuable contributions have largely been overlooked by the mainstream of instructional design literature.

There are many other people who contributed in important ways to the early development of the discipline (i.e., during the 1960s). Some of them are mentioned next.

Some other Important Contributors to Instructional Design

In addition to the people just mentioned and the eight theorists described in the remainder of this book, there are many other people who have made important contributions to instructional design. The following is a very brief summary of some of the work of some of these people. This is not intended to be a comprehensive list of such people and their contributions; rather it is intended to be illustrative of the tremendous efforts that many people have contributed to the development of knowledge about better methods of instruction.

Richard C. Anderson has, among other things, confirmed and extended Ausubel's notion that providing learners with higher-level schemata or subsuming knowledge structures makes available a framework for comprehending discourse and increases the ease of learning and retention of such content and structures (see, for example, Anderson, Spiro, & Anderson, 1978; Anderson, Spiro, & Montague, 1977).

Richard C. Atkinson's contributions to the field include his work in the development of a "decision-theoretic model of instruction" (Atkinson, 1972a), in the design of models for computer-assisted instruction (Atkinson & Wilson, 1968), and in the development and validation of strategies for using mnemonics in the teaching of foreign languages (Atkinson, 1972b).

J. H. Block (1971) has done much work in the area of mastery learning, which is primarily a set of management strategies.

C. Victor Bunderson's (1979–80) work has focused on uses of computers in instruction. He was the major force behind the TICCIT System and its learner-control capabilties (a form of management strategy), and he is now in the forefront of videodisc applications in education (see, for example, Bunderson, 1979–80).

Crowder (1960, 1962) helped make considerable advances in the programmed instruction model of instruction by simultaneously relaxing its errorless-learning requirement and introducing branching sequences in the instruction. Thus, student errors provided the basis for individualizing the instruction.

Ivor K. Davies (1972, 1980; Hartley & Davies, 1976) has made important contributions in the area of instructional strategies.

Vernon Gerlach and Donald P. Ely (1971, 1980) have developed strategies for selecting and incorporating media within instruction, among other things.

Thomas Gilbert (1962, 1978) extended the programmed instruction model of instruction to what he calls "mathetics." One of his best-known contributions is the sequencing strategy referred to as "backward chaining."

Horn's (1976) major contribution to instructional design is prescriptions for formating instruction in such a way as to facilitate skipping over blocks of information and locating desired blocks of information.

Herbert Klausmeier has developed aspects of models for teaching concept classification, especially in the selection of examples (see, for example, Klausmeier, 1971; Klausmeier, Ghatala, & Frayer, 1974).

Raymond Kulhavy has been strongly involved in identifying and validating strategies for providing feedback for practice (see, for example, Kulhavy, 1977).

Susan Markle's work in the development of models for teaching concept classification includes the specification of strategies for preventing or remediating specific types of errors in concept-classification tasks (Markle & Tiemann, 1969). She also made important contributions to the earlier programmed instruction model (Markle, 1969).

R. J. Menges (see, for example, Menges & McGaghie, 1974) has worked in the area of group-interaction learning outcomes and instructional strategies.

Joseph Novak (1977) has applied Ausubelian assimilation theory principles to the design of models for teaching elementary science and math courses.

David R. Olson's (1974) work has been in the development of descriptive and prescriptive models of the developmental acquisition of language and critical thinking skills, building on Bruner's work.

Gordon Pask (1975, 1976) has developed a "conversation theory" whereby important cognitive operations can be identified, interrelated, and reduced to manageable units for purposes of planning the instructional "conversation." One of

Pask's greater contributions is his emphasis on teaching relationships within the content.

James Popham and Eva Baker (1970) have developed a general model of instruction that helped to integrate and disseminate current ideas about instructional design.

Lauren Resnick's (1963, 1973, 1976) work has focused primarily on the development of strategies for instruction in reading and mathematics, with particularly important contributions to development of the information-processing approach to task analysis.

Richard Snow (Cronback & Snow, 1977; Snow, 1977) has made major contributions to existing knowledge about the effects of individual aptitudes in the selection of appropriate instructional strategies.

