Instructional-Design Theories and Models Volume III

Building a Common Knowledge Base

Edited by

Charles M. Reigeluth

Alison A. Carr-Chellman

Routledge
Taylor & Francis Group

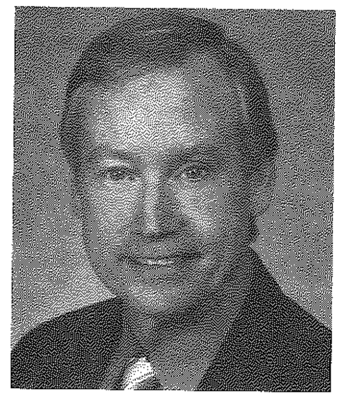
2009

TAYLOR AND FRANCIS, PUBLISHERS
New York and London

17
Theory Building

CHARLES M. REIGELUTH
Indiana University

YUN-JO AN
Texas A&M University, Texarkana



Charles M. Reigeluth received a BA in economics from Harvard University. He was a high school teacher for three years before earning his doctorate in instructional psychology at Brigham Young University. He has been a professor in the Instructional Systems Technology Department at Indiana University's School of Education in Bloomington since 1988, and served as chairman of the department from 1990 to 1992. His major area for service, teaching, and research is the process for facilitating district-wide paradigm change in public school systems. His major research goal is to advance knowledge to help school districts successfully navigate transformation to the learner-centered paradigm of education. He has published nine books and over 120 journal articles and chapters. Two of his books received an "outstanding book of the year" award from Association for Educational Communications and Technology (AECT). He also received AECT's Distinguished Service Award and Brigham Young University's Distinguished Alumnus Award.

Yun-Jo An received her PhD in instructional systems technology from Indiana University, Bloomington. She worked for an e-learning company, Option Six, as an instructional designer. She is currently Assistant Professor of Instructional Technology at Texas A&M University, Texarkana. Her research interests include designing digital learning environments, problem-based learning, games and simulations, and instructional theory building.

EDITORS' FOREWORD

Vision

- To provide guidance for developing instructional theory

Basics about Theory and Research

1. *Kinds of knowledge that need to be built*
   - *Both design theory and descriptive theory*
2. *A framework for building instructional theory*
   - *Functional contextualism utilizing multiple perspectives (eclecticism)*
3. *Kinds of research needed to build descriptive and design theory*
   - *Descriptive theory is concerned with validity and truthfulness.*
   - *Design theory is concerned with preferability and usefulness.*
   - *Design theory is advanced by research to prove (confirmatory) and by research to improve (exploratory or developmental).*
4. *When to use research to improve a design theory*
   - *The S curve of theory development*
   - *In early stages of development, use research to improve: formative research and design-based research.*
   - *In later stages of development, use both research to prove and research to improve.*

Approaches to Building Design Theory

1. *Data-based theory development*
   - *Identify boundaries for the instructional theory.*
   - *Observe what methods work and when (situationalities).*
   - *Conduct research to improve the theory.*
2. *Values-based theory development*
   - *Identify boundaries for the instructional theory.*
   - *Identify values you want the instruction to embody.*
   - *Search for imprecise methods that embody the values.*
   - *Elaborate the methods by identifying parts, kinds, and criteria, along with appropriate situationalities.*
   - *Conduct research to improve the theory.*
3. *Methods-based theory development*
   - *Select a general method and describe it on an imprecise level.*
   - *Identify boundaries for the instructional theory.*
   - *Elaborate the methods by identifying parts, kinds, and criteria, along with appropriate situationalities.*
   - *Conduct research to improve the theory.*
4. *Practitioner-driven theory development*
   - *Identify boundaries for the instructional theory.*
   - *Explicate tacit knowledge using case recall.*
   - *Elaborate the methods by identifying parts, kinds, and criteria, along with appropriate situationalities, again using case recall.*
   - *Identify variations in the methods, and the situationalities that call for each.*
   - *Conduct research to improve the theory.*

Approaches to Research on Design Theory

1. *Grounded theory development*
   - *It focuses on inductive processes of theory development without formulating hypotheses in advance.*
   - *Glaser's approach includes: (no preresearch literature review), data collection (qualitative and/or qualitative), open coding, constant comparison, selective coding, theoretical coding, theoretical memoing, and sorting and writing up.*
   - *Strauss and Corbin's approach includes: a preresearch literature review, qualitative data collection only, and different coding processes (open coding, axial coding, and selective coding).*
2. *Design-based research (DBR)*
   - *Characteristics: Driven by theory and prior research, pragmatic, collaborative, contextual, uses multiple dependent variables, is integrative, entails systematic and comprehensive documentation, is iterative, is adaptive/flexible, and seeks generalization.*
   - *Principles: Support design with research, set practical goals and initial plan, do in real-world settings, collaborate closely with participants, do systematically and purposefully, analyze data immediately and continuously, refine designs continually, document contextual influences, and validate generalizability of the design.*
   - *Guidelines: Identify a real-world problem, review literature and set theory development goals, develop a partnership with practitioners, identify dependent and independent variables, develop initial research plan, develop and implement a design, record the design process, collect data, evaluate the design, revise the design, repeat the process, and report the results.*
3. *Formative research*
   - *Purpose: Is intended to improve three things—a particular case, an instructional theory related to that case, and descriptive theory related to the instructional theory.*
   - *Activities: Evaluate the case to identify strengths, weaknesses, and likely improvements for all three; look for variations in methods and their accompanying situationalities; implement and test likely improvements in the case; explore causal dynamics; and suggest potential improvements in the design and descriptive theories.*
   - *It can be used to develop a new design theory or improve an existing design theory and can be used in designed cases, past naturalistic cases,*

and current naturalistic cases. Each of these uses requires variations in the formative research method.

