

Epistemological Foundations of Educational Design Research

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Abstract: Educational design research is a pragmatic approach to research with the dual goals of (1) solving and educational design problem in a real-world context, and (2) contributing to scholarly knowledge. The purpose of this paper is to discuss the epistemological foundations of design-based research. In this paper, the author examines the literature to answer the following questions: (1) what are the historical roots of educational design research, (2) what are the philosophical underpinnings of educational design research, (3) what are the goals of educational design research, (4) what constitutes new knowledge in educational design research, (5) what are the necessary stages of inquire in educational design research, and (6) what is the methodology of educational design research. The author presents a new perspective on the chain of inquiry for educational design research.

Introduction

Education design research is a pragmatic approach to research with the dual goals of (1) solving an *educational design problem* in a real-world context, and (2) contributing to scholarly knowledge in the form of *instructional design theory* or *design principles* (Collins, Joseph, & Bielaczyc, 2004). Born out of the desire to make educational research more relevant to practice and policy (Brown, 1992; Collins, 1992), scholars who do educational design research work with practitioners to design and test solutions to educational problems. The initial solution design is grounded in theory, and improved upon through iterative cycles of design-enact-evaluate. Each cycle is evaluated to both improve upon the solution itself, and for the emergence of design principles.

One of the major challenges for the educational design research scholar is the lack of a consistent description of what educational design research is or how to do it. Only recently has a textbook been published by McKenney and Reeves (2012), who themselves are "not convinced that educational design research has evolved to the point that a definitive guide could be written" (2012, p. 00). Furthermore, the term educational design research is still evolving. Previous iterations include design experiments, development research, formative research, and design-based research. In this paper, the term educational design research is used to clarify the context of the research as education, and the pragmatic goals to design an educational solution while engaging in research.

The purpose of this paper is to discuss the epistemological foundations of educational design research. In order to do this, the following questions are explored: (1) what are the historical roots of educational design research, (2) what are the philosophical underpinnings of educational design research, (3) what are the goals of educational design research, (4) what constitutes new knowledge in educational design research, (5) what are the necessary stages of inquire in educational design research, and (6) what is the methodology of educational design research.

Historic Roots of Educational Design Research

Educational design research evolved out of the need to make educational research more useful to practitioners. This occurred at a time when educational scholars were strongly divided among philosophical lines (post-positivist versus constructivist). A new approach to research involving mixing quantitative and qualitative methods was emerging (mixed-methods) (Johnson & Onwuegbuzie, 2004). Brown (1992) argued that doing research strictly in a laboratory or controlled setting (often with students working in isolation) was not representative of the complexity of the classroom. A way of doing research needed to be formed to move innovations in the controlled experimental classroom into a real-world classroom, with all the additional complexities that come with it. At the same time, Collins (1992), who also recognized the need for educational research to take into account the complexity of real-world contexts, introduced a methodology known as *design experiments* to address this concern. This methodology combines ideas from

mixed-methods methodologies in education with the design sciences (architecture, engineering).

In the late 1990s, scholars seeking to improve the processes involved in designing instruction began to publish research based upon Brown's (1992) and Collin's (1992) design experiments calling it *development research* (van den Akker, 1999), which emphasizes the development of educational resources; and *formative research* (Reigeluth & Frick, 1999) which emphasizes the development of instructional-design theory. In the early 2000s, educational design research again evolved to meet the needs of different areas in educational research, leading to special issues of educational journals that addressed the emerging educational design research methodology. Although different scholars used different names, the consequences of the research were the same (Wang & Hannafin, 2005; van den Akker, Gravemeijer, McKenney, & Nieveen, 2006). In this paper, I use the name educational design research to align with the latest scholars in this field (McKenney & Reeves, 2012).

In the last five years, the literature on educational design research has shifted from a focus on describing educational design research as a methodology to reporting the results of educational design research projects, indicating that educational design research is maturing (Anderson & Shattuck, 2012). Educational design research as a methodology still poses challenges to researchers, including: (a) the role of the researcher, (b) the time it takes to enact multiple cycles of a design, (c) knowing when to stop the cycles of iteration, and (d) managing the large amount of data collected. I discuss each of these challenges in the educational design research methodology section of this paper.

Philosophical Underpinnings of Educational Design Research

The philosophical underpinnings of educational design research are based upon a school of philosophy known as pragmatism (Barab & Squire, 2004; Oh & Reeves, 2010; Wang & Hannafin, 2005). Peirce, the founder of pragmatism, describes its principle as asking the question *what difference does it practically make?* He argued that if the consequences of two actions are the same, then there is no difference between the actions (as cited in James, 1907). James (1907) went further by suggesting that the ideas behind consequences are *truths*: "that ideas...become true just in so far as they help us to get into satisfactory relation with other parts of our experience" (p.100). The desire for educational design research to make a practical difference in the world is reflected in its goals, and defining new knowledge in terms of the consequences of the research. Thus, pragmatism underlies the value of the research, which is designed to improve practice and the research methodology, in its focus on the primary importance of the research question and the use of a mixed-methods approach to data collection and analysis.

In addition to its pragmatic underpinning, educational design research draws influence from the design sciences, such as architecture and engineering. Edelson (2002) defines design as "a sequence of decisions made to balance goals and constraints" (p.108). In the design sciences, it is understood that there is no perfect solution to a design problem; rather, some solutions are better than others. The goal in design is to create a better model, and this is achieved through successive approximations (Park & Zhang, 2011; Reigeluth & