

DEVELOPMENTAL RESEARCH: STUDIES OF INSTRUCTIONAL DESIGN AND DEVELOPMENT

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41.1 INTRODUCTION

The field of instructional technology has traditionally involved a unique blend of theory and practice. This blend is most obvious in developmental research, those studies that involve the production of knowledge with the ultimate aim of improving the processes of instructional design, development, and evaluation. Such research is based on either situation-specific problem solving or generalized inquiry procedures. Developmental *research*, as opposed to simple instructional development, has been defined as “the systematic study of designing, developing and evaluating instructional programs, processes and products that must meet the criteria of internal consistency and effectiveness” (Seels & Richey, 1994, p. 127). In its simplest form, developmental research can be either

- the study of the process and impact of specific instructional design and development efforts; **or**
- a situation in which someone is *performing* instructional design, development, or evaluation activities and *studying* the process at the same time; **or**
- the study of the instructional design, development, and evaluation process as a whole or of particular process components.

In each case the distinction is made between performing a process and studying that process. Reports of developmental research may take the form of a case study with retrospective analysis, an evaluation report, or even a typical experimental research report.

The purposes of this chapter are to

- explore the nature and background of developmental research;
- describe the major types of developmental research by examining a range of representative projects;
- analyze the methodological approaches used in the various types of developmental research;
- describe the issues, findings, and trends in recent developmental research; and
- discuss the future of this type of research in our field.

41.2 THE NATURE OF DEVELOPMENTAL RESEARCH

Today, even amid the calls for increased use of alternative research methodologies, the notion of developmental research is

often unclear, not only to the broader community of educational researchers, but to many instructional technology researchers as well. An understanding of this topic is rooted in the nature of development and research in general, as well as a more specific understanding of the purpose, focus, and techniques of developmental research itself.

41.2.1 The Character of Development

Development, in its most generic sense, implies gradual growth, evolution, and change. This concept has been applied to diverse areas of study and practice. For example, organization development is a strategy for changing “the beliefs, attitudes, values, and structure of organizations so that they can better adapt to new . . . challenges” (Bennis, 1969, p. 2). Educators are familiar with the notion of professional or staff development. Lieberman and Miller (1992) define this as “the knowledge, skills, abilities, and the necessary conditions for teacher learning on the job” (p. 1045). This same concept is often applied to other professional areas. In the corporate arena, the term “executive development” also refers to learning processes, and in this setting learning, as a developmental activity, often integrates both classroom instruction and work experience (Smith, 1993). The most common use of the term “development,” however, is in relation to human growth and the field of developmental psychology. The term *developmental research* is most often confused with research in this field that concentrates on particular age groups, such as in the areas of adolescent development or life-span development.

In the field of instructional technology, development has a particular, somewhat unique, connotation. The most current definition views development as “the process of translating the design specifications into physical form” (Seels & Richey, 1994, p. 35). In other words, it refers to the process of *producing* instructional materials. Development is viewed as one of the five major domains of theory and practice in the field.¹ Even though this varies from many other uses of the term *development*, it is consistent with the fundamental attribute of being a process of growth, and in our field development is a very creative process.

Historically *development* has been an ambiguous term to many instructional technologists and has generated considerable discussion regarding its proper interpretation. This debate has focused typically on the distinctions between instructional *design* and instructional *development*. Heinich, Molenda, Russell, and Smaldino (2002) define instructional development as “the process of analyzing needs, determining what content must be mastered, establishing educational goals, designing materials to reach the objectives, and trying out and revising the program in terms of learner achievement” (p. 445). They have been consistent in this orientation since the early editions of their influential book. Yet to many, this is a definition of the instructional systems design (ISD) process.

The confusion has been further exacerbated. In 1977, Briggs defined *instructional design* as “the entire process of analysis of

learning needs and goals and the development of a delivery system to meet the needs; includes development of instructional materials and activities; and tryout and revision of all instruction and learner assessment activities” (p. xx). In this interpretation design is the more generic term, encompassing *both* planning and production. The 1994 definition of the field attempts to clarify these issues by viewing design as the planning phase in which specifications are constructed, and development as the production phase in which the design specifications are actualized (Seels & Richey, 1994). This is not a new distinction (Cronbach & Suppes, 1969; National Center for Educational Research and Development, 1970), even though the past use of the term *instructional developer* (see Baker, 1973) typically referred to a person who was doing what today we would call both design and development. All would agree, however, that design and development are *related* processes, and Connop-Scollard (1991) has graphically demonstrated these relationships in a complex chart which identified hundreds of interrelated concepts.

However, the word *development* has a broader definition when it is used within the research context than it has when used within the context of creating instructional products. The focus is no longer only on production, or even on both planning and production. It also includes comprehensive evaluation. As such, developmental research may well address not only formative, but also summative and confirmative evaluation. It may address not only needs assessment, but also broad issues of front-end analysis, such as contextual analysis issues as conceived by Tessmer and Richey (1997). When evaluation is approached in a comprehensive manner, the scope of the research effort is often correspondingly expanded to encompass product utilization and management, as well as product creation. Table 41.1 displays the scope of development as discussed in this chapter.

The next step beyond “Utilization & Maintenance” in the Table 41.1 schemata would be “Impact,” the follow-up analysis of the effects of an instructional product or program on the organization or the learner. This type of research typically falls within the scope of traditional evaluation research.

41.2.2 The Character of Research

Although research methodologies vary, there are key attributes that transcend the various research orientations and goals. An understanding of these characteristics can shed light on the process of developmental research.

41.2.2.1 The Dimensions of Research. Research is typically viewed as a type of systematic investigation, and in education it typically is an empirical process that employs the systematic method (Crowl, 1996). One result of such efforts is the creation of knowledge. Even though research is typically rooted in societal problems, all knowledge produced by research is not necessarily in a form conducive to quick resolution of society’s problems. Some knowledge (which is usually generated by *basic* research) must be specifically transformed to enable its application to a given problem. Other knowledge (which is usually

¹In addition to development, the domains also include design, management, utilization, and evaluation.

TABLE 41.1. The Scope of Development in a Research Context

Design	Development	Utilization & Maintenance
Analysis and Planning for Development, Evaluation, Utilization, & Maintenance	Production & Formative Evaluation	Usage, Management, Summative & Confirmative Evaluation

generated by *applied* research) lends itself to the immediate solution of practical problems. Developmental research clearly falls in the latter category. In this respect, it is similar to other methodologies such as action research.

Although the objective of research is to produce knowledge, these products may take a variety of forms. Diesing (1991) has noted that

... the philosophers suggest that social science produces at least three kinds of knowledge: (1) systems of laws which describe interconnected regularities in society; (2) descriptions, from the inside, of a way of life, community, person, belief system, or scientific community's beliefs; (3) structural models, mathematical or verbal, of dynamic processes exemplified in particular cases. (p. 325)

Research orientations tend to conform to the pursuit of a particular type of knowledge. Experimental research tends to contribute to the construction of a system of laws. Characteristic of this method is a series of routine checks to ensure self-correction throughout the research, and in the logical positivist tradition, such checks are considered to be rooted in objectivity (Kerlinger, 1964). Qualitative research primarily contributes to the development of "mirrors for man" so that we can see ourselves better (Kluckhohn, as noted in Diesing, 1991). In the various forms of qualitative research, context and contextual influences become an integral part of the investigation (Driscoll, 1991; Mishler, 1979).

Diesing's third type of knowledge is process knowledge presented in model form. This is usually of great interest to instructional designers and developers, given our history of working with many kinds of process models, such as the graphic models of systematic design procedures and the models of media selection. When inquiry procedures result in this type of knowledge, these endeavors can legitimately be placed in the research realm.

Another traditional characterization of research is as a facilitator of understanding and prediction. In this regard "understanding results from a knowledge of the process or dynamics of a theory. Prediction results from investigation of the outcomes of a theory" (Schwen, 1977, p. 8). These goals can be achieved by either (a) providing a logical explanation of reality, (b) anticipating the values of one variable based on those of other variables, or (c) determining the states of a model (Dubin, as cited by Schwen, 1977). While these ends, especially the first two, can be achieved through traditional research methodologies, the third is uniquely matched to the goals of developmental research. This was emphasized by Schwen (1977):

Inquiry in educational technology may be associated with the planning, implementing, and/or evaluation of the management-of-learning process, where that process employs systematic technological analysis and

synthesis... current definitions of technological process may be found in development models... (having) the common attributes of 1) disciplined analysis of problem, context, constraints, learners, and task, and 2) disciplined synthesis involving the design of replicable forms of instruction and formative and summative evaluation. (p. 9)

41.2.2.2 The Relationships Between Research and Development. The traditional view of research is as the discovery of new knowledge and that of development is as the translation of that knowledge into a useful form (Pelz, 1967). This conceptual framework not only has been commonly subscribed to, but was subsequently extended into the research, development, and diffusion model (Brickell, Clark & Guba, as cited in Havelock, 1971). Early research methods texts addressed development as the "research and development" process (Borg & Gall, 1971). The processes were separate, though related, dependent, and sequential. In some situations this orientation still prevails. This view emphasizes development's function of linking practice to research and theory and recognizes the likelihood that instructional development can highlight researchable problems and, thus, serve as a vehicle for stimulating new research (Baker, 1973).

Stowe (1973) has shown the parallels between scientific research and the general methodology of instructional systems design (ISD). He notes that both

- are objective, empirical problem-solving approaches;
- employ procedural models "couched in the language of mathematics" (p. 167);
- have a predictive power dependent on the degree to which they represent the most critical aspects of reality; and
- can generate new problems and hypotheses.

Nonetheless, Stowe rejected the proposition that systematic design procedures can be viewed as research to a great extent because of the inability of ISD to discover generalizable principles and its intent to produce context-specific solutions. In addition, Stowe cited the distinctions between ISD's orientation toward explanations of "how" as opposed to research's orientation toward explanations of "why."

In the contemporary orientation toward research, Stowe's arguments can be interpreted as an overly rigid expression of positivist philosophy. The contextual richness of the typical design and development task increases the likelihood that research on such topics be especially ripe for a qualitative orientation. The ability to provide process explanations exemplifies a type of knowledge production using the Diesing framework, and an avenue to understanding and prediction using Schwen's paradigm. Stowe's arguments, drafted 30 years ago, could lead to diametrically opposite conclusions today, providing one accepts the

premise that research can have a broader function than the creation of generalizable statements of law. We are taking the position that research can also result in context-specific knowledge and can serve a problem-solving function. This is true of developmental research, as it has commonly thought to be true of evaluation research.

While instructional development typically *builds* on previous research, developmental research attempts to produce the models and principles that guide the design, development, and evaluation processes. As such, *doing* development and *studying* development are two different enterprises.

41.2.3 The Background of Developmental Research

The field of instructional technology as it exists today emerged primarily from a convergence of the fields of audiovisual education and instructional psychology. In audiovisual education the emphasis was on the role of media as an enhancement of the teaching/learning process and an aid in the communication process, and there was much interest in materials production. On the other hand, in instructional psychology the nature of the learner and the learning process took precedence over the nature of the delivery methodology, and there was much interest in instructional design. Complementing the instructional psychology roots was the application of systems theory to instruction that resulted in the instructional systems design movement (Seels & Richey, 1994). This conceptual and professional merger came to fruition in the 1960s and 1970s. During this period instructional design and development came to assume the role of the “linking science” that John Dewey had called for at the turn of the century (Reigeluth, 1983).

Not surprisingly, it was during this same period that the term *developmental research* emerged. This new orientation was exemplified by the shift in topics between the first and the second *Handbook of Research on Teaching* (Gage, 1963; Travers, 1973). In the 1963 handbook, media was addressed as an area of research with a major emphasis on media comparison research, and all research methodologies considered were quantitative. In the 1973 handbook, media continued to be included as a research area, but the research methodologies were varied, including Eva Baker’s chapter on “The Technology of Instructional Development.”² This chapter describes in detail the process of systematic product design, development, and evaluation. Of significance is the fact that the entire methodology section was titled “Methods and Techniques of Research *and Development*”.

This was a period in which federal support of educational research mushroomed. Regional research and development laboratories were established and the ERIC system was devised for dissemination. Clifford (1973) estimated that appropriations for educational “research and development for 1966 through 1968 alone equaled three-fourths of all funds ever made available” (p. 1). Research-based product and program development had

become firmly established as part of the scientific movement in education. At this time, Wittrock (1967) hailed the use of empirical measurement and experimentation to explain product effectiveness. Such activities “could change the development of products into research with empirical results and theory generalizable to new problems” (p. 148).

Hilgard (1964) characterized research as a continuum from basic research on topics not directly relevant to learning through the advocacy and adoption stages of technological development. Saettler (1990) maintained that the last three of Hilgard’s research categories were directly within the domain of instructional technology. These included laboratory, classroom, and special teacher research; tryout in “normal” classrooms; and advocacy and adoption. Note that these are portrayed as types of research, rather than applications of research, and they are all encompassed within the framework of developmental research.