—CMR & ACC

THEORY BUILDING

Building a common knowledge base requires deep understanding of the nature of theories and of the kinds of research that can help us build design theories. In this chapter, we begin by discussing some basics about theory and research. Then we describe four approaches that could be used to build design theory, followed by three approaches that could be used to do research for developing design theory.

Basics about Theory and Research

In this section we discuss: (1) what kinds of knowledge need to be built; (2) what framework is helpful for building instructional theory; (3) what kinds of research are needed to build descriptive and design theories; and (4) when one should use research to improve rather than to prove a design theory.

1. What Kinds of Knowledge Need to Be Built?

Chapter 1 distinguished between design theory and descriptive theory. It explained that *design theory* is a kind of knowledge that identifies the best available methods for accomplishing given goals within given situations. Therefore, it is instrumental knowledge. In contrast, chapter 1 also explained that *descriptive theory* is a kind of knowledge that identifies the causal dynamics that occur within given situations. Therefore, it is descriptive knowledge. Simon (1996) refers to these two types of knowledge as the sciences of the artificial and the natural sciences, respectively. Similar distinctions include applied vs. basic research, engineering vs. science, and technology (broadly defined) vs. science.

However, chapter 1 also explained that these two kinds of knowledge are inextricably interrelated, and most instructional theorists find value in building both kinds of knowledge, often simultaneously. Dewey (1900) described design theory as a "linking science" between learning theory and educational practice. Design theory provides direct guidance for accomplishing one's goals, but descriptive theory provides an understanding or rationale for why that guidance works. Theorists find that developing powerful means to accomplish a goal (design theory) helps them to identify important causal dynamics (descriptive theory) to study, and conversely that discovering important causal dynamics helps them to identify more powerful means to accomplish one's goals.

Therefore, we recommend that those who wish to contribute to knowledge about instruction (including practitioners as well as researchers) attempt to build both kinds of knowledge simultaneously. Since much has been written about how to build descriptive knowledge, we focus in this chapter on how to build design knowledge.

2. What Framework Is Helpful for Building Instructional Theory?

Over the past decade there has been much debate about behaviorism, cognitivism, and constructivism as theoretical frameworks for instructional theory. This debate has generally had a positive impact on the development of the field. However, the radical view that there is one best theoretical perspective has, in our view, had a damaging effect on instructional theory, for it denies the multiple perspectives that are so strongly advocated by constructivists. We have found that all theoretical perspectives make some valuable contributions, or they would not have a following. Holding multiple theoretical perspectives provides a practitioner with a wide variety of instructional "tools" in their toolbox for dealing most effectively with any given instructional situation they encounter.

In essence, we believe that eclecticism, an approach founded in multiple perspectives, is the best approach. This is a *functionalist* view of design theory, a view that advocates using whatever works (functions) best. This is also a *contextual* view of design theory, a view that recognizes that what works best will vary from one situation to another. Therefore, we enthusiastically support the use of *functional contextualism* as a theoretical or even philosophical framework to help in building instructional theory.

Functional contextualism provides "theoretical clarity and philosophical cohesion" (Fox, 2006, p. 6) for understanding instruction and instructional theory, and therefore for building instructional theory. According to Reigeluth and An (2006), it encourages us to focus on producing practical knowledge applicable to similar situations and also provides a philosophical foundation and framework for generating goal-oriented design theories. Functional contextualism is "well suited to the needs of a goal-oriented discipline dedicated to improving the means of fostering human learning and development" (Reigeluth & An, 2006, p. 52).

3. What Kinds of Research Are Needed to Build Each Kind of Knowledge?

Descriptive theory's primary research concern is *validity*: how well do the descriptions (usually of complex causal dynamics) match with reality? In contrast, design theory's primary research concern is *preferability*: which methods are better than the known alternatives for accomplishing given goals under given conditions (see chapter 1). Some students are likely to learn from almost any method of instruction, no matter how poor, so the issue is not whether a method is "valid," but whether it is preferable to other known methods. This is why Richard Snow (1977) characterized design theory as being concerned with *usefulness*, in contrast to descriptive theory's concern with *truthfulness*.

A key point is that design theory's concern with preferability presents different methodological challenges from descriptive theory's concern with validity. Since much has been written about research methods and methodological challenges for building descriptive theory, we will focus here on methods and challenges for building design theory. Here, the research question is not whether a method works, but how well it works and how it can be made to work better. Therefore, for design theory there are two major kinds of research that can be done: research to *prove* and research to *improve*. Research to *improve* focuses on knowledge to advance a given method's ability to achieve given goals under given conditions. In contrast, research to *prove* focuses on knowledge to confirm that a given method is of high quality, which can be assessed in either a relative or absolute way. An absolute assessment of quality measures the method against a standard, whereas a relative assessment measures it against the known alternatives. Research to improve is *exploratory* or *developmental*, whereas research to prove is *confirmatory*. The former is concerned with theory development, while the latter is concerned with theory testing.

