Instructional-Design Theories and Models
Volume III
Building a Common Knowledge Base

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the qualifications for inclusion in this list, along with the principles in brief and in more detail. The principles include the demonstration principle, application principle, task-centered principle, activation principle, and integration principle. The chapter takes up the difficult task of elaborating on these principles and relating them to one another to create a defensible set of principles that Merrill asserts will create effective and efficient instruction.

Chapter 4 (Reigeluth & Carr-Chellman) focuses on the situational principles of instruction—ones that vary from one situation to another. This chapter describes what situational principles are and links them to the notion of universal principles through an analogy of the universe and galaxies. In an effort to increase precision in our language and knowledge base, we elaborate on kinds, parts, and criteria as ways to make methods more precise. Principles as heuristics, or rules of thumb, are particularly important for precise descriptions of methods. A review of learning taxonomies leads us to a description of the instructional theories we have included in units 2 and 3.

—CMR & ACC

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Understanding Instructional Theory

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EDITORS' FOREWORD

Vision

- *To build a common knowledge base and a common language about instruction*

Definition of Instruction

- *Instruction is anything that is done purposely to facilitate learning.*

The Nature of Theories Related to Instruction

- *Design theory is goal oriented and normative.*
- *Instructional design theory is a set of design theories that pertain to various aspects of instruction and include:*
  1. *Instructional-event design theory (DT)*
  2. *Instructional-analysis DT*
  3. *Instructional-planning DT*
  4. *Instructional-building DT*
  5. *Instructional-implementation DT*
  6. *Instructional-evaluation DT*
- *Related theories include:*
  1. *Student-assessment design theory*
  2. *Curriculum design theory*
  3. *Learning theory*
  4. *Learning sciences*
- *Interrelationships among all these kinds of theories are powerful, and it is often beneficial to integrate them.*
- *Instructional design theories and layers of design*
  1. *Content layer*
  2. *Strategy layer*
  3. *Message layer*
  4. *Control layer*
  5. *Representation layer*
  6. *Media logic layer*
  7. *Data management layer*

The Role of Instructional Theory in Educational Reform

- *Why a new paradigm of education is needed and possible*
- *Relation to paradigm change in education*
- *Relation to Learner-Centered Instruction*
- *Learner-centered psychological principles*
- *The science of learning*
- *New paradigm of instructional theory (volume 2)*
- *Cognitive flexibility theory, personalized learning, brain-based learning, and differentiated instruction*

The Nature of Instructional Theories: Constructs and Terms

- *Results of a Delphi study*
- *Recommended constructs and terms*
  1. *Instructional method*
     - *1.1. Scope (micro-meso-macro)*
     - *1.2. Generality (universal-local)*
     - *1.3. Precision (imprecise-precise) based on parts, kinds, or criteria*
     - *1.4. Power (low-high)*
     - *1.5. Consistency (low-high)*
  2. *Instructional situation*
     - *2.1. Values*
       - *2.1.1. About learning goals*
       - *2.1.2. About priorities (effectiveness, efficiency, appeal)*
       - *2.1.3. About methods*
       - *2.1.4. About power (learner, teacher, institution)*
     - *2.2. Conditions*
       - *2.2.1. Content*
       - *2.2.2. Learner*
       - *2.2.3. Learning environment*
       - *2.2.4. Instructional development constraints*

—CMR & ACC

UNDERSTANDING INSTRUCTIONAL THEORY

Instructional theory may sound, at first, like a dense and difficult topic, but it is easier to understand than you might think. Furthermore, this knowledge is central to helping you improve the quality of your teaching and training. Taking the time to understand the nature of instructional theory will help you to understand individual instructional theories and even help you make contributions to this growing knowledge base. Therefore, an understanding of the nature of instructional theory is important to both your growth and the growth of our field.

Vague and inconsistent language is impeding such growth. Different theorists use the same term to refer to different things and different terms to refer to the same things. This is confusing for all of us, from beginning graduate students to expert designers and researchers. When a discipline is young, it is natural for there to be such inconsistent language. We propose that instructional theory has now reached a level of development where a common knowledge base with a consistent terminology would greatly facilitate the future development of knowledge in this important area.

This chapter begins by defining *instruction*. We then discuss the need for building a common knowledge base about instruction. We describe several different kinds of theories related to instruction and contrast them with other related

kinds of theories, such as student-assessment theories, curriculum theories, and learning theories. Then we discuss Gibbons and Rogers's concept of "layers of design" (see chapter 14) and their implications for instructional theory. Next, we turn our attention to the role of instructional theory in educational reform, and specifically discuss the relationship of learner-centered instruction to this book. Finally, we offer particular constructs and terms for a common knowledge base about instruction. These terms may be useful as a foundation upon which instructional theorists and researchers can build, and they should help you, whether a practitioner, a researcher, or a graduate student, to understand the knowledge available to you about fostering learning more effectively.

A Definition of Instruction

A distinction has been made in the literature recently between "instruction" and "construction," with the implication that instruction is necessarily done *to* learners (i.e., learners are passive), whereas construction is done *by* learners (i.e., learners are active). However, a principal tenet of constructivism is that people can only learn by constructing their own knowledge—that learning requires active manipulation of the material to be learned and cannot occur passively. Our concern is with how to help learners learn, which means identifying ways to help learners construct knowledge. Therefore, if instruction is to foster any learning at all, it must foster construction. Instruction is not instruction if it does not foster construction. Furthermore, if construction is what the *learner* does, then we need a different term for what a *teacher* (or other agent) does to foster construction, and "instruction" has commonly been used more than any other term to convey that meaning. Therefore, we define *instruction* as *anything that is done purposely to facilitate learning.* It includes constructivist methods and self-instruction, as well as more traditional views of instruction, such as lecture and direct instruction.