Although instructional technology is not the only field concerned with learning in applied settings, few would dispute the critical role played by these three types of research in our field. Moreover, our uniqueness among educational fields is not only our concern with technology, but rather our emphasis on the design, development, and use of processes and resources for learning (Seels & Richey, 1994). Given this definition of the field, developmental research is critically important to the evolution of our theory base.

41.2.4 The Character of Developmental Research

The distinctions between “doing” and “studying” design and development provide further clarification of developmental research activities. These distinctions can be described in terms of examining the focus, techniques, and tools of developmental research.

41.2.4.1 The Focus of Developmental Research. The general purposes of research have been described as knowledge production, understanding, and prediction. Within this framework, developmental research has particular emphases that vary in terms of the extent to which the conclusions are generalizable or contextually specific. Table 41.2 portrays the relationships between the two general types of developmental research.

The most straightforward developmental research projects fall into the first category in Table 41.2. This category typically involves situations in which the product development process used in a particular situation is described and analyzed and the final product is evaluated, such as McKenney’s (2002) documentation of the use of CASCADE-SEA, a computer-based support tool for curriculum development. Driscoll (1991) has used the term *systems-based evaluation* to describe a similar research paradigm. van den Akker (1999), on the other hand, prefers to label Type I research *formative research*. He further defines this type of research as “activities performed during the entire development process of a specific intervention,

²A history of instructional development is given by Baker (1973), who primarily summarizes the work in research-based product development from the turn of the century to 1970. Baker, however, does not address developmental research as it is presented in this chapter.

TABLE 41.2. A Summary of the Two Types of Developmental Research

	Type 1	Type 2
Emphasis	Study of specific product or program design, development, &/or evaluation projects	Study of design, development, or evaluation processes, tools, or models
Product	Lessons learned from developing specific products and analyzing the conditions that facilitate their use	New design, development, and evaluation procedures &/or models, and conditions that facilitate their use
	Context-specific	Generalized
	Conclusions ⇒ ⇒ ⇒	Conclusions

from exploratory studies through (formative and summative) evaluation studies” (p. 6).

Some Type 1 developmental studies reflect traditional evaluation orientations in which the development process is not addressed, and only the product or program evaluation is described. An example of this type of study is O’Quin, Kinsey, and Beery’s (1987) report on the evaluation of a microcomputer training workshop for college personnel. Regardless of the nature of the Type 1 study, the results are typically context and product specific, even though the implications for similar situations may be discussed.

The second type of developmental study is oriented toward a general analysis of design, development, or evaluation processes, addressed either as a whole or in terms of a particular component. They are similar to those studies Driscoll (1991) calls “model development and technique development research.” van den Akker (1999) calls them “reconstructive studies.” His term emphasizes the common (but not exclusive) situation in which this research takes place after the actual design and development process is completed.

Tracey’s (2002) study is an example of Type 2 developmental research that has a global design orientation. She constructed and validated an instructional systems design model that incorporated Gardner’s notion of multiple intelligences. Taylor and Ellis’ (1991) study had a similar orientation, although their orientation was far different. They evaluated the use of instructional systems design in the Navy. Other studies in this category focus on only one phase of the design/development/evaluation process, such as Jonassen’s (1988) case study of using needs assessment data in the development of a university program. Type 2 research may draw its population either from one target project such as King and Dille’s (1993) study of the application of quality concepts in the systematic design of instruction at the Motorola Training and Education Center or from a variety of design and development environments. Examples of the latter approach include Riplinger’s (1987) survey of current task analysis procedures and Hallamon’s similar study conducted in 2001. Typically, conclusions from Type 2 developmental research are generalized, even though there are instances of context-specific conclusions in the literature.

41.2.4.2 Nondevelopmental Research in the Field. A critical aspect of any concept definition is the identification of

nonexamples as well as examples. This is especially important with respect to developmental research, as it often seems to overlap with other key methodologies used in the field. Even so, developmental research does *not* encompass studies such as the following:

- instructional psychology studies,
- media or delivery system comparison or impact studies,
- message design and communication studies,
- policy analysis or formation studies, and
- research on the profession.

While results from research in these areas impact the development process, the study of variables embedded in such topics does not constitute developmental research. For example, design and development is dependent on what we know about the learning process. We have learned from the research literature that transfer of training is impacted by motivation, organizational climate, and previous educational experiences. Therefore, one may expand a front-end analysis to address such issues, or even construct design models that reflect this information, but the foundational research would not be considered developmental. If the new models were tested, or programs designed using such models were evaluated, this research would qualify as developmental.

A fundamental distinction should be made between reports that analyze actual development projects and *descriptions* of recommended design and development procedural models. Although these models may represent a synthesis of the research, they do not constitute research in themselves. A good example of the latter situation is Park and Hannafin’s (1993) guidelines for designing interactive multimedia. These guidelines are generalized principles that speak to the development process, and they are based on a large body of research. Nonetheless, the identification and explanation of the guidelines is not in itself an example of developmental research. The instructional technology literature includes many examples of such work. They often provide the stimulus for a line of new research, even though these articles themselves are not considered to be research reports themselves. There are many examples today of such work, including explorations of topics such as cognitive task analysis (Ryder & Redding, 1993) and the nature of design and designer decision making (Rowland, 1993).

41.2.4.3 The Techniques and Tools of Developmental Research. Developmental researchers employ a variety of research methodologies, applying any tool that meets their requirements. Summative evaluation studies often employ classical experimental designs. Needs assessments may incorporate qualitative approaches. Process studies may adopt descriptive survey methods. Even historical research methods may be used in developmental projects.

Traditional research tools and traditional design tools facilitate the developmental endeavor. Expertise is often required in statistical analysis, measurement theory, and methods of establishing internal and external validity. Likewise, the developmental researcher (even those studying previously designed

instruction) requires a command of design techniques and theory. Additional design proficiency is frequently required when using electronic design systems and aids, conducting environmental analyses, and defining ways to decrease design cycle time.

A developmental research project may include several distinct stages, each of which involves reporting and analyzing a data set. Merely conducting a comprehensive design and development project does not constitute conducting a developmental research project even using its most narrow Type 1 definition. One must also include the analysis and reporting stage to warrant being classified as developmental research.

Developmental research projects may include a number of component parts. Substudies may be conducted to analyze and define the instructional problem, to specify the content, or to determine instrument reliability and validity. Substudies may be conducted to provide a formative evaluation, a summative evaluation, or a follow-up of postinstruction performance. Consequently, reports of developmental research are frequently quite long, often prohibiting publication of the full study.

Reports of developmental projects can often be found in

- professional journals,
- doctoral dissertations,
- Educational Resource Information Center (ERIC) collections of unpublished project reports, and
- conference proceedings.

The nature of these reports varies depending on the dissemination vehicle. Sometimes, full developmental projects are split into more easily publishable units (or even summarized) to facilitate publication in the traditional research journals. Developmental research reports are also published in practitioner-oriented journals and magazines, and the methodology and theoretical base of the studies are omitted to conform to the traditions of those periodicals. The next section further defines the nature of developmental research by summarizing studies that are representative of the wide range of research in this category.

41.3 A REVIEW OF REPRESENTATIVE DEVELOPMENTAL RESEARCH

We have identified representative developmental research studies in the literature so that we might

- further describe the character of this type of research,
- identify the range of settings and foci of developmental research,
- summarize developmental tools and techniques commonly used,
- identify the range of research methodologies used, and
- describe the nature of the conclusions in such research.

The literature is described in terms of the two types of developmental research. This review covers research from the past 20 years, with a concentration on the most recent work.

41.3.1 Type 1 Developmental Research

Type 1 research is the most context-specific inquiry. These studies are essentially all forms of case studies and emanate from a wide range of educational needs. Table 41.3 presents an analysis of 56 studies representative of this category of research. These studies are described in terms of their focus, their methodology, and the nature of their conclusions. Focus is examined in terms of the

- type of program or product developed;
- particular design, development, or evaluation process emphasized in the study;
- particular tools and techniques emphasized; and
- organizational context for which the product is intended.

The most common characteristics among the studies are found in relation to their process foci, the research methodologies employed, and the nature of their conclusions. The product and technique focus and the user context seem to reflect individual researcher interests or participant availability more than they reflect the inherent nature of this type of research.

41.3.1.1 Process Foci of Type 1 Developmental Research. Type 1 research studies originate with the design and development of an instructional product or program. This is the crux of Type 1 research. Frequently, the entire design, development, and evaluation process is documented. Consistent with predominant practice in the field, the procedures employed usually follow the tenets of ISD, encompassing front-end analysis through formative or summative evaluation. One-third of the studies cited in Table 41.3 describe in detail the entire design, development, and evaluation process as it occurred in a particular environment. (See Table 41.3 for studies classified in terms of an "A" process focus.)

Two studies provide an example of this kind of research. Petry and Edwards's (1984) description of the systematic design, development, and evaluation of a university applied phonetics course is a classic Type 1 study with a course focus. They describe the application of a particular ISD model as well as the use of elaboration theory in content sequencing. The study also addresses the production of course materials, as well as the results of an evaluation of student performance and attitudes in the revised course. Hirumi, Savenye, and Allen's (1994) report of the analysis, design, development, implementation, and evaluation of an interactive videodisc museum exhibit is an example of a Type 1 study with a program focus. This study provides evidence that an ISD model can be adapted to informal educational settings.

Studies that did not document the entire design, development, and evaluation process tended to emphasize a particular phase of ISD such as needs assessment or formative evaluation.

For example, Link and Cherow-O'Leary (1990) document the needs assessment procedures followed by the Children's Television Workshop (CTW) to determine the needs and interests of elementary school teachers. They also describe formative evaluation techniques for testing the effectiveness of children's and parent's magazines. Klein et al. (2000) describe a needs assessment conducted to determine the optimal instructional content and delivery method for an introductory course in educational technology. The results of the needs assessment were used to revise an existing course. Fischer, Savenye, and Sullivan (2002) report on the formative evaluation of a computer-based training course for an on-line financial and purchasing system. The purpose of the study was to evaluate the effectiveness of the training and to identify appropriate revisions to incorporate into the program.

Type 1 developmental research studies often concentrate on the production aspect of the ISD approach. (See Table 41.3 for studies classified in terms of an "E" process focus.) Often these studies concerned the development of technology-based instruction, such as Bowers and Tsai's (1990), Crane and Mylonas' (1988), and Harris and Cady's (1988) research on the use of hypertext as a vehicle for creating computer-based instructional materials. The reports describe authoring procedures so specifically that one could replicate the innovative development processes. These same tactics were employed with respect to developing instructional television by Alberio-Andes (1983), and they were used in interactive videodisc projects by Alessi (1988) and C. M. Russell (1990). Similar studies can be found in the research of our field as each new technological advancement emerges.³

Type 1 developmental studies demonstrate the range of design and development procedures currently available to practitioners. In addition, these studies commonly encompassed an evaluation of the products and programs that were created, including an examination of the changes in learners who had interacted with the newly developed products.

41.3.1.2 Research Methodologies Employed in Type 1 Developmental Research. A basic premise of this chapter is that the design-development-evaluation process itself can be viewed as a form of inquiry. This is accomplished in a developmental research project by embedding traditional research methodologies into the development projects. The type of research method used in a particular project tends to vary with the type of developmental research, and Type 1 studies frequently employ case study techniques. (See Table 41.3 for studies classified in terms of an A methodology use.)

The manner in which case study techniques are used varies widely in developmental research. Most commonly, the case study is seen as a way in which one can explore or describe complex situations, which consist of a myriad of critical contextual

variables as well as process complexities. For example, Dick (1991) described a corporate design project in Singapore aimed at training instructional designers. The report of his Type 1 study focuses upon the needs assessment and actual design phases rather than the entire design-development-evaluation process. In another Type 1 study, Carr-Chellman, Cuyar, and Breman (1998) document how user design was implemented to create an information technology system in the context of home health care. This case study explored the complexities of systemic change as the organization used an educational systems design process. Both of these projects were approached from a research point of view in a qualitative manner.

Less often do studies heed the admonition of Yin (1992), who indicates that case studies are more appropriate when one is attempting to establish causal relationships rather than simply provide detailed descriptions. This approach requires a more quantitative orientation to the development case study as one seeks to explain (as well as describe) the nature of the development process. More often quantitative aspects of a Type 1 developmental research project concern efforts to determine the effectiveness or impact of the resulting instruction. In these cases the studies have experimental designs, with or without the case study component. (See Table 41.3 for studies classified in terms of an E methodology use.) An example of this methodological approach is the study by Plummer, Gillis, Legree, and Sanders (1992), which used two research methodologies—case study and experimental—in conjunction with the design and development task. This project involved the development of a job aid used by the military when operating a complicated piece of communications equipment. The experimental phase of the evaluation of the job aid was a study to evaluate the effectiveness of the job aid. Three instructional situations were compared—using the job aid alone, using it in combination with a demonstration, and using the technical manual in combination with a demonstration. Consequently, not only was impact information secured, but also information relating to the superior conditions for using the newly developed product was obtained.