4. When Should One Use Research to Improve a Design Theory Rather than Research to Prove a Design Theory?

Every design theory (or system, or technology, broadly defined) undergoes a predictable pattern of development characterized by an "S curve" (Branson, 1987): its effectiveness increases at an accelerating rate for a while, and then it increases at a decelerating rate as it approaches its upper limit (see Figure 17.1). Different theories (or systems) have different upper limits. When a method is in its early stages of development (see Theory 2 at T1 in Figure 17.1), it is premature

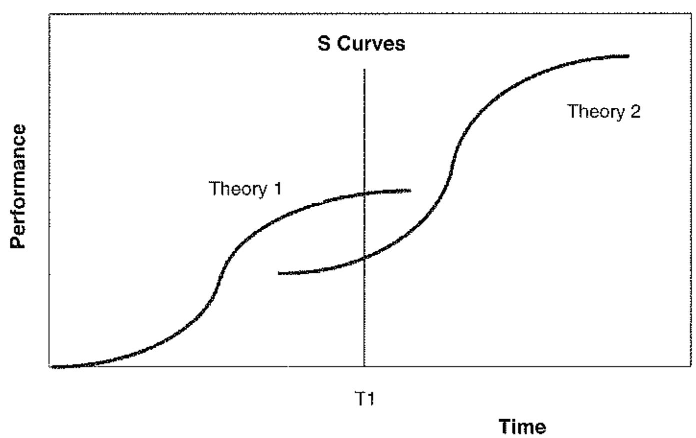


Figure 17.1 The S Curves of Development for Two Instructional Theories

to compare it with alternative methods that are at more advanced stages of development (Theory 1 at T1 in Figure 17.1), because premature comparison can result in abandoning further development that could have resulted in a method superior to the alternatives.

Therefore, research to *prove* that one method is better than another should generally be done only when the methods are at fairly similar, and advanced, stages of development. Experimental designs are highly appropriate for this kind of research. In contrast, research to *improve* a method or design theory is the most productive kind of research when the method or theory is in the earlier stages of its development (e.g., Theory 2 at T1 in Figure 17.1). Evaluation research designs, especially formative research and other kinds of design-based research, are highly appropriate for this kind of research. Therefore, an important need in our field today is not just to work toward development of a common knowledge base with a consistent terminology, but to continually improve that common knowledge base through formative or design-based research.

In the remainder of this chapter we will describe various approaches for developing instructional theories, followed by a description of design-based research and formative research for continually improving such theories. Some guidance for developing descriptive theories is offered by Eisenhardt (1989), Lewis and Grimes (1999), and Weick (1989).

Approaches to Building Design Theory

There is probably an infinite number of ways one can build instructional theory. In this section, we discuss four approaches: data-based (or grounded), values-based, methods-based, and practitioner-led theory construction. Then in the following section, we discuss three research methods that are useful tools for these approaches to theory construction.

1. Data-Based Theory Development

One of the most common approaches to developing design theory is to build it inductively from data, based on what works well. This approach commonly uses a research method called "grounded theory development" (Glaser & Strauss, 1967), which is described in some detail in the next section. However, when the focus of research is to improve rather than to prove, this data-based theory development process should go beyond the grounded theory development guidance to observe, and also try out different methods (or different variations on a method), revise those methods based on formative data, and try them out again. Cycles of trial and revision are key to research that is focused on improving a design theory of any kind. Design-based research and formative research, which are also described in some detail in the next section, are valuable research methods for doing this. We offer the following general guidelines for data-based theory construction, based on our experience with this approach at Indiana University.

Identify Boundaries Start by identifying the boundaries for the instructional theory. For what kinds of conditions is it intended (kinds of content, learners, and learning environments)? For what conditions is it not intended? This restricts the generality of the theory (see chapter 1). The data-based approach typically starts with tight boundaries (a narrow range of conditions), and after achieving a high level of usefulness for that domain, gradually broadens the boundaries and tests and revises the methods and situationalities to accommodate the new conditions.

Observe What Methods Work and When Next, using the grounded theory development method as a guide, you should observe some instruction that is taking place within the boundaries of your theory. The instruction may be designed by someone else for their own purposes or by you for the express purpose of developing your theory. The observations should identify which methods work well (or the best), and if they don't always work well, what situationalities influence when they work well. You should describe the methods in as much detail as a typical practitioner would need to use them well. It may help to interview the teacher afterwards to find out the thinking that guided his or her selection and application of the methods.

Conduct Research to Improve Finally, it is time to look for ways to improve the methods. Using formative research and other kinds of design-based research as a guide, you should use observations and interviews to identify ways that the methods could possibly be improved and to gain greater clarity on when (in what situations) each should and should not be used.

2. *Values-Based Theory Development*

Values play a central role in design theories (see chapter 1), and they can play the primary role in theory development. Values can guide the selection of learning goals that the instructional theory will address. They can guide the choice of some criteria for judging how good the methods are (effectiveness, efficiency, and appeal), identified as "priorities" in chapter 1. They can guide the choice of other criteria for judging how good the methods are (philosophical point of view). And they can guide the decisions about who will have the power to make either the choices just listed or the choices that take place during the instruction (see chapter 1). We have not been able to find much written about a values-based theory development process, so we again offer some guidelines based on our experience with this approach.

3. *Identify Boundaries*

Start by identifying the boundaries for the theory. For what kinds of conditions is it intended (kinds of content, learners, and learning environments)? For what conditions is it not intended? This restricts the generality of the theory (see chapter 1).

Identify Values Then identify the values you want the instruction to embody. This should include values about learning goals (e.g., it is important to develop learners' ability to reflect on their learning process), priorities (e.g., it is more important that the instruction be motivating than efficient), methods (e.g., it is important to provide a lot of support and scaffolding for the learner), and power (e.g., it is important to provide learners with some control over both what to learn and how to learn it) (see chapter 1).

Search for Methods Next, you should look for general approaches (called imprecise methods in chapter 1) that embody those values. Don't try to be very detailed or precise at this point about the methods. Think in terms of broad strokes, and try to prioritize the alternative methods based on how well they embody the values and are appropriate for the conditions.