The Need

Volume 2 of *Instructional-Design Theories and Models* (Reigeluth, 1999) was a small sample of the wide variety of information-age instructional-design theories that had been created by 1998. That book made it evident that many instructional theories were constructed with little regard for prior theories. Until theorists begin to build upon each other's contributions, the field will remain in its infancy. The main purpose of this volume, then, is to help instructional theorists and researchers to build a common knowledge base about instruction.

The Nature of Theories Related to Instruction

To build (or to understand) a common knowledge base about instruction, it is helpful to understand the nature of such a knowledge base. However, there are

many important things to know about instruction, including what an instructional product itself should be like, the process by which it should be designed and built, how it should be implemented, how it should be evaluated, how its effects (e.g., learning) should be assessed, what content should be instructed, how people learn, and the interrelationships among all these kinds of knowledge about instruction. It is also helpful to distinguish between design theory and descriptive theory. Each of these is discussed next.

Design Theory

Design theory is different from descriptive theory in that it is goal oriented and normative—it identifies good methods for accomplishing goals—whereas descriptive theory describes cause–effect relationships, which are usually probabilistic (meaning that the cause does not always result in the effect), especially in the social sciences. Design theory is aimed at facilitating generative outcomes; that is, it assists in the *creation* of something, while descriptive theory seeks to describe what already exists. We very much agree with Nelson and Stolterman's (2003) notions of design expertise. They recognize that there are different fields of design expertise, such as instructional design or engineering or architecture. But they also indicate that all designers share some similar field experiences:

> It is even more important to emphasize that every informally recognized designer has a similar field of expertise. It goes without saying that every designer needs knowledge and skills concerning materials, tools, methods, languages, traditions, styles, etc., in his or her specific field. (p. 25)

Their book, *The Design Way*, is not about the particular knowledge and skills, but is indeed about those areas that are relevant for all designers, including instructional designers.

Some people do not like the term *theory* for such goal-oriented or instrumental knowledge. Some of the terms that they prefer include: *method, model, technology, technique, strategy, guidance,* and *heuristic.* However, none of these terms captures the full scope of this kind of knowledge, which includes not only methods (or models, techniques, strategies, and heuristics), but also when and when not to use each method. We have found no other term that fits as well as *design theory* for capturing methods *and* when to use them. Second, these two types of knowledge (descriptive and instrumental) are widely recognized as the two major kinds (e.g., the famous distinction by Simon, 1996, between the natural sciences and the sciences of the artificial), and hence are "coordinate" (subordinate to, or kinds of, the same concept—theory). Third, the term *theory* has been used for decades to characterize the instrumental knowledge base in several fields, and in instruction its use goes back at least to Bruner (1966) and Gagné (1985). For these three reasons, we find it appropriate to refer to each of the two basic kinds of knowledge as theory, and to the

instrumental kind of knowledge as design theory. Consequently, we offer the following definitions.

Instructional Design Theory

Instructional design theory is a set of design theories that pertain to various aspects of instruction. One perspective is that those aspects include:

- what the instruction should be like, which could be called instructional-event design theory (DT), or instructional-program DT, or instructional-product DT;
- what the process of gathering information for making decisions about instruction should be like, which could be called *instructional-analysis* DT;
- what the process of creating the instructional plans should be like, which could be called *instructional-planning* DT;[1]
- what the process of creating the instructional resources should be like, which could be called *instructional-building* DT;[2]
- what the process of preparing for implementation of the instruction should be like, which could be called *instructional-implementation* DT;[3]
- what the process for evaluating the instruction should be like (summative and formative), which could be called instructional-evaluation DT.

While these six terms represent a largely new way of referring to the various design theories that inform our practice, we hope they are sufficiently more intuitive and less ambiguous that they are worth adopting. We welcome dialogue about these six terms and any changes that might make them more intuitive and less ambiguous. Since they are all design theories, we could drop "design" from the labels. A graphic is perhaps a valuable way to represent this new language (see Figure 1.1).

Note that instructional-event theory is the only one that offers guidance about the nature of the instruction itself. The other five all offer guidance about what is commonly called the *instructional systems design* (or development) process (ISD). Also, please note that there are many interrelationships among these six kinds of instructional-design theory. Obviously, they have input–output relationships with each other. However, analysis and evaluation each play a far more integrated

1. Sometimes the term *instructional design* is used with this meaning, and it is one part of the ISD process.
2. Sometimes the term *instructional development* is used with this meaning, and it is another part of the ISD process.
3. Sometimes the terms *change* or *adoption and diffusion of innovations* is used with this meaning, and it is another part of the ISD process. Please note that instructional implementation is not the same as the instructional event. Rather, it is about the process of preparing for the implementation, rather than the implementation itself. It includes procuring and installing necessary resources and providing necessary training for teachers and support personnel.

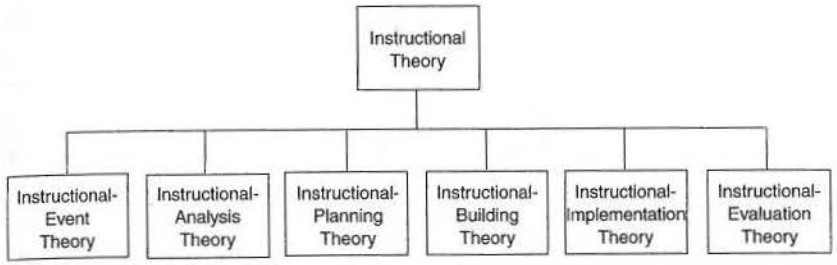

Figure 1.1 Six Major Kinds of Instructional Design-Theory

role in the other kinds of theory. For example, analysis should be used to provide useful information in the application of all the other five kinds of instructional-design theory and should be integrated with each. For example, there is a series of decisions that need to be made for planning an instructional event, including decisions about scope and sequence, instructional approach, instructional tactics, media selection, media utilization, and so forth. Each of these kinds of decisions requires a different kind of analysis at a different point in time during the planning process. So instructional-analysis theory must be integrated with instructional-planning theory. Similarly, different kinds of decisions are made during the instructional-building process, and different kinds of information are needed for making those decisions. Therefore, instructional-analysis theory must be integrated with instructional-building theory. The same applies to instructional-implementation theory and instructional-evaluation theory.