Evaluation methods are frequently used in Type 1 developmental research studies (see Table 41.3 for studies classified as a "D" methodology use). Evaluation instruments such as learner surveys, achievement tests, and performance measures are often used to collect data. For example, Martin and Bramble (1996) conducted an in-depth evaluation of five video teletraining courses for military personnel by collecting survey data from students and instructors who participated in the courses. Achievement and proficiency tests were also used. Quinn (1994) evaluated a curriculum project in which graduate students served as instructional developers in a corporate environment. He used learner, instructor, and client evaluations to determine the impact of the project. Sullivan, Ice, and Niedermeyer (2000) field-tested a K-12 energy education curriculum

³Although this is not the emphasis of this chapter, one could construct a type of history of the field of instructional technology by tracing the Type 1 developmental research. The audiovisual emphasis could be documented through a series of studies such as Greenhill's (1955) description of producing low-cost motion pictures with sound for instructional purposes. Procedural changes could be traced through studies such as those by Rouch (1969) and Gordon (1969), who describe early applications of the systems approach to designing education and training programs. Programmatic trends could be seen in studies of the design and development of competency-based teacher education programs, such as Cook and Richey (1975). Today the development of new technologies is documented in a variety of studies, many of which are discussed here.

TABLE 41.3. An Analysis of Representative Type I Developmental Research Literature

Reference	Product or Program Focus	Process Focus	Use Context	Tools and Techniques Emphasized		Research Method(s) Used	Nature of Conclusions
Albero-Andes (1983)	C, F, I	A, E, F	A	B	A	B	
Alessi (1988)	J	A, H	B	H, K	A	C	
Aukerman (1987)	J	G, J	D	H	D, G, I	A	
Bednar (1988)	B	B	B	A, B	A	B	
Blackstone (1990)	H	E, F, I, J	F	K	A, E, D, J	A	
Borras (1993)	B, J, L	D, F	B	K	E	B	
Bowers & Tsai (1990)	J	E, G	G	K	A, E	D	
Buch (1989)	C	A, J	C	B, F	A, D, E	B	
Cantor (1988)	D, E, F, G	E	E	K	A, D	B	
Capell & Dannenberg (1993)	J	C, D	A, B	F, G, L	A, D	B	
Carr-Chellman, Cuyar, & Breman (1998)	J	D, F, G	D	L	A	B	
Chou & Sun (1996)	J	A	B, H	L	D	A	
Corry, Frick, & Hansen (1997)	L	B, F	B	B, L	A	A	
Coscarelli & White (1982)	A	A, G, H	B	E	A, D	B	
Coyle (1986)	B, J	G, J	B		A, G	B	
Coyle (1992)	B	E, G	B		D	A	
Crane & Mylonas (1988)	J	E	B	K	A	A	
Cregger Metzler (1992)	A	A, G, H	B	G	A, D, J	B	
Dabbagh et al. (2000)	A	A	B		A	B	
Dick (1991)	B	B, D	C, H	B, F	A	B	
Fischer, Savenye, & Sullivan (2002)	J	F	G	J	D	B	
Fox & Klein (2002)	A	B	B	B	J	B	
Gay & Mazur (1993)	J	E, H	G	K	A, F	C	
Gettman, McNelly, & Muraida (1999)	M	D	E		D	A	
Gustafson & Reeves (1990)	K	A	G	B, C, D, E, H	D	C	
Harris and Cady (1988)	J	E	A	K	A	A	
Herrington & Oliver (2000)	J, L	D, E, G	B	K	I	B	
Hirumi, Savenye, & Allen (1994)	B	A	F		A	B	
Jonassen (1988)	B	B, D	B	B	J	A	
Jones (1986)	C	J	B		A, C, E, J	A	
Kanyarusoke (1985)	A, F	A, B, C, J	B		A, B, J	A	
Kearsley (1985)	J	G	I	K	D	B	
Klein et al. (2000)	A	B, C	B	B	J	A	
Lewis, Stern, & Linn (1993)	H, J	E	A		A, B	A	
Li & Merrill (1991)	J	C, D	I		A, D	C	

Link & Cherow-O'Leary (1990)	D	B, F	A, F, G	B, G, J	B
Martin & Bramble (1996)	A	A	E	J	B
McKenney (2001)	J, M	A	A, H	G, I, J	B
Medsker (1992)	A, B	A, H, J	B, C, G	A, B	D
Mendes & Mendes (1996)	J	D, E, F	A, H	D	A
Mielke (1990)	I	A	A, F	A	A
Munro & Towne (1992)	J	D, E	A, B, E, G	A, D	B
Nieveen & van den Akker (1999)	J, M	F	I	A, G, J	C
Noel (1991)	B	A, B	A, H	A	C
O'Quin, Kinsey, & Beery (1987)	C, J	I, J	B, G	D, E	A
Petry & Edwards (1984)	A	A	B	A	A
Pirolli (1991)	J	C, D	I	A, D	B
Pizzuto (1983)	C, H	A, C, E, F, I, J	C	A, D, G, J	A
Plummer, Gillis, Legree, & Sanders (1992)	G	E, I	C	A, E, J	A
Quinn (1994)	A	A	B, C, G	D	D
Ross (1998)	A	G	I, C	I	A
Russell (1990)	J	A, E, F, G, J	B	D, E	B
Russell (1988)	J	C, D	I	A, D	B
Sullivan (1984)	B	D, F, G	A	A	C
Sullivan, Ice, & Niedermeyer (2000)	B	D, F, G	A	D	D
Watson & Belland (1985)	E				
	A. Full course	A. Gen. des/ devel./ evaluation proc.	A. K-12 schools	A. Problem analysis	A. Context/product specific
	B. Full program	B. Needs assessment	B. Postsecondary	B. Needs assessment	B. Context/product specific with some generalization
	C. Workshop	C. Content selection	C. Business and industry	C. Environmental anal.	C. Generalizations with some context/product specific
	D. Gen. print mat.	D. Design/development	D. Health care	D. Job analysis	D. Generalizations
	E. Instruct. module	E. Production	E. Military and govt. community educ.	E. Task analysis	E. Experimental
	F. Study guide	F. Form. evaluation/ usability	F. Continuing and employee	F. Learning hierarchy	F. Historical
	G. Job aid	G. Implementation/ utilization/delivery	G. Community educ. trng. —other	G. Sequencing	G. Observational
	H. Games/simulation	H. Management	H. International	H. Cost analysis	H. Philosophical
	I. Instruct. television	I. Summative evaluation	I. Context-free	I. Dissemination	I. Qualitative
	J. Computer-based	J. Learner outcomes	J. Learner outcomes	I. Learner verification	J. Survey
	K. Any project	K. No dev. involved	K. No dev. involved	J. Specific technique	K. Other
	L. Multimedia/Web-based			K. Prototype/usability testing	D. Generalizations
	M. Performance support system			L. Prototype/usability testing	

by implementing student and teacher attitude surveys and student achievement tests. In most cases, Type 1 developmental studies using evaluation research methods employ several techniques for collecting data.

41.3.1.3 The Nature of Conclusions from Type 1 Developmental Research. Type 1 studies are characterized by their reliance on contextually specific projects and contextually specific conclusions that emerge from such research. This is consistent with the more qualitative orientation of the research, with the applied nature of the research, and with the field's history of using practitioner experience as a source of knowledge.

Over three-quarters of the Type 1 representative developmental studies identified in Table 41.3 have conclusions that are either exclusively directed toward the target product and situation in which the project occurred or have predominantly context-specific conclusions, even though they did generalize to some extent to other situations. (See Table 41.3 for studies classified in terms of A and B types of conclusions.) These context-specific conclusions address issues such as the following.

- *Suggested improvements in the product or program* (Albero-Andres, 1983; Coyle, 1986; Corry, Frick, & Hansen, 1997; Crane & Mylonas, 1988; Cregger & Metzler, 1992; Fischer, Savenye, & Sullivan, 2002; Kanyarusoke, 1985; Klein et al., 2000; Link & Cherow-O'Leary, 1990; Martin & Bramble, 1996; McKenney, 2002; Mendes & Mendes, 1996; Munro & Towne, 1992; C. M. Russell, 1990)
- *The conditions that promote successful use of the product or program* (Borras, 1993; Dabbagh et al., 2000; Hirumi et al., 1994; McKenney, 2002; Munro & Towne, 1992; Pizzuto, 1983; Quinn, 1994; Ross, 1998)
- *The impact of the particular product or program* (Aukerman, 1987; Blackstone, 1990; Cantor, 1988; Fischer et al., 2002; Jones, 1986; Kearsley, 1985; Martin & Bramble, 1996; Petry & Edwards, 1984; Pirolli, 1991; Plummer et al., 1992; D. M. Russell, 1988)
- *The conditions that are conducive to efficient design, development, and/or evaluation of the instructional product or program* (Albero-Andres, 1983; Bednar, 1988; Blackstone, 1990; Buch, 1989; Capell & Dannenberg, 1993; Chou & Sun, 1996; Coyle, 1992; Dick, 1991; Harris & Cady, 1988; Herrington & Oliver, 2000; Jonassen, 1988; Jones, 1986; Kearsley, 1985; Link & Cherow-O'Leary, 1990; Martin & Bramble, 1996; McKenney, 2002; Mielke, 1990; Munro & Towne, 1992; Petry & Edwards, 1984; Pirolli, 1991; Quinn, 1994; C. M. Russell, 1990; D. M. Russell, 1988; Sullivan et al., 2000; Watson & Bellend, 1985)

Even though these conclusions are directed toward a particular product or program, it is clear that the foundational design and development procedures are as important as the product. However, it is possible for these conclusions, even though they are context specific, to provide direction to others who are confronting similar design and development projects.

Some Type 1 studies did present conclusions that were directed toward applications of a more general nature. It should

be noted that these studies (see C and D classifications, Table 41.3) were published in journals with a national audience. This may have influenced the manner in which the report was written, or it may have been recommended by a reviewer or even a condition of publication. In any case, many journal articles tend to be less focused on context-specific conclusions than dissertation research reports. The conclusions of these studies, especially those with a less formal quantitative design or with a more descriptive qualitative design, tend to be presented as "lessons learned" rather than as hypothesized relationships or predictions. These generalized lessons are often supported by and discussed in the context of current related literature as well as the design, development, and evaluation project that prompted them. The content of the conclusions in the studies identified in Table 41.3 with more generalized conclusions relate to the conditions that are conducive to efficient design, development, and/or evaluation of instructional products or programs (Alessi, 1988; Bowers & Tsai, 1990; Gay & Mazur, 1993; Medsker, 1992; Noel, 1991; Quinn, 1994; Sullivan, 1984; Sullivan et al., 2000).

41.3.1.4 Typical Type 1 Developmental Studies. This section has described the nature of Type 1 developmental research in terms of their focus, specifically examining the design, development, and evaluation processes addressed, the research methodologies employed, and the nature of their conclusions. While recent studies have been used to exemplify the range of Type 1 research, thus far particular studies have not been described in detail. Here, we summarize the research by McKenney (2002) and Sullivan et al. (2000) as studies that are representative of the group. These studies reflect the two key Type 1 research formats; McKenney's work was a doctoral dissertation and Sullivan and his co-researchers' was a long-term ID project published in a research journal.

The McKenney (2002) study examined the development of a computer program to support curriculum materials development in the context of secondary science and mathematics education in southern Africa. As with any traditional research project, the study was guided by predetermined questions and was embedded into a conceptual framework supported by current literature on curriculum development, teacher professional development, and computer-based performance support. The project was a careful and extensive documentation of the phases of ISD—needs and context analysis, design, development, and formative evaluation of several prototypes, and summative evaluation. Each phase included different expert and novice participant groups; a total of 510 participants from 15 countries was involved. Like many developmental research projects, the researcher used several different types of instruments for data collection including interviews, questionnaires, observations, logbooks, and document analysis. However, this study included more data collection than most; a total of 108 instruments was employed. Also typical of many Type 1 studies, the conclusions were focused on context-specific variables. McKenney (2002) discusses the validity, practicality, and potential impact of the computer-based performance support program. In addition, she discusses the design principles followed and provides suggestions for conducting developmental research.