Elaborate the Methods Now the imprecise methods need to be elaborated to greater precision. As described in chapter 1, this is done by identifying (1) parts of each method; (2) kinds of each method or part; or (3) criteria for applying each method. We recommend that this elaboration be done in cycles that span the full range of parts of the method, beginning with relatively imprecise descriptions of the method(s) and progressing to ever greater levels of precision. From a systems thinking perspective, each part of the method must be designed in consideration of the other parts, so that all the parts will work synergistically. So generally it is better if the level of precision for one part of the method does not get too far ahead of that of the other parts. Furthermore, whenever a method is broken into kinds of that method, those kinds are alternatives from which a designer must choose. Therefore, you should identify the situationalities (situational variables) that represent the basis for choosing, so that you can formulate guidelines about when and when not to use each kind.

Conduct Research to Improve Finally, it is time to see how well those methods work and identify ways to improve them. Formative research and other kinds of design-based research are valuable tools for doing this.

4. *Methods-Based Theory Development*

Instructional methods are the most important part of any instructional theory, because the best selection and use of them is the purpose of an instructional theory (see chapter 1). Therefore, they can play the primary role in theory development. To some extent, the methods-based theory development process can be viewed as a hybrid between the values-based and data-based approaches, because the choice of a method as the starting point for your theory tends to be based heavily of both values and experience. We have not been able to find much written about a methods-based theory development process, so we offer some guidelines based on our experience with this approach.

Select a General Method Start by selecting a general method or methods that you think are likely to be important or useful. As just mentioned, this tends to be strongly influenced by your values and experience. As with the values-based approach, don't try to be very detailed or precise at this point about the methods. Think in terms of broad strokes.

Identify Boundaries Then identify the boundaries for the theory, by trying to imagine the situations (called preconditions) in which you would likely want to use the general method—and trying to imagine the situations in which you would likely not want to use it. The boundaries will later need to be empirically verified.

Elaborate the Method Now the imprecise methods need to be elaborated to greater precision, in the same manner as described for the values-based approach, including the identification of situationalities whenever a method is broken into kinds.

Conduct Research to Improve Finally, it is time to see how well those methods work and identify ways to improve them. Again, formative research and other kinds of design-based research are valuable tools for doing this.

5. *Practitioner-Driven Theory Development*

Those who use methods of instruction in their work can gain powerful insights into what methods work well and when they work well. They intuitively develop a theory of instruction based on their practice to guide their practice. However, this is often tacit knowledge and is seldom shared with other practitioners or researchers. This is a terrible waste of opportunity to advance our collective knowledge about how to create powerful instruction. Therefore, we strongly encourage all practitioners to contribute to our collective knowledge by using a theory development approach such as the following.

Identify Boundaries Start by identifying the range of situations for which you would like to offer instructional guidance. This may be as narrow as "teaching algebra to ninth graders over the Internet," or as broad as "developing deep understandings in children and adults."

Explicate Tacit Knowledge Next, imagine yourself in a fairly common specific situation—teaching a specific topic or skill to a specific learner or learners in a

specific learning environment—within the boundaries of your theory. Go through the process from beginning to end in your mind, and write down the methods at each stage of the process. Also, think if there are general principles that apply more broadly to one particular stage of the process.

Elaborate the Methods Now elaborate those methods to greater precision, in the same manner as described for the values-based approach, including the identification of situationalities whenever a method is broken into kinds, except do so by continuing to imagine yourself in the same specific situation.

Broaden the Methods and Situations Imagine other situations (content, learners, or learning environments) within the boundaries of your theory, and identify ways that the original methods should differ. Describe both the variations in methods and the situations that call for each variation. Elaborate those variations in the same manner as for the initial methods.

Conduct Research to Improve Finally, it is time to test those methods and identify ways to improve them. Again, formative research and other kinds of design-based research are valuable tools for doing this.

6. *Section Summary*

In summary, there are many different ways to develop an instructional theory. The four described here are the ones we have found most useful, but don't hesitate to experiment and come up with your own approach. These four approaches use many of the same activities, but in different orders or with different emphases. Selection of an approach should depend primarily on personal experiences and preferences. For example, if you feel strongly that a philosophy or set of values should influence your theory, then the values-based approach will likely work best for you. If you like a particular method, then you will probably select the

Table 17.1 Four Approaches for Constructing Instructional Theory

Grounded theory development	Identify boundaries		Observe what works and when		Do research to improve the theory
Values-based theory development	Identify boundaries	Identify values	Search for methods	Elaborate the methods	Do research to improve the theory
Methods-based theory development	Select a general method	Identify boundaries		Elaborate the methods	Do research to improve the theory
Theory development for practitioners	Identify boundaries	Explicate tacit knowledge	Elaborate the methods	Broaden the methods and situations	Do research to improve the theory

methods-based approach. If you have a lot of experience teaching in a certain area, then the practitioner approach should work best. And if you don't have much experience or many preconceptions about what the instruction should be like, the inductive, grounded-theory approach will likely work best for you. Table 17.1 summarizes the main activities for these four approaches.

Approaches to Research on Design Theory

There are many research methods that can help you to build instructional theory. In this section, we discuss three methods: grounded theory development, design-based research, and formative research.

1. Grounded Theory Development

Grounded theory is a research method developed by Barney Glaser and Anselm Strauss that seeks to generate theory from empirical data through both inductive and deductive reasoning processes. In grounded theory, the researcher constantly compares conceptualized data and may also try to verify the hypotheses generated by constant comparisons of data (Glaser & Strauss, 1967). Grounded theory is distinguished from other research methods in that it focuses on inductive processes of theory development without formulating hypotheses in advance (Glaser & Strauss, 1967; Patton, 2002).