In a parallel manner, evaluation should be conducted on each major decision that is made during the instructional-planning process, so instructional-evaluation theory must be integrated with instructional-planning theory. Similarly, it must also be integrated with each of the other four kinds of instructional theory.

So while it is conceptually helpful to understand that all these different kinds of instructional design-theory exist, it is essential to understand that useful guidance for practitioners must integrate *all* of them.

An Analogy

We feel that a good analogy here would be that of the building process that results in homes, offices, skyscrapers, hospitals, and other buildings. First, there is a body of theory about architecture. These theories are about the buildings themselves, about the products. They study Gaudí and his use of art in the form of everyday structures, for example. This is most akin to instructional-event theory. Then there is a body of literature that looks at theories of architectural process; that is, what architects *do*, how they go about the business of creating and producing a blueprint. This is most akin to instructional-planning theory. Now the architect produces a blueprint, which is given to a builder, and the

builder translates that blueprint into a physical manifestation in the form of a final home, or townhouse, or shopping mall. This process is guided by design theories as well, which are most akin to instructional-building theory. Next, people are prepared to use the building. A homeowner may be shown how to use and provide light maintenance on the furnace, water heater, oven, electrical panel, and so forth. And the utilities will be connected. These kinds of activities are similar to instructional-implementation theory. Finally, as a building is lived in, worked in, or shopped in, we and others draw some conclusions about it. Do the air systems work well, or are some rooms always too hot or too cold? If this can be fixed, we might see this as formative evaluation. If not, it might be considered, unfortunately, a summative evaluation of the effectiveness of the building. This, of course, is most like instructional-evaluation theory.

Now we turn to a discussion of several other kinds of theory that are not kinds of instructional-design theory. They include student-assessment theory, curriculum theory, learning theory, learning sciences, and instructional science.

Student-Assessment Design Theory

Student-assessment design theory is guidance for assessing student learning. To the extent that student assessment is integrated with instruction, it would make sense to combine student assessment theory with all six kinds of instructional theories: integrating guidance about the nature of assessment with guidance about the nature of instruction, integrating guidance for the process of analysis for assessments with guidance for the process of analysis for instruction, and so forth for planning, building, implementing, and evaluating assessments and instruction.

Curriculum-Design Theory

Curriculum-design theory concerns *what* should be learned, the content of instruction, including higher-order thinking skills and metacognitive skills, in contrast to instructional-event theory, which concerns *how* it should be learned (Snelbecker, 1974; see also Reigeluth, 1999, chapter 1—volume 2 of this series). For example, a curriculum-design theory may address the inclusion of more racial and gender diversity in American history. To the extent that "what to teach" is interdependent with "how to teach it," it would make sense to combine curriculum theory with all six kinds of instructional theories. It is no wonder that many departments in schools of education are called "Curriculum and Instruction."

Learning Theory

Learning theory is descriptive theory rather than design (or instrumental) theory, for it describes the learning process. For example, schema theory and

information-processing theory describe processes that are believed to occur within learners' heads. If they identified methods for helping those processes to occur, they would be instructional-event design theories. Learning theory may provide an understanding of why a certain method of instruction (in an instructional-event theory) works so well, and hence a rationale for using it, but an instructional-event theory can as easily lead to the development of learning theory (to explain that instructional-event theory) as a learning theory can lead to the development of an instructional-event theory (to apply the learning theory).

Learning Sciences

Learning Sciences is a term that has become popular recently. The term *instructional science* has also been used, and there is a journal by that name. Based on those labels, one would expect that the learning sciences are dedicated to the development of learning theory, and that instructional science is dedicated to the development of instructional theory. However, in practice most learning scientists are interested in developing knowledge about both learning (descriptive theory) and instructional events (design theory). An operational definition of learning sciences would perhaps be a hybrid discipline that includes learning theory and instructional-event theory. It also seems that most learning scientists are not interested in instructional-planning theory, instructional-building theory, instructional-implementation theory, instructional-evaluation theory, or curriculum theory. There is some interest in student-assessment theory. The field of learning sciences is akin to cognitive science in that it is purposely multidisciplinary and not so interested in goals as in the use of certain kinds of instructional methods to shed light on certain kinds of learning processes.

Interrelationships

The interrelationships among all the kinds of theories related to instruction are powerful and systemic. In many cases, it is most helpful for a theory to be a hybrid of several of these kinds of theories, as we have already mentioned. Such hybrids have been common from the early pioneers in instructional theory (e.g., Dewey, Skinner, Gagné, and Ausubel) to recent theorists (e.g., Bransford, Brown, & Cocking, 2000; McCombs & Whisler, 1997).

In spite of the importance of *all* these kinds of theories and the relationships among them, this book focuses on instructional-event theory, not just because it would be too large an undertaking to do justice to all of the above theories and their interrelationships, but more importantly because instructional-event theory is in dire need of a common knowledge base. Since the term *instructional theory* is commonly used to refer to what we have called "instructional-event design theory," we often use this simpler term in the remainder of this book.