McKenney's work (2002) is a detailed report of an extensive study that includes both context-specific and some generalized conclusions, although the clear focus of the study is on the design, development, and evaluation of a computer program to support curriculum development in Africa. As it is a study completed as part of the requirements of a doctoral degree, length is not an issue and the format was undoubtedly dictated by the degree requirements. On the other hand, the Sullivan et al. (2000) study was reported in a research journal. Consequently, it takes on a different form, even though it too is representative of Type 1 developmental research.

Sullivan et al. (2000) describe the development and implementation of a comprehensive K-12 energy education curriculum. When the article was published, the program had been implemented over a 20-year period and used by more than 12 million students in the United States. The report describes the components of the program itself including instructional objectives and test items covering a variety of learning outcomes such as facts, concepts, problem solving, and behavior change. A description of the instructional materials is also provided. Field test data such as posttest scores and student and teacher attitudes are reported and the implementation phase of the project is discussed in detail. Based on two decades of experience with the program, the authors provide 10 guidelines for long-term instructional development projects. The conclusions and recommendations are written in a more general tone; they are lessons learned from a specific practical situation.

The McKenney (2002) dissertation and Sullivan et al. (2000) article exemplify Type 1 developmental research. They are studies that

- describe and document a particular design, development, and evaluation project;
- employ standard design and development procedures;
- utilize a range of research methodologies and data collection instruments;
- draw conclusions from their research which are context specific; and
- tend to serve as dissemination vehicles for exemplary design, development, and/or evaluation strategies.

41.3.2 Type 2 Developmental Research

Type 2 developmental research is the most generalized of the various orientations and typically addresses the design, development, and evaluation processes themselves rather than a demonstration of such processes. The ultimate objective of this research is the production of knowledge, often in the form of a new (or an enhanced) design or development model. This research tends to emphasize

- the use of a particular design technique or process, such as formative evaluation; or
- the use of a comprehensive design, development, or evaluation model; or
- a general examination of design and development as it is commonly practiced in the workplace.

Fifty-eight examples of Type 2 research have been analyzed using the same framework previously employed in the analysis of Type 1, and the results are presented in Table 41.4.

41.3.2.1 Process Foci of Type 2 Developmental Research. We have previously distinguished between *doing* development and *studying* development. In Type 1 research there is a pattern of combining the doing and the studying in the process of discovering superior procedures. However, Type 2 research often does *not* begin with the actual development of an instructional product or program. These studies are more likely to focus on the more generic use of development processes, offering implications for *any* design or development project.

Type 2 studies are more likely to concentrate upon a particular ISD process, rather than the more comprehensive view of development. (See those studies in the Table 41.4 Process Focus column that are labeled B through J as opposed to those labeled A.) For example, Abdelraheem (1990) and Twitchell, Holton, and Trott (2000) both studied evaluation processes, one with respect to instructional module design and the other in reference to the practices of technical trainers in the United States. But while Abdelraheem was involved in a specific design and development project, Twitchell et al. were not. They studied the extent to which technical trainers employ accepted evaluation methods and techniques. The key difference between Type 1 and Type 2 studies that focus on a particular aspect of the total process is that goals of Type 2 studies tend to be more generalized, striving to enhance the ultimate models employed in these procedures. Type 1 research, on the other hand, is more confined to the analysis of a given project.

Type 2 developmental research projects span the entire range of design and development process components from needs assessment and performance analysis (Cowell, 2000; Kunneman & Sleezer, 2000; Tessmer, McCann, & Ludvigsen, 1999) to evaluation (Le Maistre, 1998; Phillips, 2000; Twitchell et al., 2000). In addition, there are studies that address design processes in a more generic fashion. Sample studies of this nature include those by Adamski (1998), Nelson (1990), Rowland (1992), Rowland and Adams (1999), Tracey (2002), Visscher-Voerman (1999), Klimczak and Wedman (1997), and Wedman and Tessmer (1993). This research is part of the growing body of literature contributing to an understanding of the nature of designer decision making. It provides another topical orientation in addition to those studies that examine the various components of traditional instructional systems design models.

Although the majority of the studies cited in Table 41.4 do not tackle the entire design and development process in a comprehensive fashion, some do. For example, Spector, Muraida, and Marlino (1992) proposed an enhanced ISD model for use in courseware authoring, which is grounded in cognitive theory. This use of this model was then described and evaluated in a military training environment. This is a good example of a Type 2 study. Likewise, Richey (1992) proposed a modified ISD procedural model that was based on an empirical examination of those factors that influence employee training effectiveness. This is another example of a comprehensive Type 2 study.

Recently, a few Type 2 studies have examined how ISD models can be applied in settings outside of traditional education

TABLE 41.4. An Analysis of Representative Type 2 Developmental Research Literature

Reference	Product or Program Focus	Process Focus	Use Context	Tools and Techniques Emphasized	Method(s) Used	Nature of Conclusions
Abdelraheem (1990)	E	F, J	A, H	J, K	E	C
Adamski (1998)	G	A	C	A, J, K	E, I, K, L	C
Beauchamp (1991)	K	A	A	B	J	D
Burkholder (1981–82)	E, A	F	B	K	E	D
Capell (1990)	J	A	B		B, I	D
Carliner (1998)		D	F		I	C
Cowell (2000)	K	B	C	B	I	D
Cummings (1985)	K	B	C		J	D
Driscoll & Tessmer (1985)	E, K	D, J	A	G, J	E	D
English & Reigeluth (1996)	D	D	B	G	D, I	D
Ford & Wood (1992)	K	D	I	E, F, G	D	C
Forsyth (1997)	B	A	F		I, D, K	C
Fuchs & Fuchs (1986)	A, K	F	A	J	K	D
Gauger (1987)	B	I	B, D		D	C
Goel & Pirolli (1988)	K	A, K	C		G, I	D
Hallam (2001)	K	C	I	E	J	D
Harrison et al. (1991)	B	A, G, H	B		I, J	C
Higgins & Reiser (1985)	K	D	C		E	D
Jones & Richey (2000)	E	A	C	A, J	Q	D
Julian (2001)	K	A	I		I	C
Keller (1987)	A, K	D	A, I	J	E, J, K	C
Kerr (1983)	A, E	A	A, B		J	C
Kim (1984)	K	A	H			C
King & Dille (1993)	K	A	C	H	A	B
Klimczak & Wedman (1997)	K	A	G		I, J	C
Kress (1990)	A	A	C		E, J	D
Kunnean & Sleezer (2000)	K	K	C		A	B
Le Maistre (1998)	K	F	I		I	B
Le Maistre & Weston (1996)	D	F	C		E	B
Lutz (1983)	K	A	I		H	D
McAleese (1988)	K	D	I	E, F, G	D	C
Means, Jonassen, & Dwyer (1997)	D, E	J	B		E	B
Nadolski, Kirschner, van Merriënboer, & Hummel (2001)	J	D	B	E, G	A, D, I	C
Nelson (1990)	K	A, K	G	A, D, E	G, I	D
Nicolson (1988)	K	D, E	B	E, F, G	D	C
Phillips (2000)	K	I	C	K	I	D
Piper (1991)	K	H	C	J	A	D
Pirolli (1991)	K	D, E	I	E, F, G	D	D
Plass & Salisbury (2002)	L	A	C, E	L	D	C

Richey (1992)	C, K	A, J	C	B, C	I, J	D
Riplinger (1987)	K	B, C	J	E	B, J	D
Rojas (1988)	C	I	C		D	D
Rowland (1992)	K	A, K	B, C, E		G, I	D
Rowland & Adams (1999)	K	A	B, C		J	D
Roytek (1999)	K	D	C	L	A, I, K	B
Shambaugh & Magliaro (2001)	A	A	B	J	A	C
Shellnut (1999)	K	A	A, B, C, D, E	K	J	D
Spector, Muraida, & Marilino (1992)	J	A, E	E	K	G	B
Taylor & Ellis (1991)	A	A	E		D	B
Tessmer, McCann, & Ludvigsen (1999)	B	B	C, D	B	A	D
Tracey (2002)	K	A	I		E, I, K	D
Twitchell, Holton, & Trott (2000)	K	F, I	C, G		J	D
Visser-Voerman, (1999)	K	A	I		A, I	D
Wagner (1984)	A, K	I	B	J, K	E	D
Wedman & Tessmer (1993)	K	A, K	C		J	D
Weston, McAlpine, & Bordonaro (1995)	K	F	I		B	D
Wreathall & Connelly (1992)	K	I, J	E	J, K	A, J	C
Zemke (1985)	K	A, K	C		J	B
	A. Full course	A. Gen. des/develop./ evaluation proc.	A. K-12 schools	A. Problem analysis	A. Case study	A. Context/product specific
	B. Full program	B. Needs assessment	B. Postsecondary	B. Needs assessment	B. Descriptive	B. Context/product specific with some generalization
	C. Workshop	C. Content selection	C. Business and industry	C. Environmental anal.	C. Ethnography	C. Generalizations with some context/product specific
	D. Gen. print mat.	D. Design/development	D. Health care	D. Job analysis	D. Evaluation	D. Generalizations with some context/product specific
	E. Instruct. module	E. Production	E. Military and govt.	E. Task analysis	E. Experimental	E. Generalizations with some context/product specific
	F. Study guide	F. Form. evaluation/ usability	F. Continuing and community educ.	F. Learning hierarchy	F. Historical	F. Generalizations with some context/product specific
	G. Job aid	G. Implementation/ utilization/delivery	G. Employee trng.—other	G. Sequencing	G. Observational	G. Generalizations with some context/product specific
	H. Games/simulation	H. Management	H. International	H. Cost analysis	H. Philosophical	H. Generalizations with some context/product specific
	I. Instruct. television	I. Summative evaluation	I. Context-free	I. Dissemination	I. Qualitative	I. Generalizations with some context/product specific
	J. Computer-based	J. Learner outcomes	J. Learner outcomes	J. Learner verification	J. Survey	J. Generalizations with some context/product specific
	K. Any project	K. No dev. involved	K. No dev. involved	K. Specific tech.	K. Other	K. Generalizations with some context/product specific
	L. Multimedia/Web-based			L. Prototype/usability testing		
	M. Performance support system					

and training. For example, Plass and Salisbury (2002) described and evaluated a design model for a Web-based knowledge management system. Carliner (1998) conducted a naturalistic study of design practices in a museum setting and proposed an enhanced model of instructional design for informal learning in museums. Both of these studies included empirical data to support the use of the ISD approach to nontraditional products and settings.

41.3.2.2 Research Methodologies Employed in Type 2 Developmental Research. While the case study served as the dominant methodological orientation of Type 1 developmental research, it is far less prominent in Type 2 studies. This is not surprising given the fact that Type 2 research typically does not involve a specific design and development project. There is a much greater diversity of research methods employed in the representative Type 2 studies identified in Table 41.4. Not only are experimental and quasi-experimental studies common, but this table even shows a study using philosophical techniques, as well as a variety of qualitative methodologies. (See Table 41.4's Research Methods Used column.)

Even though case studies are not the overwhelming norm in Type 2 research, they are nonetheless found. (See Table 41.4 for studies classified in terms of an A-type research methodology.) As with other developmental studies, case study techniques are sometimes employed in Type 2 research, which includes a description of the actual design and development processes followed in the creation of a particular product or in the demonstration of a particular process. Wreathall and Connelly (1992) document the development of a method of using performance indicators as a technique for determining training effectiveness. In true Type 1 fashion they describe the technique and the manner in which they applied it in a given context. This facet utilizes case study methods. However, they extend their study to verify the relevance of their technique through the use of a structured survey interview of other professionals in the field. (The latter phase of the research warrants its classification as a Type 2 study.) The Wreathall and Connelly study is typical of the Type 2 research, which uses case study methods in that the methods are used in combination with other research techniques.

Experimental and quasi-experimental techniques can serve a variety of functions in Type 2 developmental research. (See Table 41.4 for studies classified in terms of an E-type research methodology.) They are often used as a way of verifying the procedure in terms of learner outcomes. Means, Jonassen, and Dwyer (1997) examined the impact of embedding relevance strategies into instruction following the ARCS model by using experimental design to determine their influence on achievement and motivation. Keller (1987) used quasi-experimental methods to test the impact of the ARCS model as it was applied to the development of teacher in-service training workshops. Le Maistre and Weston (1996) used a counterbalanced design to examine the revision practices of instructional designers when they are provided with various types of data sources. In these studies, the experimentation is critical to the verification and evaluation of a particular design and development technique. This is not unlike the use of experimental and quasi-experimental techniques in other types of research.