With disagreement between Glaser and Strauss on how to do grounded theory (Glaser, 1992; Strauss, 1987; Strauss & Corbin, 1990), two different approaches have emerged.

Glaser's Approach

According to Glaser, grounded theory is not a qualitative research method but a general method that can use any kind of data (Glaser, 2001, 2003). His approach highlights the "emergence" of conceptual hypotheses from empirical data. The following are its major features.

No Preresearch Literature Review Glaser recommends that the researcher refrain from conducting a preresearch literature review that may give preconceptions about the study, and read the literature in the sorting stage treating it as data to code. He insists that "there is a need not to review any of the literature in the substantive area under study" (Glaser, 1992, p. 31).

Data Collection According to Glaser, all is data. The researcher can use any kind of data that he or she encounters (Glaser, 2001). Even television shows or informal chats with people can be used as data in grounded theory. Collected data are recorded in field notes for data coding.

Open Coding At the beginning of the study, the researcher starts with open coding, conceptualizing written data in field notes line by line. The coding is often done in the margin of the field notes. During open coding, substantive codes (categories and properties) are developed ad hoc (Glaser, 1978).

Constant Comparison The researcher constantly compares conceptualized data as he or she codes more data. In this process, coded data may be renamed or merged into new categories (Glaser & Strauss, 1967). The constant comparison of data enables the generation of theory through systematic data analysis.

Selective Coding After identifying the core category, the researcher systematically relates it to other categories. In the selective coding stage, the researcher selectively samples new data with the core category in mind (theoretical sampling), which is a deductive part of grounded theory (Glaser, 1998). For instructional theory, it is likely that the core category will be methods of instruction, and other categories are likely to include the situations in which the methods were used and how well they worked.

Theoretical Coding Theoretical coding is applying a theoretical model to the data. Glaser emphasizes that the theoretical model should not be forced but emerge during the process of constantly comparing the data. Theoretical codes "conceptualize how the substantive codes may relate to each other as hypotheses to be integrated into a theory" (Glaser, 1978, p. 72). For instructional theory, data about how well the methods worked might be used to offer guidelines about which methods to use in which situations.

Theoretical Memoing Theoretical memoing is a continual process conducted in parallel with data collection, coding, and analysis. A memo is a write-up of some hypotheses the researcher has about categories, properties, and their relationships (Glaser, 1998). For instructional theory, this could include hypotheses about which methods should be combined and how they should be combined, unless there are direct data available to guide such syntheses of methods into "package deals."

Sorting and Writing Up Once the researcher has reached theoretical saturation of the categories, he or she starts sorting memos. The sorted memos generate a theoretical outline that is close to the written grounded-theory product (Glaser, 1978). This would be the instructional theory in its full glory.

Strauss and Corbin's Approach

Strauss and Corbin (1990) define grounded theory as "a qualitative research method that uses a systematic set of procedures to develop an inductively derived grounded theory about a phenomenon" (p. 24). This more specific focus is in contrast to Glaser's view that grounded theory is not limited to the realm of qualitative methods (Glaser, 2001, 2003). Strauss and Corbin (1990) also propose conducting a pre-research literature review to identify categories and relate them in meaningful ways, mentioning that "all kinds of literature can be used before a research study is begun" (p. 56). The coding processes they suggest are different from Glaser's approach as well.

Open Coding The researcher identifies categories and their properties by examining field notes and other documents line by line or even word by word.

Axial Coding After open coding, the researcher conducts axial coding by making explicit connections between categories and their properties.

Selective Coding Selective coding involves identifying the core category and relating other categories to that core category. In the case of instructional theory, the core category would likely be methods of instruction.

For axial coding, Strauss and Corbin provide a well-defined coding paradigm which consists of "phenomena," "causal conditions," "context," "intervening conditions,"[1] "action strategies,"[2] and "consequences"[3] (Strauss, 1987, p. 32). The coding paradigm helps the researcher build an "axis" for generating theory and "think systematically about data and to relate them in very complex ways" (Strauss & Corbin, 1990, p. 99).

Glaser (1992) cautions researchers not to "force" categories on the data instead of allowing them to "emerge" by using concepts such as "axial coding" and "coding paradigms." However, the coding paradigm might be most useful to novice researchers who need clear guidance on how to structure data (Kelle, 2005).

These two approaches to grounded theory development (Glaser's and Strauss & Corbin's) are useful tools for data-based theory development, particularly for the "observe what works and when" stage of that process (see Table 17.1).

2. Design-Based Research (DBR)

DBR is "a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories" (Wang & Hannafin, 2005, pp. 6–7). We will describe the characteristics of DBR, principles that underlie it, and guidelines for conducting it.