Instructional Design Theories and Layers of Design

One additional aspect of the nature of theories related to instruction is the notion of "layers of design" discussed by Gibbons and Rogers in chapter 14. Their chapter helps us to understand that designing an instructional system requires considerable attention to the ways in which its parts will interact, wear out, progress, and be utilized at different rates and in different ways. A good example of this, given by Gibbons at a recent conference, was that, while many classrooms did not have overhead fixed video projectors in their ceilings when they were built, the "ceiling layer" of the room was created in such a way as to afford that change in the delivery system by putting in a drop ceiling with tiles that were easily removed. This is an example of one layer wearing out or becoming obsolete sooner than others, and ways that a layer can shift around others without an entire building having to be gutted each time new wires need to be run, for instance.

In chapter 14 Gibbons and Rogers identify seven layers of design that they believe are important in designing instruction: content, strategy, message, control, representation, media logic, and data management layers. Each of these is briefly described next.

Within the *content layer* a designer specifies the structure of the subject-matter elements. This layer is most concerned with the many ways content can be structured. For example, instructional theories related to the content layer of designs might identify subject matter elements divided into sets of tasks, sets of propositions, sets of if/then rules, or sets of discrete semantic (meaning) elements.

Within the *strategy layer* a designer specifies the organization and properties of learning events, including participant roles and responsibilities, goals and times afforded to goals, and instructional strategies. Theories pertaining to the design at the strategy layer therefore pertain to the setting, the social organization, the "siting," and the strategies of instructional interactions.

Within the *message layer* a designer describes the ways that individual messages are used to communicate content and other information to the learner. In essence, if the strategy layer describes a general strategic plan, then the message layer describes the tactical messaging plan for carrying out that strategy. For example, a designer might define in a messaging plan the elements to be used to construct feedback messages in terms of individual message units (right/wrong judgment, error explanation, remedy explanation, etc.) that will generally comprise feedback messages. There are many classes of messages used during most typical instructional interactions.

Within the *control layer* a designer specifies how learners express messages back to the source of learning. Theories related to control-layer designs describe ways that learners can take actions, ask questions, make responses, and generally carry out their side of the instructional conversation. An example might be a theory that specifies ways that the learner can take action during practice in an interactive medium, such as a computer.

Within the *representation layer* a designer describes the way or ways in which messages will be delivered to the learners' senses, including the media channels that will be used, how messages will be assigned to those channels, and how individual messages that use multiple channels are synchronized. Thus, theories used within the design of the representation layer might describe how to visualize certain kinds of messages, how to maximize the coordination of different media channels, and how to synchronize the messages within their different channels for best effect.

Within the *media logic layer* a designer specifies how media mechanisms will be made to deliver representations, how to carry out communications (through messaging and control operation), how to implement strategies in a dynamic, unpredictable interaction, how to compute current knowledge model states, and how to gather and analyze data in ways useful during the instruction. This is the part of the design that tells us how media will be used to carry out instructional event plans. For example, a theory related to media logic design might specify ways in which a multimedia computer could be made to deliver a dynamic visual representation simultaneously with an audio description while teaching how to prepare a fine soup.

Within the *data management layer* a designer specifies what we do with data in the system in terms of capture, archiving, analysis, interpretation, and reporting. An instructional theory related to the design of the data management layer might specify that the result of each step of the process of adding a fraction be captured and analyzed for correctness or incorrectness so that errors can be debugged, or might specify that certain response patterns should be noted as a student executes a tricky procedure so that later analysis can identify possible sources of errors.[4]

We believe that there is an interaction between Gibbons and Rogers's concept of layers (chapter 14) and the application of the six types of instructional theory (event, analysis, planning, building, implementation, and evaluation) that we have defined. For example, to be comprehensive, instructional-event theory should provide guidance for what all seven layers should be like, given the nature of the situation. Similarly, instructional-planning theory should offer guidance for a process in which all seven layers will be designed, and instructional building theory should offer guidance for a process in which all seven layers will be developed, and so forth.

The Role of Instructional Theory in Educational Reform

The major purpose of most instructional theories is to improve learning in P-12 schools (from preschool through 12th grade), though instructional theories are

4. The authors thank Andrew Gibbons for his contribution to writing the previous seven paragraphs. For more information about these layers, see chapter 14.

also valuable in many other contexts. Chapter 1 in volume 2 proposed that the industrial-age paradigm (or factory model) of schooling is obsolete—inadequate to meet learning needs today—and that a new paradigm of education is needed.

Why Is a New Paradigm Needed?

We know that students learn at different rates, yet the current industrial-age paradigm of education requires all students to learn the same thing at the same time and rate. This means that slow learners are forced on before mastering the content, and they accumulate learning deficits that make future learning more difficult, while fast learners are forced to wait and lose both motivation and the opportunity to learn more. The alternative to holding time "constant" for all students and thereby forcing achievement to vary, is to hold achievement constant (at the level specified by the standards), which requires time to vary—to allow each student the time needed to attain each standard, and allow each student to move on as soon as the standard is attained (Reigeluth, 1994). Without this change in paradigm, we will inevitably continue to leave many children behind no matter what reforms we implement, and we will continue to waste much of our top talent in schools.

Is a New Paradigm Possible?

Two developments allow such a customized, attainment-based paradigm of education to replace the current standardized, time-based paradigm: (1) the development of advanced technologies and (2) the advancement of learner-centered psychological principles and methods of instruction, such as active learning and collaborative problem-based learning. These developments allow a true paradigm shift in instruction that has the potential for a quantum improvement in learning (Banathy, 1991; Branson, 1987; Covington, 1996; Duffy, Rogerson, & Blick, 2000; Egol, 2003; Jenlink, Reigeluth, Carr, & Nelson, 1996; Reigeluth, 1994), not just the 5 or 10% improvement found in typical piecemeal educational reform efforts, including most Comprehensive School Reform programs (American Institutes for Research, 1999; Franceschini, 2002; Holdzkom, 2002; Ross et al., 1997; Wong, Nicotera, & Manning, 2003).