Surveys are frequently used in Type 2 developmental studies. In Type 1 studies surveys were typically another means of determining product impact or effectiveness with learners and/or instructors in a given education or training situation. This technique is also used in Type 2 research as in the studies by Keller (1987) and Richey (1992). However, in Type 2 studies the survey is frequently used as a means of gathering data from designers in a variety of settings. Beauchamp (1991), Hallamon (2002), Klimczak and Wedman (1997), Rowland and Adams (1999), Twitchell et al. (2000), and Wedman and Tessmer (1993) all conducted surveys across a range of typical design environments—Beauchamp to validate the use a wide range of affective variables in the instructional design process, Hallamon to investigate the factors that influence the use of task analysis, Klimczak and Wedman to examine success factors in instructional design projects, Rowland and Adams to explore designers' perspectives toward systems thinking, Twitchell et al. to determine evaluation practices in technical training settings, and Wedman and Tessmer to analyze the nature of designer decisions.

Qualitative research methods are often employed in Type 2 developmental research studies. (See Table 41.4 for studies classified in terms of an I-type research methodology.) These studies frequently employ a structured interview to gather data from participants. For example, Nadolski, Kirschner, van Merriënboer, and Hummel (2001) used structured interviews to determine how different types of practitioners approached cognitive task analysis. Jones and Richey (2000) interviewed instructional designers and customers to investigate the use of rapid prototyping. Interviews are sometimes used in combination with other data collection methods. Visscher-Voerman (1999) conducted interviews of professional designers and analyzed project documents to determine the design strategies used in various training and education contexts. Richey (1992) conducted structured personal interviews with trainees to verify and/or expand the more quantitative data collected in her study. Similarly, Rowland (1992) used a systematic posttask interview in addition to other data collection techniques designed to document one's decision-making processes.

In addition to interviews, other qualitative methods are used in Type 2 studies. English and Reigeluth (1996) used qualitative data analysis techniques to examine the use of elaboration theory for sequencing instruction. Harrison et al. (1991) used qualitative data in the development of a distance education assessment instrument. Nelson's (1990) Le Maistre's (1998), Nelson's (1990), and Rowland's (1992) use of "think-aloud protocols" reflects not only a cognitive orientation, but also a qualitative one.

41.3.2.3 The Nature of Conclusions from Type 2 Developmental Research. Type 2 studies are unique among developmental research in that they are ultimately directed toward general principles, which are applicable in a wide range of design and development projects. Those studies described in Table 41.4 are typical. Most of these studies present generalized conclusions (see the studies in Table 41.4 that are classified in terms of C and D types of conclusions), and the majority of these studies have *all* generalized conclusions.

The nature of the conclusions in Type 2 research also varies somewhat from that in Type 1. The most noticeable difference is that the Type 2 conclusions pertain to a technique or model, as

opposed to a product or program. The issues that are addressed in these conclusions can be summarized in the following manner.

- *Evidence of the validity and/or effectiveness of a particular technique or model* (Adamski, 1998; Beauchamp, 1991; Burkholder, 1981–1982; Driscoll & Tessmer, 1985; English & Reigeluth, 1996; Forsyth, 1998; Fuchs & Fuchs, 1986; Gauger, 1987; Harrison et al., 1991; Keller, 1987; Kim, 1984; Kress, 1990; Kunneman & Sleezer, 2000; Means et al., 1997; Nadolski et al., 2001; Plass & Salisbury, 2002; Richey, 1992; Shambaugh & Magliaro, 2001; Shellnut, 1999; Tessmer et al., 1999; Twitchell et al., 2000; Tracey, 2002; Wagner, 1984; Weston, McAlpine, & Bordonaro, 1995; Wreathall & Connelly, 1992)
- *Conditions and procedures that facilitate the successful use of a particular technique or model* (Abdelraheem, 1990; Adamski, 1998; Beauchamp, 1991; Burkholder, 1981–1982; Cowall, 2001; Cummings, 1985; English & Reigeluth, 1996; Ford & Wood, 1992; Forsyth, 1998; Fuchs & Fuchs, 1986; Gauger, 1987; Goel & Pirolli, 1988; Hallamon, 2002; Jones & Richey, 2000; Keller, 1987; Kim, 1984; King & Dille, 1993; Kress, 1990; Le Maistre & Weston, 1996; Nelson, 1990; Nicholson, 1988; Phillips, 2000; Piper, 1991; Rowland, 1992; Rowland & Adams, 1999; Roytek, 2000; Shambaugh & Magliaro, 2001; Shellnut, 1999; Spector et al., 1992; Tracey, 2002; Twitchell et al., 2000; Visscher-Voerman, 1999)
- *Explanations of the successes or failures encountered in using a particular technique or model* (Cowall, 2001; Higgins & Reiser, 1985; Jones & Richey, 2000; Kerr, 1983; King & Dille, 1993; Klimczak & Wedman, 1997; Kress, 1990; Le Maistre & Weston, 1996; McAleese, 1988; Means et al., 1997; Nicolson, 1988; Pirolli, 1991; Roytek, 2000; Taylor & Ellis, 1991; Tracey, 2002; Wedman & Tessmer, 1993; Zemke, 1985)
- *A synthesis of events and/or opinions related to the use of a particular technique or model* (Carliner, 1998; Cowall, 2001; Jones & Richey, 2000; Julian, 2001; Le Maistre, 1998; Luiz, 1983; Nadolski et al., 2001; Phillips, 2000; Pirolli, 1991; Riplinger, 1987; Rojas, 1988; Roytek, 2000; Visscher-Voerman, 1999; Weston et al., 1995)
- *A new or enhanced design, development, and/or evaluation model* (Adamski, 1998; Beauchamp, 1991; Carliner, 1998; Forsyth, 1998; Jones & Richey, 2000; King & Dille, 1993; McAleese, 1988; Nadolski et al., 2001; Plass & Salisbury, 2002; Richey, 1992; Spector et al., 1992; Tessmer et al., 1999; Tracey, 2002; Wedman & Tessmer, 1993)

It is not uncommon for a given Type 2 study to generate more than one type of conclusion. This was less likely to be the case with respect to Type 1 developmental research.

41.3.2.4 Typical Type 2 Developmental Studies. We now illustrate two typical Type 2 research studies in more detail. Tessmer et al. (1999)⁴ described a theoretical and procedural model for conducting a type of needs assessment, called *Needs*

reassessment. According to the authors, “Needs reassessment is a hybrid process, one that has the purposes of needs assessment and the timing of summative evaluation” (p. 86). The model is used to reassess existing training programs to determine if training excesses and deficiencies exist. Like many other authors in the field who propose a new ISD model, Tessmer et al. (1999) use an acronym for their model—CODE—which stands for the four foci of the needs reassessment process (criticality, opportunity, difficulty, and emphasis). However, unlike many recent ISD models, the validity of the CODE model was empirically tested. Tessmer et al. (1999) report on two studies—a needs reassessment of corporate training program and a medical training program reassessment. Both employed the case study method to examine the application of the CODE model. A variety of data sources was used including surveys, interviews, and extant data analysis. The authors provide generalized conclusions but wisely caution that their model requires further validation in other instructional settings.

Another example of Type 2 developmental research is a study by Jones and Richey (2000). These authors conducted an in-depth examination of the use of rapid prototyping methods in two instructional design projects in natural work settings. The study used qualitative methods; data were collected from structured personal interviews, activity logs, and a review of extant data. Participants included two experienced instructional designers who employed rapid prototyping to the design and development of two projects—a 1-day instructor led course with a matching on-line tutorial for the automotive industry and a 1-day instructor led training program in the health-care industry. In addition, one client was interviewed to obtain perceptions of product quality and usability, cycle time reduction, and customer satisfaction. After discussing how rapid prototyping was successfully used in the context of the study, Jones and Richey (2000) provide generalized conclusions and suggest a revised model of ISD that includes rapid prototyping.

Each of these studies represents Type 2 developmental research. They are typical of Type 2 studies because of the following characteristics:

- an orientation toward studying the design and development process, rather than demonstrating particular strategies;
- a tendency toward the use of multiple sources of data;
- a tendency to develop generalized principles and conclusions with respect to the design and development process, or a part of the process; and
- an effort to identify, describe, explain, or validate those conditions that facilitate successful design and development.

41.4 THE METHODOLOGY OF DEVELOPMENTAL RESEARCH

The aim of this section is to provide some methodological direction to those entertaining a developmental research project. In

⁴The article by Tessmer et al. won the 1999 ETR&D Award for Outstanding Research on Instructional Development. The award is given by the development section of *Educational Technology Research and Development (ETR&D)* for the best paper describing research findings that can be used to improve the process of instructional design, development, and evaluation.

essence, it is a discussion of establishing the credibility of a given developmental study by assuring authenticity and methodological rigor. Because many topics can be addressed in a number of ways, this section may also help one recognize the potential of a given problem to be addressed as a developmental topic. This section describes developmental methodologies in terms of the traditional stages of planning and reporting research projects:

- problem definition,
- literature reviews, and
- research procedures.

41.4.1 Defining the Research Problem

The perceived authenticity of a particular developmental research project often depends on the problem selected. Is the problem one that is common to many designers and developers? Is it one that is currently critical to the profession? Does the problem reflect realistic constraints and conditions typically faced by designers? Does the problem pertain to cutting-edge technologies and processes? Answers to these questions predict not only interest in the project, but also whether the research is viewed as relevant. “Explorations of research relevance are typically examinations of shared perceptions, the extent to which researchers’ notions of relevance are congruent with the perceptions and needs of practitioners” (Richey, 1998, p. 8). This is particularly true with developmental research, where the object of such research is clearly not simply knowledge, but knowledge that practitioners consider usable.

41.4.1.1 Focusing the Problem. Given a relevant topic, the research project must first be given a “developmental twist.” This begins in the problem definition stage. It is done by focusing the research problem on a particular aspect of the design, development, or evaluation *process*, as opposed to focusing on a particular variable that impacts learning or, perhaps, the impact of a type of media (to name two alternative approaches). Type 1 developmental studies focus upon a given instructional product, program, process, or tool. They reflect an interest in identifying either general development principles or situation-specific recommendations. These studies may ultimately validate a particular design or development technique or tool. Type 2 studies, on the other hand, focus on a given design, development or evaluation model or process. They may involve constructing and validating unique design models and processes, as well as identifying those conditions that facilitate their successful use.

The problem definition stage must also establish the research parameters. At the minimum, this involves determining whether the research will be conducted as the design and development is occurring or whether retrospective data will be collected on a *previously* developed program or set of materials. Then the scope of the study must be established. How much of the design and development process will be addressed? Will the research address

- all parts of the *design* of the instruction?
- the *development* (or part of the development) of the instruction?

- the *evaluation* of the instruction? If so, will formative, and summative, and confirmative evaluation be addressed?
- the *revision* and *retesting* of the instruction?

Developmental studies often are structured in phases. For example, comprehensive Type 1 studies may have an analysis phase, design phase, a development phase, and a try-out and evaluation phase. Another organization of a Type 1 study would include phases directed toward first analysis, then prototype development and testing, and, finally, prototype revision and retesting. McKinney (2001) is an example of this type of study. Type 2 studies may have a model construction phase, a model implementation phase, and a model validation phase. Forsyth (1998), Adamski (1998), and Tracey (2002) followed this pattern. In these studies the model construction phase was further divided to include comprehensive literature reviews, model construction, and model revision phases.

41.4.1.2 Framing the Problem. Seels (1994) describes typical processes one uses to explain the goals of a developmental research project. For example, *research questions*, rather than hypotheses, commonly serve as the organizing framework for developmental studies. This tactic is appropriate if there is not a firm base in the literature that one can use as a basis for formulating a hypothesis. This is often the case with such research, especially if the problem focuses on emerging technologies. However, research questions are also more appropriate for qualitative research, a common developmental methodology.

41.4.1.3 Identifying Limitations. Because developmental research is often context specific, one must be particularly concerned with the limitations or unique conditions that may be operating in a particular study. Such limitations will effect the extent to which one may generalize the conclusions of the study. The results may be applicable only in the situation studied or to others with similar characteristics, rather than being generalizable to a wider range of instructional environments.

41.4.2 Review of Related Literature

Typically, literature reviews concentrate on the specific variables being studied, usually the independent and dependent variables. This orientation may not prove useful in many developmental studies. The goal of the literature review, however, remains the same as with other types of research projects. It is to establish the conceptual foundations of the study.

The literature review in Type 1 developmental studies, for example, may address topics, such as

- procedural models that might be appropriate for the task at hand;
- characteristics of similar effective instructional products, programs, or delivery systems;
- factors that have impacted the use of the target development processes in other situations; and

- factors impacting the implementation and management of the target instructional product, program, or delivery system in other situations.

Literature reviews in Type 2 studies may address topics such as

- a description of models (either formally published or currently in use) similar to the one being studied, including their strengths and weaknesses;
- research on the targeted process (for example, task analysis or evaluation of organizational impact); and
- research on factors impacting the use of a given model or process (for example, factors that facilitate the use of rapid prototyping models).

Both types of studies often address the methodology of developmental research itself in the literature review.