Patrick Suppes' work (1965, 1975) has been concerned with the development and utilization of instructional strategies for computer-assisted instruction.

Among Donald Tosti's contributions to the field are his work with reinforcement strategies and management strategies (Tosti & Ball, 1969).

We would like to emphasize that this is but a sampling of the people who have made important contributions to the development of strategies, principles, models, and/or theories of instruction. It is also but a small indication of the total contributions that these people have made. Also, we have omitted any reference to the aforementioned people's (and other people's) contributions to such areas as learning theory and instructional-development procedures. For a more substantive review of these and other people's contributions to the more broadly defined field of instruction and learning, we strongly recommend Merrill, Kowallis, and Wilson (1981).

ADVANCED TOPICS

How Do You Build Instructional-Design Theory?

There are many different procedures for theory construction, but we have found one particular general procedure to be especially valuable. The stages in this procedure correspond roughly to what Snow (1971) referred to as different levels of theory. We propose that it is more valuable to view them as stages in a theory-construction procedure than as different levels of theory.

1. *Develop formative hypotheses* about instructional design on the basis of data, experience, intuition, and/or logic. These hypotheses may be fairly narrow and local (the start of a basically inductive—or bottom-up—approach to theory construction) or fairly broad and comprehensive (the start of a basically deductive—or top-down—approach to theory construction). This corresponds to Snow's F-theory.
2. *Develop a taxonomy* of variables related to instructional design. This stage entails identifying, describing, and classifying variables that may be of importance to instructional-design theory. (Many of those variables are indicated by the formative hypotheses.) It is usually best to start with a clear description of desired outcomes. Then generate as many methods as you can for achieving those outcomes. Finally, identify different conditions that will influence which methods will work best. This stage also entails the analysis of the method variables into fairly elementary units. These activities correspond to Snow's D-theory and E-theory, respectively. This stage is an extremely important one in the process of theory construction.
3. *Derive principles* of instructional design. These principles usually describe cause-and-effect relationships among the variables identified in stage 2, and many of them are derived from the formative hypotheses developed in stage 1. This stage relies heavily on experience, intuition, and logic for postulating the principles and on empirical research for testing them. The empirical research has traditionally used the controlled experimental study. No attempt is made to interrelate the principles during this stage. This stage does not correspond to any of Snow's levels.
4. *Develop models and theories* of instructional design. Theories can be developed by integrating strategy components into models that are likely to be optimal for different sets of conditions and outcomes. Here there is an emphasis on empirical research, but the methodology is very different than that for deriving and testing principles. Stepwise multiple regression can be used to rankorder the contribution of each strategy component to the instructional outcomes, when adjusted for all strategy components that contribute more. In this manner, "optimal" models of varying degrees of richness can be derived. This may be the most promising of several approaches to developing optimal prescriptive theories. This stage probably comes closest to Snow's B-theory.

Inductive and deductive approaches. Stages 3 and 4 are used as described earlier in an inductive approach to theory construction. For a deductive approach, stage 4 would precede stage 3 and would entail an intuitive or logical derivation of a theory rather than an empirical derivation. Stage 3 would then be done as a process of working out the details of the theory.

Contrary to implication, the just-described stages are not followed in strictly linear fashion. Rather, it is an interactive process entailing much recycling through the stages and much simultaneous activity on different stages. For example, the taxonomy (stage 2) may be revised as empirical research on principles of instructional design (stage 3) reveals the need for changes. Hence, it would be very rare to find either a purely inductive or a purely deductive approach to theory construction.

Controversy over Instructional-Design Theory

There has been some controversy over the useful breadth of instructional-design theory. Richard Snow is well known for his work on individual differences under the rubric of *ATI*, or aptitude-treatment interactions (see, for example, Cronbach

& Snow, 1977). ATI is a metatheory that in effect states that theories of instruction should prescribe methods (called *treatments*) on the basis of student characteristics (called *aptitudes*), because the effectiveness of those methods varies depending on student characteristics. Snow (1977) has stated that ATI (aptitude-treatment interaction) "makes general theory impossible [p. 12]"—that instructional-design theories must be *narrow and local* to be of value. On the other hand, Scandura (1977) represented the view of many when he stated that instructional-design theories must be *broad and comprehensive* to be useful. We believe this controversy can be reconciled with the help of the conditions–methods–outcomes framework described earlier.