3. Characteristics

DBR has the following characteristics:

1. *Editors' note: Equivalent to instructional situations in instructional theory.*
2. *Editors' note: Equivalent to instructional methods.*
3. *Editors' note: Equivalent to learning outcomes and instructional outcomes.*

- *It is driven by theory and prior research* (Cobb, Confrey, deSessa, Lehrer, & Schauble, 2003; DBRC, 2003; Edelson, 2002; Wang & Hannafin, 2005). DBR researchers seek to revise and refine the theory they selected at the outset, and they draw on prior research.
- *It is pragmatic* (Cobb et al., 2003; Collins, Joseph, & Bielaczyc, 2004; DBRC, 2003; Reigeluth & Frick, 1999; Wang & Hannafin, 2005). It is intended to refine both theory and practice, and the value of theory is appraised by the extent to which principles and concepts of the theory inform and improve practice.
- *It is collaborative* (Barab & Squire, 2004; Cobb et al., 2003; Collins et al., 2004; DBRC, 2003; Wang & Hannafin, 2005). DBR researchers collaborate and interact socially with practitioners in the design, implementation, and analysis aspects of the research.
- *It is contextual* (Collins et al., 2004; DBRC, 2003; Wang & Hannafin, 2005). DBR is conducted in real-world contexts rather than in laboratory settings. Therefore, research results are connected with the authentic setting. Also, guidance for applying generated principles is developed.
- *It uses multiple dependent variables* (Barab & Squire, 2004; Collins et al., 2004). DBR involves multiple dependent variables, including climate variables, outcome variables, and system variables.
- *It is integrative* (Wang & Hannafin, 2005). DBR uses a variety of research methods that "vary as new needs and issues emerge and the focus of the research evolves" (p. 10).
- *It entails systematic and comprehensive documentation* (Cobb et al., 2003; Edelson, 2002; van den Akker, 1999). "To support the retrospective analysis that is an essential element of design research, the design process must be thoroughly and systematically documented" (Edelson, 2002, p. 116).
- *It is iterative* (Cobb et al., 2003; Collins et al., 2004; DBRC, 2003; Wang & Hannafin, 2005). DBR processes are iterative cycles of analysis, design, implementation, and redesign. Formative evaluation is a critical element in DBR (Edelson, 2002; Reigeluth & Frick, 1999; van den Akker, 1999).
- *It is adaptive/flexible* (Barab & Squire, 2004; Cobb et al., 2003; Collins, 2004; DBRC, 2003; Edelson, 2002; Schwartz et al., 1999; Wang & Hannafin, 2005). Initial design plans are revised when necessary, to respond to emergent features of the setting. Although they should be flexibly adaptive, designs should also be consistent with important principles of learning.
- *It seeks generalization* (DBRC, 2003; Edelson, 2002; Wang & Hannafin, 2005). DBR researchers expand their focus beyond the current design context to look for generalization to other contexts. Of course, some methods and some causal relationships are situational—they do not generalize to other contexts. So a key to looking for generalization is to look for situationalities (contextual factors that you think may restrict the generalizability). If none seem important, then you have a case for generalization. If some seem important, then look for other methods (or variations of a

method) or causal relationships that might be appropriate for the other situations to which you might want to generalize, and try to extend your research into those contexts.

4. Principles of DBR

Principles of DBR include the following (Wang & Hannafin, 2005):

1. Support design with research from the outset.
2. Set practical goals for theory development and develop an initial plan.
3. Conduct research in representative real-world settings.
4. Collaborate closely with participants.
5. Implement research methods systematically and purposefully.
6. Analyze data immediately, continuously, and retrospectively.
7. Refine designs continually.
8. Document contextual influences with design principles.
9. Validate the generalizability of the design. (pp. 15–19)

5. Guidelines for Conducting DBR

Guidelines for conducting DBR include the following:

1. Identify a real-world problem (Cobb et al., 2003; Collins et al., 2004; DBRC, 2003; Wang & Hannafin, 2005).
2. Conduct a literature review and set theory development goals (Edelson, 2002; Wang & Hannafin, 2005). Adopt, adapt, or initiate a theory about learning and teaching, and clarify the theoretical intent.
3. Develop a collaborative partnership with practitioners (Barab & Squire, 2004; Cobb et al., 2003; Collins et al., 2004; DBRC, 2003; Wang & Hannafin, 2005).
4. Identify dependent and independent variables (Collins et al., 2004). Try to identify all the variables that affect any dependent variables of interest, rather than controlling them.
5. Develop an initial research plan (Wang & Hannafin, 2005).
6. Design, develop, and implement a design in one or more real-world settings (Collins et al., 2004; DBRC, 2003; Wang & Hannafin, 2005).
7. Generate a comprehensive and systematic record of the design process (Cobb et al., 2003; Edelson, 2002; van den Akker, 1999).
8. Collect data from multiple sources (Cobb et al., 2003; Wang & Hannafin, 2005). Use multiple methods, including observations, interviews, surveys, and document analysis.
9. Analyze data and evaluate the design (Wang & Hannafin, 2005). Conduct data analysis simultaneously with data collection and coding to improve the design and to address theory-generation goals.

10. Revise and refine the design (Collins et al., 2004; DBRC, 2003; Wang & Hannafin, 2005).
11. Iterate the processes of analysis, design, implementation, and redesign (Cobb et al., 2003; Collins et al., 2004; DBRC, 2003; Wang & Hannafin, 2005).
12. Report the results. Collins et al. (2004) suggest that there should be the following five sections:
    a. Goals and elements of the design.
    b. Settings where implemented.
    c. Description of each phase.
    d. Outcomes found.
    e. Lessons learned.

Wang and Hannafin (2005) suggest that DBR reports should generally include:

a. Purpose and goals
b. Design framework
c. Design setting and processes
d. Outcomes
e. Design principles

Design-based research is well suited for the last activity in each of the four approaches for constructing instructional theory shown in Table 17.1.

6. Formative Research

Formative research is a kind of developmental research or design-based research that is intended to improve three things: a particular case (product, event, or combination), an instructional theory related to that case, and descriptive theory related to the instructional theory. Its primary focus is on *improving*, rather than on proving. It can also be used to develop a new design theory instead of improving an existing design theory. It follows a case study approach and uses formative evaluation techniques. It is well suited to functional contextualism, for it explores how to make those three things (case, design theory, and descriptive theory) function better and it explores situational variables that influence how well they work.