What Areas of Knowledge Need to Be Developed to Make It Possible?

Much remains to be learned about the learner-centered paradigm of instruction (Bransford et al., 2000; McCombs & Whisler, 1997). However, the major gap in our knowledge for dramatic improvements in learning is how to help schools transform themselves from the standardized, industrial-age paradigm to a learner-centered, information-age paradigm of education. The history of fundamental educational reform has been dominated by classroom-based

and school-based efforts to change to a learner-centered paradigm; but those changes have been incompatible with the larger school systems, communities, and social systems within which they existed and consequently were gradually forced by those encompassing systems to transform back into the industrial-age model (Sarason, 1990, 1995; Tyack & Cuban, 1995). While fundamental changes are needed in the ways teachers and students interact to foster learning, those changes require changes at the classroom level, which in turn require changes on the school level, which in turn require changes on the district level. In other words, to be successful, fundamental transformation of education must occur on the school district level, as well as the school and classroom levels (Duffy et al., 2000; Squire & Reigeluth, 2000). There is also evidence that related changes are helpful, if not essential, on the state level (Fullan, 2003).

Therefore, large improvements in learning in public schools require advances in two kinds of knowledge: knowledge about learner-centered methods of instruction (e.g., Watson & Reigeluth, 2008, for an overview) and knowledge about how to help school districts transform themselves to an information-age paradigm of education (e.g., Duffy & Reigeluth, 2008; Reigeluth & Duffy, 2008). This book focuses on advancing the former: knowledge about the learner-centered paradigm of instruction. We see this as pivotal to the advancement of the larger agenda of school reform as well as reform of all organizations in which intentional human learning occurs.

Relation to Learner-Centered Instruction

To make the most valuable contribution to knowledge, this book attempts to synthesize the current knowledge about effective instruction to formulate a common knowledge base about instruction and a common terminology about instruction. Toward this end, it may be helpful to briefly summarize current knowledge about learner-centered instruction (see also Watson & Reigeluth, 2008).

Learner-Centered Psychological Principles

The present knowledge about the learner-centered paradigm of instruction is widely dispersed, but several noted attempts to synthesize or summarize that knowledge have been published. First, the American Psychological Association conducted an extensive project to identify research-based, learner-centered, psychological principles (American Psychological Association Presidential Task Force on Psychology in Education, 1993). Its report identifies 12 such principles and presents the research evidence that supports each. McCombs and colleagues (Lambert & McCombs, 1998; McCombs & Whisler, 1997) summarize that work and describe specific features and characteristics of learner-centered classrooms and schools, along with descriptions of their experiences with learner-centered teachers and schools. They describe the nature of the shift in focus from teaching to learning, including ways to customize learning to student differences, how to

motivate students to put more effort into learning, how to help students assume increasing responsibility for directing their own learning (to prepare them better to be lifelong learners), how to manage the learning process so that faster students can move on as soon as they reach a standard and slower students are not forced to move on before they have reached a standard, and much more. Technology plays a central role in all of these aspects of the learner-centered paradigm. Methods such as these have been proven to significantly advance the ability of students to reach high standards (American Psychological Association Presidential Task Force on Psychology in Education, 1993; Lambert & McCombs, 1998; McCombs & Whisler, 1997). However, McCombs and Whisler caution that "learner-centered teaching is as much a way of being, a disposition, as it is doing one thing or another" (p. 100), and they discuss the qualities that learner-centered teachers need to have, along with ways to help develop those qualities. These are all important elements of a comprehensive design theory for learner-centered instruction.

The Science of Learning

A second line of work was undertaken by the National Research Council to synthesize present knowledge about how people learn (Bransford et al., 2000). This two-year study resulted in a comprehensive synthesis of research findings that suggest there are new approaches to instruction that "make it possible for the majority of individuals to develop a deep understanding of important subject matter" (p. 6). This growing body of knowledge, which the authors called the science of learning, emphasizes the importance of customizing the instruction to the preexisting knowledge of each individual learner, helping learners take control of their own learning, and developing deep understandings of the subject matter. Both design theory and descriptive theory are offered regarding the design of learning environments that are learner centered, knowledge centered, assessment centered, and learning-community centered. Technology also plays a central role in such learning environments and in design theory to guide creation of such environments. There is much overlap between this line of work and the APA learner-centered psychological principles in terms of the research-based design theory offered by each.

New Paradigm of Instructional Theory

A third line of work was undertaken by Reigeluth in volume 2 to summarize and compare a broad range of instructional design theories that fit the learner-centered paradigm of instruction (Reigeluth, 1999). This included design theories for fostering a wide range of kinds of human learning and development, namely cognitive, physical, affective, and integrated learning of all those types. It also included a wide range of methods, such as problem-based, collaborative, self-directed, individualized, discussion-based, and much more. Again, there is great overlap between this line of work and the first two.

Other Work

We are particularly impressed with Rand Spiro's cognitive flexibility theory (Spiro et al., 1992) and his observation that information-age (or "post-Gutenberg") technologies both require and facilitate a different worldview (or frame of mind) and a different style of thinking, through prefigurative schemas (schemas for the development of schemas). This has important implications for dramatic changes in the goals of education, as well as the means, as we evolve deeper into the information age. Other lines of work include personalized learning (Clarke, 2003; Keefe, 2007), brain-based learning (Caine, 2005; Caine & Caine, 1997), and differentiated instruction (Tomlinson, 1999, 2001, 2003). Of course, there is much additional work that has been done by researchers that contributes valuable elements of a comprehensive design theory for learner-centered instruction that is frequently made possible only by advanced technologies. This book attempts to identify and synthesize new work as knowledge that educators can utilize to improve learning for all students.