The major source of the difference in opinion over the useful breadth of instructional-design theory can be traced to different definitions of such theory by Snow and Scandura. In reference to Fig. 1.5, Scandura includes only *organizational* strategies, whereas Snow puts heavy emphasis on *management* strategies and relatively little emphasis on organizational strategies. This difference in definition is crucial because research literature indicates relatively little ATI with organizational strategies but very strong ATI with management strategies (hence the configuration of student characteristics in the conditions section of Fig. 1.5).

A useful distinction in the discussion of student characteristics is trait versus state. *Traits* are student characteristics that are relatively constant over time, such as cognitive styles and those kinds of abilities that are measured by IQ tests, whereas *states* are student characteristics that tend to vary during individual learning experiences, such as level of content-specific knowledge.

We believe, as Scandura maintained, that broad and comprehensive instructional-design models and theory can be developed in the area of organizational strategies. Many strategy components have been shown to help students with *all kinds* of traits to learn. For example, matched nonexamples can help students of all traits to learn concept classification. And several quasimodels have also been shown to help all kinds of students to learn (e.g., see Bloom, 1968; Robin, 1976; Schutz, 1979). We believe that such theory can be and will be developed in the area of delivery strategies also. But questions as to which organizational strategy components should be provided when and for how long (which are properly classified as instructional-management decisions) are highly sensitive to student states, and such decisions about the use of organizational strategies will vary considerably over time as a student's understanding develops and misconceptions arise and are dispelled. Hence, broad and comprehensive theory is considerably easier to develop in the area of organizational strategies than in the area of management strategies.

Nevertheless, the difficulty in developing broad and comprehensive theory in the area of management strategies may be attributable to what Snow (1971) refers to as inadequate metatheory:

> The need for new metatheory arises out of the inadequacy of existing metatheory. When hypotheses too frequently fail to be confirmed, when results of investigations are insignificant or inconsistent, and when findings with theoretical or practical value appear too seldomly, a field of research becomes ripe for the emergence of new metatheories [p. 97].

It may be time for the ATI metatheory for management strategies to give way to new metatheories.

One emerging alternative that shows great promise is the "learner-control" metatheory (Merrill, 1975, 1979, 1980; Reigeluth, 1979), which emphasizes training the learner to make the decisions about which strategy components to study when and for how long. Learner control appears to be equally useful for accommodating individual differences due to either trait or state. For example, rather than presenting "visual" instruction to some students and "verbal" instruction to others, learner control prescribes making both representations available to all students, along with some brief training about what to pick and choose when, rather than studying everything. (It is also likely that the vast majority of students are not strictly verbal or strictly visual and can therefore benefit from having both whenever the content is a bit difficult.) For more about learner control, see Chapter 9. This metatheory is attractive not only for its potential for the construction of a highly *useful, broad,* and *comprehensive* theory, but also for its potential for the construction of theory that can be easily and economically *implemented* in the design of instruction.

Hence, ATI is but one approach to the question of individual differences as a basis for prescribing instruction. But strategies are only one aspect of instruction to be prescribed. Another approach to individualizing instruction is that the *initial state* of the learner is an important basis for prescription of *content* as well as strategy. There is considerable evidence that learner control over content is not always advisable. For example, Brown and Burton (1978) indicate that different learners make errors in certain arithmetic problems because of relatively unique "bugs" in the steps they follow. A student may have difficulty in selecting the content that will correct his or her unique "bug." Therefore, student state is an important condition variable for the selection of some content, and management strategies other than learner control are important for the selection of some content on the basis of student state. However, this does not mean that learners should never have control over the selection of any content. For more about learner control over the selection of content, see Chapter 10.

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2 A Metatheory of Instruction: A Framework for Analyzing and Evaluating Instructional Theories and Models

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CONTENTS

[1]The views expressed here do not necessarily reflect those of the Digital Equipment Corporation.