The underlying logic of formative research is that if a case is designed using an instructional theory, whatever ways one can find to improve the case may illuminate ways to improve the instructional theory. Furthermore, what one learns about ways to improve the case and theory should illuminate the causal dynamics (descriptive theory) that underlie those improvements.

The major elements of formative research include:

- *observing* the instruction and interviewing the participants (learners and teachers) to identify *strengths* (what should not be changed), *weaknesses* (what should be changed), and *improvements* (what changes should be made) for the instruction,
- *repeating* the observations and interviews for each specific finding to test its trustworthiness and generalizability across different learners and different parts of the instruction (content, teachers, etc.),
- *looking* for variations in how well a method works; and, where there are important variations, exploring what *situationalities* may account for those variations,
- *implementing* potential *improvements* in the case as soon as possible, to test them in a similar manner,
- *asking* "why" questions in the interviews to gain insights into the *causal dynamics* that underlie the effects of different methods in different situations,
- *suggesting* potential improvements for the methods and situationalities in the *instructional theory*, based on your findings in the case, and
- *suggesting* potential improvements for the causal relationships in the *descriptive theories* that are related to the instructional theory.

Reigeluth and Frick (1999, chapter 26—Vol. 2), offer considerable guidance about how to conduct formative research: They report that the methodological procedures vary depending on whether the case is *designed* (based on an instructional theory) or is "*naturalistic*" (not designed based on an instructional theory). Furthermore, for naturalistic cases, the methodology varies depending on whether the observation is conducted *during* or *after* the case. This results in three major types of formative research studies:

1. *Designed cases*, in which the theory is intentionally instantiated for the research.
2. In vivo *naturalistic cases*, in which the formative evaluation of the instantiation is done *during* its application.
3. Post facto *naturalistic cases*, in which the formative evaluation of the instantiation is done *after* its application.

Table 17.2 Kinds of Formative Research Studies

	For an Existing Theory	For a New Theory
Designed Case	Designed case for an existing theory	Designed case for a new theory
In Vivo Naturalistic Case	*In vivo* naturalistic case for an existing theory	*In vivo* naturalistic case for a new theory
Post Facto Naturalistic Case	*Post facto* naturalistic case for an existing theory	*Post facto* naturalistic case for a new theory

Within each of these types of formative research studies, the methodological process also varies depending on whether the study is intended to improve an existing theory or to develop a new theory, resulting in six variations (see Table 17.2). Following is a brief summary of Reigeluth and Frick's methodology for each.

Designed Case to Improve an Existing Theory

1. *Select a design theory.* Begin by selecting an existing design theory that needs improvement.
2. *Design an instance of the theory.* Select a situation that fits within the general class of situations to which that design theory applies, and then design a specific application of the design theory (the case).
3. *Collect and analyze descriptive and formative data on the instance.* Conduct a formative evaluation of the design instance focusing on how to improve the case and on understanding the causal dynamics in it. Three techniques are useful for collecting the descriptive and formative data: observations, documents, and interviews. Conduct data analysis during the data collection process.
4. *Revise the instance.* Make revisions in the instance of the design theory based on the formative data.
5. *Repeat the data collection and revision cycle.* Several additional rounds of data collection, analysis, and revision are recommended. It is important to systematically vary what situationalities you can from round to round, within the boundaries of the theory.
6. *Offer tentative revisions for the theory.* Hypothesize an improved design theory based on your research findings.

Designed Case to Develop a New Theory

1. *Create a case that helps generate the design theory.* Begin by selecting a situation that fits within the general class of situations to which your new design theory is expected to apply. Then design a case for that situation, using experience, intuition, and trial and error. As you develop the case, you should develop a tentative design theory in parallel (methods, plus guidelines for when to use each).
2. *Collect and analyze descriptive and formative data on the instance.* (Same as above)
3. *Revise the instance.* (Same as above)
4. *Repeat the data collection and revision cycle.* (Same as above)
5. *Fully develop your tentative theory.* Revise and elaborate the tentative design theory based on your research findings.

Naturalistic Case to Improve an Existing Theory

1. *Select a design theory.* Begin by selecting an existing design theory that needs to be improved.

2. *Select a case.* Instead of creating an instance or case, select a case that is about to begin (for an in vivo study) or a case that has been completed (for a post facto study). The case should be in a situation that fits within the general class of situations to which the theory applies.
3. *Collect and analyze descriptive and formative data on the case.* There are three major kinds of data to be collected, based on the presence and absence of elements in the theory and in the case: (a) elements that are present in both the theory and the case; (b) elements that are present in the theory but absent in the case; and (c) elements that are absent in the theory but present in the case. These three kinds of data can be collected through observations, interviews, and documents.
4. *Offer tentative revisions for the theory.* Hypothesize an improved design theory based on your research findings.

Naturalistic Case to Develop a New Theory

1. *Select a case.* (Same as above)
2. *Collect and analyze descriptive and formative data on the case.* Use grounded theory techniques (either Glaser's or Straus and Corbin's) to study the case and identify instructional methods—and situationalities when possible. You should rely heavily on intuition, experience, and knowledge of relevant descriptive theory to form categories for methods and situationalities. However, you should go beyond such descriptive data to identify participants' suggestions (through interviews) for ways of improving the methods and their situationalities (if any).
3. *Fully develop your tentative theory.* Revise and elaborate your tentative design theory based on the research findings.

Given that the primary purpose of formative research is to *improve* rather than to prove, it is ideally suited for the last activity in each of the four approaches for constructing instructional theory shown in Table 17.1.