The Nature of Instructional Theories: Constructs and Terms

Instructional theorists often use different terms to refer to the same constructs and the same term to refer to different constructs. This is confusing for researchers, practitioners, and graduate students, and it is the most obvious indicator of the lack of a common knowledge base. Therefore, as a first step to building a common knowledge base for instructional theory, it would be helpful to reach some consensus on constructs about the nature of instructional theory and terms for those constructs.

To initiate this first step, we engaged in several rounds of a Delphi process (Adler & Ziglio, 1996) in which we sent out a list of constructs and terms to a sample of leading instructional theorists to try to build some consensus. A total of 53 e-mail invitations to participate in the Delphi were sent to authors of chapters in all three volumes of *Instructional-Design Theories and Models*, and to other well-known instructional theorists. The e-mail asked them to read a preliminary version of the terms and definitions that we felt might be best and to click on a link to answer four questions online about the constructs and terms *they* felt were best for the discipline of instructional theory. The Internet was used to ensure anonymity for their responses, thereby encouraging complete frankness. The response rate on the first round was low (16%), which we believe was, in part, due to our attaching a 3-page preliminary version of terms and definitions to the e-mail. We suspect that participants felt it would take too much time to open and read and review a document prior to taking the survey.

Delphi Results: Round 1

The results of the first round of the Delphi were varied, though most (6 of 9) respondents saw *instructional theory* as the best term to represent the knowledge

base about ways to facilitate human learning and development. However, *learning and performance technology* and *instructional model* were also supported. There was a certain amount of criticism of the terms *instructional-design theory* and *instructional-development design theory* as being "unwieldy," though clearly descriptive. An alternative term, *instructional design principles*, was offered during round 1. Suggesting that we link with other design disciplines was another idea offered by three of the nine participants in round 1. In some cases, participants felt that the definitions needed to remain somewhat fuzzy and not get too specific. In other cases, the participants really wanted to narrow the definitions that were seen as too broad, such as for "instructional situation." One participant felt uncomfortable about the entire survey, indicating, "I do not believe in instructional theories of any kind...." There was also a sense that stronger contrasts were needed among the definitions that were provided for the terms. Finally, respondents to round 1 generally did not find any additional new terms they thought should be added, but did caution us about being too ambitious in terms of the possibilities of this Delphi leading to consensus. As one respondent wrote,

> What you are hoping to achieve is consensus. That won't happen.... Learning is such a complex phenomenon that shares little common variance with instruction. Micro-macro is overly simplistic (even if we include meso). They are too arbitrary. Learning aggregates in many ways, depending on activity, interests, needs. You can use those terms to describe aggregates, but unfortunately, such categories have a tendency to become self-fulfilling prophecies.

Two respondents were concerned that we were not sufficiently tuned in to the need for, and power of, localized and flexible definitions.

> In general, it is useful to have definitions, but I would add some caution with regard to this task. Definitions should be regarded with some degree of fuzziness and not held too rigidly. When definitions prove useful and enlightening, great—when they become burdensome and are used to badger people, then they have outlived their usefulness.

Delphi Results: Round 2

The second round Delphi took the responses from the first round and carefully represented them to the same 53 participants, whether or not they had participated in round 1, for further refinement of the terms and definitions of importance in instructional theory. We sent no attachments, and we achieved a higher response rate (39%).

A few reasons were given by some of the people who did not participate in either round of the study. A few challenged the very notion that we, as a field, really need to have further clarification of terms and constructs. Several stated that they were no longer active in the field and felt that the opportunity to help

define the terms should be reserved for those who are currently engaged in the field. In addition, some felt that, during the second round, the choices were too narrowly defined or circumscribed. One respondent who did participate sent feedback indicating that he felt the answers were "predetermined and restrained" and suggesting that it was impossible to "define an enterprise as complex and dynamic as ours."

Despite these few criticisms, we found that a considerable degree of consensus was reached among those who participated, and therefore we believe that the results are an important step in the process of reaching some consensus on constructs and terms for a common knowledge base in instructional theory.

In Round 2 the largest number of respondents (n = 10 or 45%) again felt that *instruction* is the proper term to refer broadly to all ways of facilitating human learning and development (see Table 1.1). However, the term *education* also enjoyed some support (n = 5 or 22%). Most of the respondents felt that the term *design theory* (n = 12 or 54%) was the appropriate term to characterize sets of goal-oriented, normative, artificial-science principles. However, the term *instructional theory* only enjoyed 18% (n = 4) support, while there was strong support for *learning sciences* as a more appropriate alternative to instructional theory (n = 7 or 32%). During the initial round of the Delphi there was a suggestion that there was no need for "design theories" to be part of the label for different kinds of instructional theory (e.g., instructional-development design theories), but rather to make things less awkward by simply saying "instructional development theories." There was mild support for this by the broader round 2 Delphi respondents, with an average of 3.1 (meaning "neutral") on a Likert scale of 1–7 (with 1 being strongly agree). There was broad support for greater recognition of the ways the word *design* has been used in related fields (average 2.5 agreement on the Likert scale). Similarly, there was support for explicit recognition of the evolutionary nature of definitions themselves as changes in technology and context accompany definitional refinement (average 2.3) (see Table 1.1).

Thus, while this Delphi study did not enjoy as high a response rate as we might like, there was consensus among respondents around some terms for use in our field. There was also clear support for flexible definitions and giving greater importance to design theories in the field.

Recommended Constructs and Terms

Following is the description of constructs and terms that resulted from this process, though we hasten to add that these are offered as a suggestion to theorists, and we encourage those who believe they have a better term or definition to propose it to the community of instructional theorists. Furthermore, we expect that some of these constructs and terms, even if accepted now, will evolve over time. Examples of the following constructs are identified with editors' notes in the theory chapters that follow (chapters 5–9 and 10–13).