In developmental studies directed toward innovative instructional environments or innovative design and development processes, it would not be unusual to find little research in the literature that is *directly* relevant. In such cases the researcher must still identify literature that is relevant to the foundational theory of the project, even though the link may be indirect. For example, there *is* literature on factors that affect the use of computers and other media in instruction, but there may be little on factors related to the specific use of virtual reality as a delivery system. In developmental research the conceptual framework for the study may be found in literature from actual practice environments (such as an evaluation report) as well as from traditional research literature directed toward theory construction.

41.4.3 Research Procedures

Often developmental research occurs in natural work environments. This tends to enhance the credibility of the research, as well as create methodological dilemmas for the researcher. Nonetheless, whether the research is conducted during the design and development process or retrospectively, the best research pertains to actual projects, rather than simulated or idealized projects. Perhaps it is the “real-life” aspect of developmental research that results in studies that frequently take even more time to complete than other types of research. There are often more changes in one’s research plans and procedures as a result of unanticipated events than is typical in other types of research. Consequently, detailed research procedures and time lines are most important.

41.4.3.1 Participants. There are often multiple types of participants in a given developmental research project, and if the study is conducted in phases, the participants may vary among phases. The nature of the participating populations tends to vary with the type of developmental research being conducted. Typical populations include

- designers, developers, and evaluators;
- clients;
- instructors and/or program facilitators;

TABLE 41.5. Common Participants in Developmental Research Studies

Developmental Research	Function/Phase	Type of Participant
Type 1	Product design & development	Designers, Developers, Clients
Type 1	Product evaluation	Evaluators, Clients, Learners, Instructors, Organizations
Type 1	Validation of tool or technique	Designers, Developers, Evaluators, Users
Type 2	Model development	Designers, Developers, Evaluators, Researchers, Theorists
Type 2	Model use	Designers, Developers, Evaluators, Clients
Type 2	Model validation	Designers, Developers, Evaluators, Clients, Learners, Instructors, Organizations

- organizations;
- design and development researchers and theorists; and
- learners and other types of users.

Table 41.5 shows the array of persons that most commonly participate in these projects and the various phases of the project in which they tend to contribute data.

For example, participants in the Tracey (2002) study included researchers and theorists in model development, designers in model use, and learners and instructors in model validation. This was a comprehensive Type 2 study. The participants in Jones and Richey’s (2000) Type 2 study were designers, developers, and clients. This study primarily addressed model use. McKenney’s research (2002) was a Type 1 study. Here, in the phase addressing the construction and prototyping of an electronic design tool, the participants were developers, users, evaluators, and a variety of ID experts. Then, in the phase evaluating and validating the tool, participants were users (preservice and in-service teachers and curriculum developers, i.e., designers) and experts.

41.4.3.2 Research Design. It is not uncommon for a developmental research project to also utilize multiple research methodologies and designs, with different designs again being used for different phases of the project. Table 41.6 presents a summary of those research methods that are most frequently used in the various types and phases of developmental research. This table reflects those studies presented in Tables 41.3 and 41.4.

Table 41.6 highlights some typical methodology patterns used in developmental studies. In Type 1 studies critical design and development processes are often explicated using case study methods. Interviews, observations, and document analysis are techniques used to gather the case study data and to document the processes used and the conditions under which they are employed as well. Pizzuto’s (1983) development of a simulation game is a classic example of this type of methodology.

TABLE 41.6. Common Research Methods Employed in Developmental Research Studies

Developmental Research Type	Function/Phase	Research Methodologies Employed
Type 1	Product design & development	Case study, In-depth interview, Field observation, Document analysis
Type 1	Product evaluation	Evaluation, Case study, Survey, In-depth interview, Document analysis
Type 1	Validation of tool or technique	Evaluation, Experimental, Expert review, In-depth interview, Survey
Type 2	Model development	Literature review, Case study, Survey, Delphi, Think-aloud protocols
Type 2	Model use	Survey, In-depth interview, Case study, Field observation, Document analysis
Type 2	Model validation	Experimental, In-depth interview, Expert review, Replication

Evaluation research techniques are often employed in Type 1 studies to determine the effectiveness of the resulting product or the particular techniques used during the design and development project. As with all evaluation research, a variety of data collection techniques is possible. Sullivan and co-Researchers' (2000) examination of the development and use of a K-12 energy education program employed a formal evaluation design, in addition to a case study. Smith (1993) used in-depth interviews and document analysis techniques in her evaluation of an executive development program. Sometimes, a full experiment is constructed to test the product or technique.

In Type 2 research models of the full design and development process, or of a particular part of the process, are constructed in a variety of ways, including the following.

- By conducting surveys of designers and developers with regard to projects in which they have been involved, such as Shellnut's (1999) study of motivation design or Phillip's (2000) study of organizational impact evaluation techniques
- By synthesizing models from the literature, such as Adamski's (1998) reviews of instructional technology, human factors, and aviation literature in his efforts to devise an initial model for designing job performance aids for use in high-risk settings
- By arriving at a consensus of opinion of respects experts in the field using Delphi techniques, such as Tracey's (2002) methods of finalizing her multiple intelligence design model
- By conducting experiments to validate particular design and development models, such as Tracey's (2002) and Adamski's (1998) projects

Developmental researchers are commonly confronted by methodological dilemmas. One is the need to account for contextual variables, especially in those studies taking place in a natural work setting. For example, to what extent do the client's design experience and sophistication, or designer expertise, or time pressures impact the success of a particular project? Because it is typically not possible to control such factors in the research design, the researcher is then obligated to describe

(and measure, if possible) these variables carefully in an effort to account for their impact.

Another common situation that is potentially problematic is when the researcher is also a participant in the study, such as when the researcher is also the designer or developer. Although this situation is not preferable, it is not unusual. Care must be taken to ensure objectivity through consistent, systematic data collection techniques and the collection of corroborating data, if possible. Often structured logs and diaries completed by several project participants according to a regularly established schedule create a structure that facilitates the generation of reliable and comparable data.

Another frequent problem is maintaining the integrity of recall data. Many studies rely on self-reports of past projects. Others use structured interviews of participants. Using previously prepared documents or data from others involved in the same project facilitates a triangulation process to validate the data collected.

41.4.3.3 Collecting, Analyzing, and Reporting Data.

Data collection in a developmental study takes a variety of forms depending on the focus of the research. The validity of the conclusions is often dependent on the richness of the data set as well as the quality of the research design. Typical types of data collected in developmental research relate to

- documentation of the design, development, and evaluation tasks, including profiling the design and development context and collecting data such as work time and expenses, problems encountered and decisions made, adjustments made in the original plans, designer reactions and attitudes, or records of concurrent work patterns;
- documentation of the conditions under which the development and implementation took place, including factors such as equipment and resources available, participant expertise and background, or time and client constraints; and
- identification of the results of predesign needs assessments, formative, summative, and confirmative evaluations,

including documentation of the target populations and the implementation context and measures of learning, transfer, and the impact of the intervention on the organization.

As with all research projects, participants must be fully informed of the nature of the research, not be coerced to be involved, and be assured that the data will be both anonymous and confidential. Not only must the participants be informed and give their consent, but often written consent from their organizations is required as well. Data may be sensitive and proprietary in nature, and researchers must be attuned to these issues and their ramifications.

Data analysis and synthesis in a developmental study are not unlike those in other research projects. There are likely to be descriptive data presentations and qualitative data analyses using data from documentation, interviews, and observations. Traditional quantitative data analyses techniques are used as well.

The best techniques for reporting developmental data, however, have not been firmly established. There can be a massive amount of data, especially with Type 1 studies. Journals do not provide for a detailed documentation of such data. Often, the raw data sets are too massive even to include in a dissertation appendix.

In response to this dilemma, some researchers are using Web sites as data repositories. For example, full results of a needs assessment may be included in a Web site, or complete copies of electronic tools can be provided, or full transcripts of designer interviews can be presented. Assuming that these Web sites are stable and accurate, this solution allows for full disclosure of data that should prove valuable to practitioners and researchers alike. With full data sets, practitioners should be to apply general lessons to their own work environments. With full data sets, researchers should have opportunities for secondary analysis of data (an option seldom available to researchers in this field), as well as opportunities to replicate fully the research in other settings.

41.5 RECENT INNOVATIVE DEVELOPMENTAL RESEARCH

Recently, innovative lines of developmental research have extended the boundaries of the more traditional orientation to developmental research previously discussed in this chapter. This work concerns mainly the development of instructional design using newer models and procedures of instructional design that reflect the influence of cognitive science, especially with respect to higher-level cognitive skills (van Merriënboer, Jelsma, & Paas, 1992). Moreover, constructivist influences are evident in the emphasis on the role of context in design (Richey & Tessmer, 1995), in examination of the social and collaborative nature of learning (Duffy & Jonassen, 1992), and in the development of new approaches to instruction such as anchored instruction (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990), or case-based instruction (Schank, Berman, & Macpherson, 1999). The more recent research to be considered here addresses areas such as designer decision making, knowledge acquisition tools, and the use of automated development tools.

By its very nature, the research on designer decision making is Type 2 research aimed at understanding and improving the design process. The other research tends to focus on improving the design process through the development of new tools and techniques. Sometimes this is Type 1 research involving a particular product or context, but more frequently it is Type 2 research oriented toward the development of generic tools. The following section summarizes important findings and issues emerging from these research activities.

41.5.1 Trends in Research on Design and Designer Decision Making

Design has been described as decision making, simulation, a creative activity, a scientific process or “a very complicated act of faith” (Freeman, 1983, p. 3). Research on how people design, regardless of what is being designed, has shown that designers select certain elements from a large number of possibilities and combine these elements to develop a functional and aesthetically pleasing solution to a problem (Zaff, 1987). Although a definitive, unified description of how people design is yet to be fully developed (Shedroff, 1994), most researchers agree that design combines both rational and intuitive thought processes that are derived from the knowledge and creativity of the designer (Nadin & Novak, 1987).

To understand the design process, it is necessary to distinguish design activities from other forms of thinking. The theoretical basis for most studies of design comes from the literature on human problem solving, where Simon (1981) suggests an all-encompassing view of design that incorporates nearly any kind of planning activity. In fact, he considers design as a fundamental characteristic of human thought: Everyone designs who devises courses of action aimed at changing existing situations into preferred ones. Simon’s conception of design as problem solving leads to the characterization of design as a process of optimization among various solution alternatives.

An alternative theoretical orientation views design as an experiential, constructive process where an individual designer shapes the problem and solution through cycles of situated action and reflection (Suchman, 1987). In this sense, design problems are constructed by the designer through a process of “dialogue” with the situation in which the designer engages in metaphorical processes that relate the current design state to the repertoire of objects/solutions known by the designer. Design typically flows through four major stages: *naming* (where designers identify the main issues in the problem), *framing* (establishing the parameters of the problem), *moving* (taking an experimental design action), and *reflecting* (evaluating and criticizing the move and the frame). Schon (1983, 1985, 1987) has noted that designers reflect on moves in three ways: by judging the desirability and consequences of the move, by examining the implications of a move in terms of conformity or violation of earlier moves, and by understanding new problems or potentials the move has created. In part, this involves “seeing” the current situation in a new way (Rowland, 1993). As a designer moves through the design process, the situation “talks back” to the designer and causes a reframing of the problem. This reframing

is often accomplished by relating the current situation to previous experiences. Obstacles or difficulties in the design situation provide opportunities for new insights into the problem. Because of its cyclical nature, design thinking naturally benefits from reflection in action, and designers often maintain sketchbooks and diaries to support reflection (Cheng, 2000; Webster, 2001). These and other aspects of reflection assume that a designer possesses a willingness to be thoughtful and reflective, is able to understand the context in which assumptions and actions are formed, and is willing to explore alternatives and be exposed to interpretive considerations through dialogue with others (Moallem, 1998). In some sense, a designer is engaged in learning as well as design, because the designer's personal knowledge structures are altered by the information present in the design environment (McAleese, 1988).

From a social view, design is a collaborative activity where conversation, argumentation, and persuasion are used to achieve consensus about perspectives and actions that might be taken to solve the design problem (Bucciarelli, 2001; Lave & Wenger, 1991; Stumpf & McDonnell, 1999). The design process, therefore, includes both shared and distributed cognition (Lanzara, 1983; Roth, 2001), with the design team developing a shared understanding of the problem through conversations and representations (Hedberg & Sims, 2001; Rowland, 1996), and a solution to the problem through individual and collaborative design efforts (Hutchins, 1991; Walz, Elam, & Curtis, 1993). Often, collaborative design processes generate questions and requests for information and opinions among group members. Conflicting viewpoints are debated and differences of opinion are negotiated. Mutually agreeable solutions result from rethinking, restructuring, and synthesizing alternate points of view. In this way, dialogue transforms individual thinking, creating collective thought and socially constructed knowledge within the team (Sherry & Myers, 1998).