Conclusion

In this chapter, we began by discussing what kinds of knowledge need to be built, and we concluded that design theory is most useful to practitioners but descriptive theory is also useful. Second, we described how the "paradigm wars" have been counterproductive for instructional theory and advocated the use of functional contextualism as a helpful framework for building instructional theory. Third, we identified two major kinds of research for design theory: research to prove (confirmatory) and research to improve (exploratory). For both, preferability (usefulness) should replace validity (truthfulness) as the most important research criterion. Fourth, we described the "S curve" of development for instructional theories and argued that research to prove should only be done when a theory has approached its upper limit. Otherwise, research to improve a design theory is far more valuable.

Then we described four approaches that can be used to build design theory: (1) data-based; (2) values-based; (3) methods-based; and (4) practitioner-driven; and we encouraged readers to experiment and develop their own approaches. Finally, we described three research methods for developing design theory: (1) grounded theory development; (2) design-based research; and (3) formative research.

We would like to close by recommending to all who build instructional theory that you place your work in the context of the growing common knowledge base about instruction in an effort to continually improve that common knowledge base. Show where and how it fits and what unique contributions it makes that have not been offered by other theorists. And try to use existing terminology whenever the meaning is the same as yours. This will make life much easier for practitioners, graduate students, and researchers, and it will help our field to advance beyond the early stages of development.

References

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences, 13*(1), 1–14.

Cobb, P., Confrey, J., deSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9–13.

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design Research: Theoretical and Methodological Issues. *Journal of the Learning Sciences, 13*(1), 15–42.

Design-Based Research Collective. (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher, 32*(1), 5–8.

Edelson, D. C. (2002). Design research: What we learn when we engage in design. *Journal of the Learning Sciences, 11*(1), 105–121.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review, 14*(4), 532–550.

Fox, E. J. (2006). Constructing a pragmatic science of learning and instruction with functional contextualism. *Educational Technology Research & Development, 54*(1), 5–36.

Glaser, B. G. (1978). Theoretical sensitivity: Advances in the methodology of grounded theory. Mill Valley, CA: Sociology Press.

Glaser, B. G. (1992). *Emergence vs. forcing: Basics of grounded theory analysis.* Mill Valley, CA: Sociology Press.

Glaser, B. G. (1998). *Doing grounded theory: Issues and discussions.* Mill Valley, CA: Sociology Press.

Glaser, B. G. (2001). *The grounded theory perspective: Vol. 1. Conceptualization contrasted with description.* Mill Valley, CA: Sociology Press.

Glaser B. G. (2003). *The grounded theory perspective: Vol. 2. Description's remodeling of grounded theory.* Mill Valley, CA: Sociology Press.

Glaser, B. G., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research.* Chicago: Aldine.

Kelle, U. (2005). "Emergence" vs. "forcing" of empirical data? A crucial problem of "grounded theory" reconsidered. *Forum: Qualitative Social Research, 6*(2). Retrieved July 11, 2007, from http://www.qualitative-research.org/fqs-texte/2-05/05-2-27-e.pdf.

Lewis, M. W., & Grimes, A. J. (1999). Metatriangulation: Building theory from multiple paradigms. *Academy of Management Review, 24*(4), 672–690.

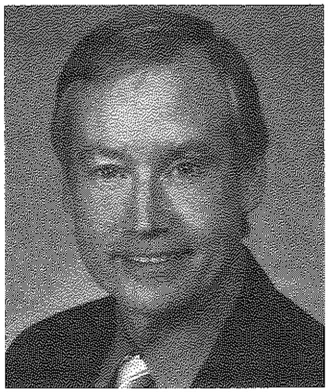
Patton, M. (2002). *Qualitative research & evaluation methods* (3rd ed.). Thousand Oaks, CA: Sage.

Reigeluth, C. M., & An, Y. J. (2006). Functional contextualism: An ideal framework for theory in IDT. *Educational Technology Research & Development, 54*(1), 46–50.

Reigeluth, C. M., & Frick, T. W. (1999). Formative research: A methodology for creating and improving design theories. In C. M. Reigeluth (Ed.), *Instructional-design theories and models: Vol. 2. A new paradigm of instructional theory* (pp. 633–651). Mahwah, NJ: Erlbaum.
Strauss, A. (1987). *Qualitative research for social scientists.* Cambridge, UK: Cambridge University Press.
Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques.* Newbury Park, CA: Sage.
van den Akker, J. (1999). Principles and methods of development research. In J. van den Akker, N. Nieveen, R. M. Branch, K. L. Gustafson, & T. Plomp (Eds.), *Design methodology and development research in education and training* (pp. 1–14). The Netherlands: Kluwer Academic.
Wang, F., & Hannafin, M. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development, 53*(4), 5–23.
Weick, K. E. (1989). Theory construction as disciplined imagination. *Academy of Management review, 14*(4), 516–531.

18
Instructional Theory for Education in the Information Age

CHARLES M. REIGELUTH
Indiana University



Charles M. Reigeluth received a BA in economics from Harvard University. He was a high school teacher for three years before earning his doctorate in instructional psychology at Brigham Young University. He has been a professor in the Instructional Systems Technology Department at Indiana University's School of Education in Bloomington since 1988, and served as chairman of the department from 1990 to 1992. His major area for service, teaching, and research is the process for facilitating district-wide paradigm change in public school systems. His major research goal is to advance knowledge to help school districts successfully navigate transformation to the learner-centered paradigm of education. He has published nine books and over 120 journal articles and chapters. Two of his books received an "outstanding book of the year" award from the Association for Educational Communications and Technology (AECT). He also received AECT's Distinguished Service Award and Brigham Young University's Distinguished Alumnus Award.