Perhaps the most important construct is defined as "all things that are done

Table 1.1 Delphi Round 2 Results

Question	Responses	Comments/Interpretation
What term should be used to refer broadly to "all ways of facilitating human learning and development? (Selecting more than one option was permissible.)	10 - Instruction 5 - Education 1 - Education engineering or learning design 1 - Training 1 - Facilitating learning and development 3 - Numerous terms 1 - Learning opportunities 1 - Not sure	These terms were provided by round-I respondents
What term should be used for the knowledge base associated with human learning and development?	7 - Learning sciences 5 - Education 4 - Instructional theory 4 - Other 2 - Instructional design principles 2 - Instructional design theory 1 - Learning and performance technology 0 - Instructional model 0 - Learning environments 0 - Instructional science	It is interesting that the group felt that "learning sciences" was a better term than "learning theory" for the descriptive knowledge base.
Given Simon's distinction between the natural sciences and the sciences of the artificial, if "descriptive theory" is the term used to characterize sets of natural-science principles, what term should be used to characterize goal-oriented, normative, artificial-science principles?	12 - Design theory 2 - Design 2 - Prescriptive theory 1 - Technological theory 1 - Read Stokes, Pasteur's Quadrant 1 - Not sure	Design theory is clearly the most preferred term for this construct; there is considerable agreement here.
It is not useful to have "design-theories" as part of the label for the different kinds of instructional theory—just say "theories" (e.g. in "instructional development design-theories" just say "instructional development theories."	Average of 3.1 on a 7-point Likert scale (n=20)	This seems, on the face of it, very middle of the road, but when compared with the neutral rating of 4, it does represent some small level of agreement.
We need further recognition and acknowledgement of the contributions and the ways "design" has been used in other related fields.	Average of 2.5 on a 7 point Likert scale (n=20)	Respondents generally agreed with this finding from round I.
We need, as a field, to explicitly recognize the evolutionary nature of definitions (that they change as technologies, goals, and our context change).	Average of 2.3 on a 7 point Likert scale (n=20)	Consensus for flexible definitions over time

to facilitate learning," for those are the tools that an instructional theory offers to accomplish its goals. The next most important construct is defined as "all factors that help one to decide when each of those tools should and should not be used." All elements of any instructional theory can be categorized as one or the other of these two constructs.

1. *Instructional method*: Anything that is done purposely to facilitate learning or human development.
   Other terms often used for part or all of this construct include strategy, technique, tactic, and approach.
2. *Instructional situation*: All aspects of an instructional context that are useful for deciding when and when not to use a particular instructional method. Each individual aspect of the context is referred to as a "situationality." Collectively, they are the "situation."[5]
   Other terms often used include context and condition.

Instructional methods can vary in several ways, each of which is an important construct for instructional theories. They are as follows.

1.1 *Scope* of a method: The amount of instruction with which a method deals.
   While this is really a continuum, it is often divided into three major levels (van Merriënboer, 1997):
   1.1.1. Micro: Instruction on an individual skill or understanding, such as a sequence of examples and practice.
   1.1.2. Meso: Instruction on a single unit (or cluster of related skills and understandings), such as a sequence of types of cases for a complex cognitive task.
   1.1.3. Macro: Instruction on a course (or even a curriculum), such as a sequence of different types of complex tasks.

1.2. *Generality of a method*: The breadth of instructional situations in which a method should be used.
   This is a continuum that ranges from high to low or universal to local. Other descriptors include pervasive, common, restricted, rare, narrow, and local.

1.3. Precision of a method: The level of detail of the description of a method.
   Precision is a reflection of the componential nature of methods. A description of a method typically can be broken down or elaborated into more precise descriptions of the method for facilitating learning. While this characteristic is commonly referred to as a general-versus-

5. The situations in which a whole instructional theory should be used are referred to as "preconditions" (see Reigeluth, 1999, chapter 1).

detailed distinction among descriptions of a method (or a general-to-detailed continuum of descriptions of a method), "general" can be confused with the generality of a method itself (versus its description; see 1.2), so we prefer the term precision of a description of a method (imprecise-to-precise continuum). The level of precision is influenced by three constructs:

1.3.1. *Parts: More precise descriptions that describe pieces that, when combined, make up the method.*

1.3.2. *Kinds: More precise descriptions that describe alternatives from which one must choose in using the method.*

1.3.3. *Criteria: More precise descriptions that provide criteria for making a decision regarding the method.*

1.4. *Power of a method*: The amount a method contributes toward the attainment of the learning goal for which it was selected.

Using any particular instructional method does not ensure that the learning goal will be attained, for there are many factors that influence whether or not learning occurs. Some methods are more powerful than others in fostering learning. Every method contributes a certain amount to the probability that learning will occur. The power contribution of any given method can vary from very low (or even zero) to very high (though never reaching a probability of 1.0).

1.5. *Consistency of a method*: The reliability with which a method contributes its power toward the attainment of the learning goal for which it was selected within the situations for which it is appropriate.

Whereas power is similar to the concept of between-group variance in statistics, consistency is related to the concept of within-group variance. A method may be highly consistent in contributing a given amount of power toward the attainment of a learning goal within the situations for which it is appropriate, or it may be highly inconsistent in the amount of power (or probability) it contributes. In other words, the probability that the method contributes toward learning may be very high in some situations, but only moderately high in other situations for which it is still appropriate to use. The consistency of a method (or the variability of its power) within appropriate situations may range from low to high. Regarding generality and precision, it is helpful to note that the more precise (or detailed) a method, the less general (or more situational) it is.

Instructional situations, like instructional methods, can vary in several ways, each of which is an important construct for instructional theories. They are as follows.

2.1. *Values*: The elements of instruction that are deemed important by an instructional theory but are a matter of opinion rather than a matter that can be empirically verified.