41.5.1.1 The Instructional Design Task Environment.

What makes design a special form of problem solving, in part, is the nature of design problems. Reitman (1964) has identified a category of problems that he calls "ill defined," where starting states, goal states, and allowable transformations of the problem are not specified. Simon (1973) proposes a similar classification but notes that problems can fall along a continuum between well defined and ill defined. The point at which a problem becomes ill defined is largely a function of the problem solver, in that the goals, attitudes, and knowledge of the problem solver determine the degree to which a problem may be ill defined. Goel and Pirolli (1988) take issue with Simon's broad characterization of design. They identify several features that distinguish design from other forms of problem solving, including the initial "fuzziness" of the problem statement, limited or delayed feedback from the world during problem-solving activities, an artifact that must function independently from the designer, and "no right or wrong answers, only better and worse ones" (Goel & Pirolli, 1988, p. 7). Chandrasekaran (1987) concurs, noting that at one extreme are those rare design problems that require innovative behavior where neither the knowledge sources nor the problem-solving strategies are known in advance. Such activity might be more properly termed creating or inventing,

and results in a completely new product. Other design problems are closer to routine but may require some innovation because of the introduction of new requirements for a product that has already been designed.

Certainly, how a designer functions in the design environment is related to what is being designed (the design task environment). Initially, design goals are often poorly specified and can involve the performance goals for the object or system, constraints on the development process (such as cost), or constraints on the design process (such as time required for completion). Part of the designer's task is to formulate more specific goals based on the constraints of the problem. The designer then identifies criteria for selecting and eliminating various elements and, finally, makes decisions based on these criteria (Kerr, 1983). Pirolli and Greeno (1988) noted that the instructional design task environment consists of "the alternatives that a problem solver has available and the various states that can be produced during problem solving by the decisions that the problem solver makes in choosing among alternatives" (p. 182). They suggest that instructional design has three levels of generality: global, intermediate, and local. At each level, designers are concerned with three types of issues: goals and constraints, technological resources, and theoretical resources. Global-level design decisions are concerned mainly with the content and goals of instruction. At the intermediate level, lessons and activities are identified and sequenced. At the local level, instructional designers make decisions about how information is to be presented to learners and how specific learning tasks are to be organized. This description of the instructional design task environment is similar in many respects to the "variables" of instruction identified by Reigeluth (1983a). However, Pirolli and Greeno (1988) also noted an interesting gap in instructional design research: nearly all of the descriptive and prescriptive theories of instructional design focus on instructional products, while there is little research dedicated to describing the instructional design process. A few researchers have subsequently addressed issues surrounding the instructional design task environment (Dijkstra, 2001; Murphy, 1992), attempting to draw parallels to other design domains. Rathbun (1999) has provided a comprehensive activity-oriented analysis of the work of instructional design that confirms many of the theoretical predictions of design studies in other areas. Other researchers have established that the way the process is portrayed visually impacts a designer's impression of the process (Branch, 1997; Branch & Bloom, 1995; Rezabek & Cochenour, 1996). New approaches to instructional design have emerged as designers explore procedural techniques from other fields, such as rapid prototyping (Rathbun, 1997) and situated instructional design (Rowland, 1993; Wilson, 1995). Research has also focused on collaborative aspects of the instructional design and development process, to understand and improve design team interactions (Hedberg & Sims, 2001), content production procedures (Keppel, 2001), and project management strategies (McDaniel & Liu, 1996; Phillips, 2001)

41.5.1.2 Design Thinking and Instructional Design.

Studies of the cognitive processes of designers in domains other than instructional design indicate that the design process is iterative and cyclical, with two distinct categories of

designer behavior: problem structuring and problem solving (Akin, Chen, Dave, & Pithavadian, 1986). Problem structuring transforms the information obtained through functional analysis into scenarios that partition the design space into a hierarchical organization of design units along with the parameters of the units and relationships between units. The design units are then arranged in various ways until a solution is found that meets the requirements and constraints established earlier. Furthermore, the structure of the problem can affect the designer's performance. When the information of a design problem is provided in a more hierarchical structure, solutions tend to be faster, more clustered, stable, and more successful in satisfying design requirements (Carroll, Thomas, Miller, & Friedman, 1980). While problem structuring establishes the problem space, problem solving completes the design task by producing solutions that satisfy the requirements and constraints for each design unit. Solution proceeds under a control structure that is established through problem structuring and consists of successive generate/test actions that progress toward the final solution. Problem solving in design also contains a feedback component that communicates results of the solution to higher levels, where restructuring of the problem space can be undertaken if the partial solution demands such an action (Akin et al., 1986).

In their studies of the design process, Goel and Pirolli (1988) noted a number of additional characteristics of design problem solving. Observations of three experienced designers (an architect, a mechanical engineer, and an instructional designer) using think-aloud protocols revealed that during the design task these designers engaged in extensive problem structuring (decomposing the problem into modules) and performance modeling of the artifact at various stages of its design. Each designer also employed evaluation functions and "stopping rules" that controlled the decomposition of the problem. Designers tended to evaluate their decisions at several levels continuously through the process, employing cognitive strategies to decompose problems into "leaky modules" (Goel & Pirolli, 1988, p. 20). Although extensive restructuring of the design problem into several modules was observed, the designers did not encapsulate each module, but rather they monitored the design process to assure that decisions made in one module did not adversely affect other modules. The designers handled "leaks" between modules by "plugging" the leaks, that is, ignoring the effects of low-level decisions in one module after making high-level assumptions about the other modules.

Several other studies have provided valuable insights into the design process. Kerr (1983) studied the thought processes of 26 novice instructional designers using interviews and planning documents produced by the designers during a graduate course in instructional design. He found that the processes employed by the designers were not systematic, that their solutions were generated based largely on their personal experiences in various instructional settings, and that problem constraints greatly influenced their solutions. Using a think-aloud task and protocol analysis, Nelson (1990) studied the initial phase of problem structuring in four experienced instructional designers. Although the experimental task only approximated a "first pass" at the problem, the designers tended to focus on information related to available resources, the learners, and the skills to

be trained. Specific information regarding content and learning tasks was not examined in detail. It was also apparent that specific pieces of information constrained the possible solutions that the designers considered. In other words, a "stopping rule" was evoked that led the designers to a particular solution without considering additional alternatives (Goel & Pirolli, 1988). A more comprehensive study of instructional designers was reported by Rowland (1992), where four expert and four novice designers were given a task to design instruction for an industrial setting involving training employees to operate two hypothetical machines. Verbal reports of the designers' thoughts while completing the task were coded and analyzed, and the results of this study suggest that the design process alternates between two phases that Rowland terms *problem understanding* and *solution generation* (p. 71). Experts tended to take much more time in the problem understanding phase, constructing a rich representation of the problem that was guided by a template, or mental model, of the process (Rowland, 1992). Novices did not develop a rich representation of the problem, relying on the materials given rather than making inferences about the constraints of the problem or the structure of the content. They also quickly began to generate possible solutions after briefly examining the problem materials and frequently returned to the problem materials as the process unfolded. Consequently, their problem representation grew as they progressed through the solution generation phase.

Observations of designer behavior using a case study methodology (Spector et al., 1992) have revealed that many variables affect the ability of designers to author computer-based instruction effectively, especially prior experience (both as a designer and with computer-based authoring systems). In another context, a naturalistic study of instructional design for informal learning settings noted the effects of constraints on the design process (Carliner, 1998). Other studies of instructional design practice have employed self-report methods using surveys to elicit designers' opinions about how they actually practice instructional design. Zemke's (1985) survey indicated that instructional designers in business and industry are selective in terms of the design activities in which they engage, often ignoring needs assessment, task analysis, and follow-up evaluations. Similar results were found by Mann (1996). Wedman and Tessmer (1993) extended this work by examining the factors that might contribute to the selective use of instructional design activities. Surveys of more than 70 instructional design professionals indicated that activities such as writing learning objectives, developing test items, and selecting media and instructional strategies are nearly always completed. On the other hand, these designers reported that needs assessment, task analysis, assessing entry-level skills, and pilot testing instruction are performed selectively, if ever. Reasons for not performing some activities included lack of time and that the decisions had already been made by others. Interestingly, lack of money or expertise in performing the activity was rarely cited as a reason the activities were not performed.

41.5.1.3 The Role of Knowledge in the Design Process. The success of the designer's problem-solving processes is directly related to the designer's experience and knowledge

in the design task environment. Researchers have speculated about general cognitive structures for design that contain both the elements of a designed product and the processes necessary for generating the design (Akin, 1979; Jeffries, Turner, Polson, & Atwood, 1981). Goel and Pirolli (1988) also discuss the role of knowledge in the design process, noting that the personal knowledge of expert designers is organized in rich and intricate memory structures that contain both general knowledge (extracted from the totality of an individual's life experiences) and domain-specific knowledge derived from their professional training. This knowledge is used in many cases as a template for understanding the characteristics of the design task, as well as generating solutions.

So it seems that a well-organized knowledge base for instructional design is crucial to the process. The knowledge available to instructional designers, either individual knowledge stored in memory or other forms of knowledge embodied in the models and tools used for design, will influence the kinds of instruction they create (Nelson & Orey, 1991). An instructional designer's knowledge base should include not only conceptual and procedural structures for controlling the design process, but also cases or scenarios of exemplary instructional products and solutions that can be recalled and applied to particular situations (Nelson, Magliaro, & Sherman, 1988; Rowland, 1993). It is also necessary for an instructional designer to be familiar with concepts and procedures derived from general systems theory, psychological theory, instructional theory, and message design (Richey, 1993). In fact, it has been argued that successful implementation of instructional design procedures ultimately depends on whether designers have "adequate understanding and training in higher-order problem-solving principles and skills such that the necessary expertise can be applied in the process" (McCombs, 1986, p. 78). More recent studies suggest that complex case studies grounded in real-world, ill-defined problems are effective in developing the kind of knowledge and expertise necessary to be an effective instructional designer.

41.5.1.4 Overview of Designer Decision-Making Studies as Developmental Research. Designer decision-making research is typically Type 2 research and has the ultimate goal of understanding the design process and, at times, producing design models that more closely match actual design activity. The populations of the studies are naturally designers—not learners—and frequently designers are classified as either novice or expert. The effort to identify the impact of various design environments is a common secondary objective. Consequently, the project itself is often a second unit of analysis and data are collected on the nature of the content, work resources, and constraints. Methodologically the studies tend to be more qualitative in nature, although survey methods are not uncommon.

41.5.2 Trends in Research on Automated Instructional Design and Development

The systematic instructional design and development procedures common to our field have been developed as a means to

organize and control what is essentially a very complicated engineering process. Even with systematic methods, however, the instructional design process can become very time-consuming and costly (O'Neil, Faust, & O'Neil, 1979). As computer technology has proliferated in society, and as more training has become computer based, it is not surprising that efforts in the instructional design field have concentrated on the development of computer-based tools intended to streamline the design and development of instruction, for both novice designers and expert designers.

41.5.2.1 Tools for Content Acquisition. One of the major tasks to be completed by the instructional designer is to identify and structure the content of instruction. Both instructional designers and instructional developers consult with subject matter experts to determine the content that must be acquired by the learners, and the forms in which this content might best be communicated to the learners. In this respect, instructional design activities are similar to the knowledge engineering process that is utilized in the development of expert systems and intelligent tutoring systems (McGraw, 1989; Nelson, 1989; Rushby, 1986). Knowledge engineers typically work with subject matter experts to identify and organize the knowledge that is necessary for solving problems in a domain. Although the ultimate goals of content acquisition for instructional design and knowledge engineering differ, the processes and tools used by instructional designers and knowledge engineers are complementary. In fact, many of the techniques and tools used in knowledge engineering are becoming common in instructional design.