The complete set of values underlying a theory of instruction represents a philosophy of instruction. It is helpful to ensure alignment of values about instruction across all stakeholders. Therefore, values about instruction should be made explicit for every instructional theory, to aid in selection of an appropriate instructional theory. The values of the designer are less important than the values of the "owners" of the instruction, the teachers, the learners, and the other beneficiaries (e.g., employers and communities). We have identified four major kinds of instructional values.

2.1.1. *Values about learning goals:* Statements about which learning outcomes are valued philosophically (opinion). These stand in contrast to identifying goals empirically through a needs analysis.

2.1.2. *Values about priorities:* Statements about which priorities should be used to judge the success of the instruction. These were formerly called "instructional outcomes" in volumes 1 and 2 (Reigeluth, 1983, 1999), but that term led to a misunderstanding of the construct. Values about priorities address the relative importance of the effectiveness, efficiency, and appeal of the instruction as criteria for judging how good the instructional methods and guidelines are.

2.1.3. *Values about methods:* Statements about which instructional methods are valued from a philosophical point of view (opinion). These stand in contrast to selecting methods empirically based on research results.

2.1.4. *Values about power:* Statements about who is given the power to make decisions about goals, priorities, and methods.

While values about power could be viewed as subcategories of the three other kinds of instructional values, we believe power is such an important issue that it deserves a category of its own. Learner empowerment is an integral part of the whole concept of an information-age, learner-centered paradigm of instruction (see Reigeluth, 1999), but different amounts of empowerment are often appropriate for different situations, making empowerment a method variable (that spans goals, priorities, and methods), as well as a value.

2.2. *Conditions*: All other factors that influence the selection or effects of methods.

The word *context* has a similar meaning, but not all aspects of context influence when a method of instruction should and should not be used. For example, one could find oneself in a context of low socioeconomic standing (SES) and find that this situation has a major impact on what instructional method should be used, or it may not have such an impact, as many things are taught in similar ways regardless of student SES or

community poverty. On the other hand, there are times when context is very important and should affect our instructional choices. We have identified four major kinds of instructional conditions.

2.2.1. *Content:* The nature of what is to be learned, defined comprehensively to include not only knowledge, skills, and understandings, but also higher-order thinking skills, metacognitive skills, attitudes, values, and so forth.

2.2.2. *Learner:* The nature of the learner, including prior knowledge, learning styles, learning strategies, motivations, interests, and so forth.

2.2.3. *Learning environment:* The nature of the learning environment, which includes human resources, material resources, organizational arrangements, and so forth.

2.2.4. *Instructional development constraints:* The resources available for designing, developing, and implementing the instruction, including money, calendar time, and person hours.

Figure 1.2 shows a summary of these constructs. While each of these constructs can and should be further broken down into additional constructs, if instructional theorists would use these constructs and terms in describing their instructional theories, that would represent an important step in building a foundation, or common knowledge base, to which instructional theorists and researchers could add, and it would help practitioners and graduate students understand the knowledge available to them. Yet, as our Delphi study pointed

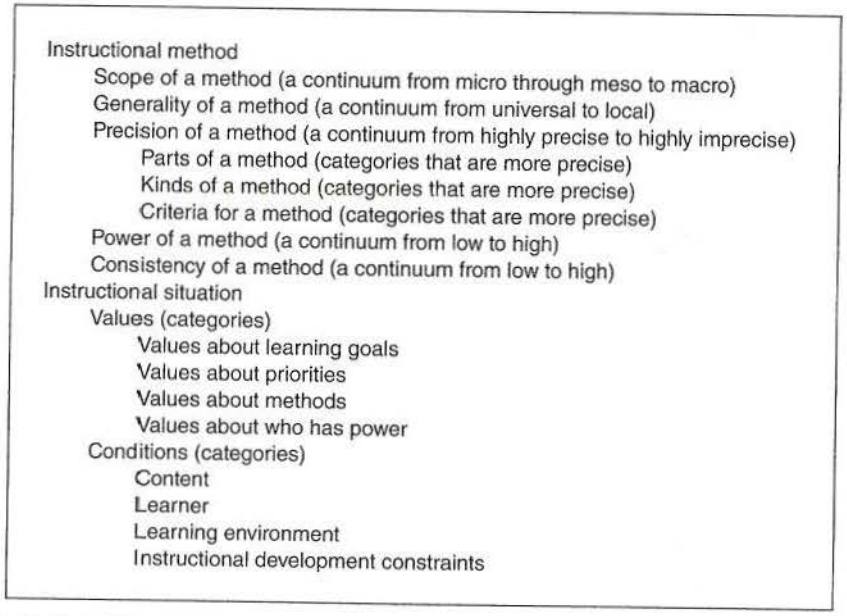

Figure 1.2 Constructs about the Nature of Instructional Theory

out, it is important to always keep in mind that an evolving field must have evolving constructs and evolving terminology. These terms and constructs are offered as a beginning point for building an ever-evolving consensus on terms and constructs.

In this chapter we offered a definition of *instruction and have started the significant task of creating a common knowledge base and language about instruction.* We described six different kinds of theories related to instruction (event, analysis, planning, building, implementing, and evaluation theories) and contrasted them with other related kinds of theories (student-assessment, curriculum, and learning theories, as well as learning science and instructional science). Then we discussed Gibbons and Rogers's concept of "layers of design" (see chapter 14) and their implications for instructional theory. Next, we turned our attention to the role of instructional theory in educational reform, and discussed the relationship of learner-centered instruction to this book. Finally, we presented the results of a Delphi study and offered particular constructs and terms for a common knowledge base about instruction. These terms may be useful as a foundation upon which instructional theorists and researchers can build, and they should help you, whether you are a practitioner, a researcher, or a graduate student, to understand the knowledge available to you about fostering learning more effectively.

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2
Understanding Instruction

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