Until recently, the procedures utilized for content acquisition in instructional design and development relied largely on task analysis (e.g., Merrill, 1973) and information processing analysis (Gagné, Briggs, & Wager, 1988). A large number of task analysis procedures have been employed for instructional design and development, as summarized by Jonassen, Hannum, and Tessmer (1989). In general, these analysis techniques are used by designers to describe the nature of the learning tasks and to identify and sequence the content of the instruction. Information processing analysis further delineates the decision-making processes that may underlie a task, allowing the designer to identify any concepts or rules that may be necessary to complete the task. The process of content acquisition generally follows several stages, including (a) a descriptive phase, where basic domain concepts and relations are identified; (b) a structural phase, where the information is organized into integrated structures; (c) a procedural phase, where the reasoning and problem-solving strategies are identified; and (d) a refinement phase, where the information structures procedures, and strategies are tested with a wider range of problems and modified as needed (Ford & Wood, 1992; McGraw, 1989). Using structured interviews and a variety of documentation activities, concepts and relations can be identified during the descriptive phase of content acquisition. McGraw (1989) recommends the use of concept dictionaries or cognitive maps to represent the major domain concepts graphically. Many of the automated tools for instructional design discussed later feature some kind of graphical representation tool to help define domain concepts and relations (e.g., McAleese, 1988; Nicolson,

1988; Pirolli, 1991). During the structural phase, the concepts and relations identified earlier are organized into larger units. This phase has been described as “a precondition to effective instructional design” (Jones, Li, & Merrill, 1990, p. 7) and is critical to the specification of content. Interviewing is the most widely employed technique, however, at this stage it is important to begin prompting the expert to clarify distinctions between concepts in order to structure the knowledge (Ford & Wood, 1992). Besides interviews, various statistical procedures such as multidimensional scaling (e.g., Cooke & McDonald, 1986), path analysis (Schvaneveldt, 1990), ordered trees (Naveh-Benjamin, McKeachie, Lin, & Tucker, 1986), and repertory grid techniques (Boose, 1986; Kelly, 1955) can be used to help structure the knowledge.

Content does not consist solely of concepts and relations. Experts also possess highly proceduralized knowledge in the form of rules and heuristics that help them solve problems. A variety of methods can be used to identify and describe these procedures. Task analysis methods yield a description of the tasks that constitute performance, along with the skills necessary to perform each task (Jonassen et al., 1989). Additional methods that provide useful descriptions of domain expertise include time-line analysis for sequencing tasks, information processing analysis for describing decision making, and process tracing to determine the thinking strategies used by the expert during task performance (McGraw, 1989). Protocol analysis (Ericsson & Simon, 1984) is a particularly effective process tracing technique, although it is time-consuming because of the extensive data analysis that is required. Observations, constrained tasks (Hoffman, 1987), and simulations can also be useful at this stage of knowledge acquisition, especially when two or more experts collaborate to solve or “debug” a problem (Tenney & Kurland, 1988). It is also advisable to perform similar analyses of novices in order to identify specific difficulties that learners are likely to encounter (Means & Gott, 1988; Orey & Nelson, 1993).

Advances in database technologies and Web-based delivery systems have created new opportunities for research in content acquisition, management, and delivery. The focus in recent research has been on the feasibility of creating and maintaining reusable, scalable, and distributed content. Much research has been devoted to the definition and organization of “learning objects” or “knowledge objects” (Wiley, 2000; Zielinski, 2000). Systems to store and deliver content modules that are “tagged” with descriptors related to various learning or instructional characteristics of the content modules, as well as the characteristics of the content itself, are being developed and tested. The modules can be retrieved and dynamically assembled by the system based on learner actions or requests.

Standards for structuring and tagging content objects have been developed and evaluated (Cuddy, 2000). Several models for automating the delivery process have been proposed and tested, including Merrill’s (1999) instructional transaction theory, interactive remote instruction (Maly, Overstreet, Gonzalez, Denbar, Cutaran, & Karunaratne, 1998), and learning engines (Fritz & Ip, 1998). Other research has focused on assembling content and demonstrating the effectiveness of learning object technologies (Anderson & Merrill, 2000; Merrill, 2001). The impact of these approaches is evident in the rapid adoption of open

architectures for learning objects (Open Courseware, 2002) and the proliferation of shared content databases (Labeuf & Spalter, 2001).

41.5.2.2 Knowledge-Based Design Tools. Knowledge-based design systems are becoming common in many design professions as researchers strive to acquire and represent in computer systems the kinds of knowledge and reasoning necessary to interpret design problems, control design actions, and produce design specifications (Coyne, Rosenman, Radford, Balachandran, & Gero, 1990). Some computer-based design environments have been developed as extensions of the tools used by designers, such as the computer-aided design (CAD) systems used in professions where sketches or blueprints are used as a part of the design specifications (architecture, electronics, automobiles, etc.). Other systems have been developed around “libraries” or “templates” of primitive design elements or as critiquing environments that monitor the designer’s activities and suggest alternatives when an action that may be inappropriate is taken (Fischer, 1991). These types of knowledge-based design systems require an extensive database of rules that functions in the background as the designer works with the system.

Although a wide variety of approaches to knowledge-based instructional design has been attempted, all are characterized by the need to formalize the knowledge and decision-making processes necessary for effective instructional design. These efforts began with attempts to provide “job aids” for novice instructional designers, especially those in military settings (Schulz & Wagner, 1981). Early efforts using computers to automate various instructional development tasks focused on the production of print-based materials for programmed instruction (Braby & Kincaid, 1981; Brecke & Blaiwes, 1981), adaptive testing systems (Weiss, 1979), and, more recently, paper-based training materials (Cantor, 1988). A more ambitious project was undertaken in conjunction with the PLATO system. Beginning with libraries of code to produce various types of test items, Schulz (1979) completed extensive research to produce and test a number of on-line authoring aids designed to be integrated with the military’s IPISD model. Various activities specified by the model were identified and the associated tasks analyzed. Flowcharts of the design activities were then converted to interactive instructional segments that could be accessed by users as on-line aids during authoring activities. Findings indicated that the aids were accepted by the authors and that development time was significantly decreased.

41.5.2.3 Design Productivity Tools. Numerous tools based on expert system technology have been developed to aid instructional designers in making decisions about various aspects of instructional design. These tools function as intelligent “job aids” where the designer enters information about the present situation in response to system queries, and the system then provides a solution based on domain-specific rules and reasoning strategies. Such tools do not provide a complete working environment for the design task but, rather, can serve as an expert consultant when the designer is not sure how to proceed in a particular situation (Jonassen & Wilson, 1990). A number of expert system tools for instructional design have been

developed by Kearsley (1985) to provide guidance for classification of learning objectives, needs assessment, cost benefit analysis, and decisions about the appropriateness of computers for delivery of instruction. Other expert system tools have been developed to aid in media selection (Gayeski, 1987; Harmon & King, 1985) and job/task analysis (Hermanns, 1990), while researchers in artificial intelligence are developing tools to analyze a curriculum for an intelligent tutoring system based on prerequisites and lesson objectives (Capell & Dannenberg, 1993).

Expert system technology has also been employed in the development of integrated instructional design systems that provide guidance and support for the complete design process. Merrill (1987) was an early advocate for the development of authoring systems for computer-based instruction that provide guidance for the user throughout the design process. His work has focused on a comprehensive instructional design environment that queries the user about the nature of the problem, guides in the specification and structuring of content, and recommends strategies and instructional transactions (Li & Merrill, 1991; Merrill & Li, 1989; Merrill & Thompson, 1999). Nicolson (1988) has described a similar system named SCALD (Scriptal CAL Designer) that was developed to produce automatically computer code for computer-assisted instruction systems. Using a script representation, SCALD users enter descriptions of the instructional components of the system by filling out forms to specify the script for each component. The system then creates an appropriately organized and sequenced "shell" from the scripts, and content (specific questions, information, graphics, etc.) can then be added to the shell by the developer.

Alternative approaches to rule-based expert system technologies for knowledge-based instructional design have been examined by other researchers. Some of these systems serve as working environments for the instructional designer but without the system-controlled advisory sessions common to expert system approaches. Instead, these systems provide structured environments and tools to facilitate the instructional design process, sometimes in very specific domains such as the tools described by Munro and Towne (1992) for the design and development of computer-based simulations and sometimes comprehensive systems to support all aspects of the instructional design process, including tutorials and support for novice designers (Gayeski, 1987; Seyfer & Russell, 1986; Spector & Song, 1995; Whitehead & Spector, 1994). IDioM (Gustafson & Reeves, 1990) is an instructional design environment used by Apple Computer employees to aid in their training design activities. Consisting of several modules related to analysis, design, development, evaluation, implementation, and management activities, IDioM helps to impose structure on the design process while maintaining flexibility for the designer to engage in various design and development activities. The Instructional Design Environment (IDE), developed at Xerox, is a similar system that allows designers to enter and manipulate the information necessary for analysis and specification activities (Pirulli, 1991). The environment is completely open, allowing the designer to represent the problem in a way that is comfortable and appropriate for the situation. Tools are provided to assist the designer in activities related to

task and content analysis, sequencing, delivery, and evaluation. Another set of tools, the IDE-Interpreter, has been developed to generate automatically instructional plans based on the specifications previously stored in the IDE knowledge base by the designer (D. M. Russell, 1988). Research in this area has expanded in recent years to include new commercial products such as Designer's Edge (Chapman, 1995) and Design Station 2000 (Gayeski, 1995), as well as tools for Web-based learning environments (Wild, 2000)

41.5.2.4 The Practicality of Automated Instructional Design. The question that remains unanswered with respect to research in the area of knowledge-based instructional design systems is whether such systems will be used by practicing instructional designers. Gayeski (1988, 1990) has pointed out several problems with automating instructional design processes, especially the difficulty of representing instructional design expertise as decision algorithms that can be executed by a computer. She also speculates that using an automated instructional design system may stifle creativity and that systems may need to be customized and tailored to the design procedures and practices of a particular organization. On the other hand, there has been growth in the development of these tools (Kasowitz, 1998) and increased interest in design and utilization issues (Tennyson & Baron, 1995). The open-ended workbench approach to knowledge-based instructional design can pose problems for some users, even though it may be a more appropriate architecture given the nature of the instructional design task (Duchastel, 1990). Because of the high degree of user control, an instructional design workbench can be useful for experienced instructional designers, helping them to streamline their work and providing assistance in documenting and managing the design process. But a system such as Designer's Edge is not designed to provide guidance to novice instructional designers and, therefore, may not be useful in many situations where trained instructional designers are in short supply.

The most appropriate architecture for knowledge-based instructional design systems may be a hybrid system that incorporates open-ended tools for experts along with an advisory system and solution library for novices. Fischer (1991) has developed such a system for architectural design that includes several modules: a construction kit, a simulation generator, a hypertext database of design principles, and a design catalog. As the designer works, an on-line design critic monitors activities, interrupting the user when a design principle has been violated. At such times, the design critic module presents an argument for modification of the design, supporting the argument with a design principle retrieved from a hypertext database along with examples of correct designs in the design catalog. The user can then browse both modules to obtain more information about the principle that was violated and other related principles and examples. The user can also access the simulation generator to test the current design using "what if" scenarios that simulate usage in various situations.

Even if we never use a knowledge-based instructional design system on a daily basis, research in this area has not been futile. In part, the interest in developing automated instructional design systems has precipitated research into the nature

of the instructional design process (Pirolli, personal communication). Work in this area may also help to identify those instructional design tasks that can be successfully automated, leaving the tasks that require creativity and “fuzzy” reasoning to human designers. And finally, attempts to acquire and represent instructional design expertise will result in a better understanding of the nature of that expertise, suggesting alternative approaches to teaching instructional design (Rowland, 1992).

41.5.2.5 Overview of Studies of Automated Instructional Design and Development. These studies are Type 2 research directed toward the production and testing of tools that would change design procedures, although some studies focus on only one phase of the design process—pre-design content identification and analysis. The research on content is directed primarily toward producing new content analysis tools and procedures and then determining the conditions under which they can be best used. There are often multiple units of analysis in these studies, including designers, subject-matter experts, and the design tasks themselves. Much of this research is based on “artificial” design tasks, or projects that have been devised solely for the purposes of the research. Again, it is common for researchers to use qualitative techniques in these studies.

Research on automated design tools and systems is also primarily Type 2 research, however, Type 1 studies that would describe and analyze design projects using these new automated tools and evaluate the impact on learners of the materials produced using these tools are not precluded. The focus of analysis in the Type 2 studies of automated design tools tends to be the tools themselves, and in some instances the designers who use such tools are also studied. The studies are typically descriptive

and observational in nature and typically seek to identify those conditions that facilitate successful use.

41.6 CONCLUSIONS

Developmental research methodologies facilitate the study of new models, tools, and procedures so that we can reliably anticipate their effectiveness and efficiency and, at the same, time address the pressing problems of this field. Such research can identify context-specific findings and determine their relevance for other teaching and learning environments. It can also identify new principles of design, development, and evaluation. Developmental research techniques not only expand the empirical methodologies of the field, but also expand the *substance* of instructional technology research. As such, it can be an important vehicle in our field’s efforts to enhance the learning and performance of individuals and organizations alike.

The history of developmental research parallels the history and growth of instructional technology. Findings from past research provide a record of the technological development of the field, as well as a record of the development of the instructional design movement. The impetus for developmental research lies in the concerns of the field at any point in time. For example, the field is currently preoccupied with the idiosyncrasies of e-learning, while it continues to grapple with ways of reducing design and development cycle time while maintaining quality standards. It is concerned with the implications of globalization and diversity for instructional design. Issues such as these should give rise to new research, and developmental projects are well suited to address many of these problems.

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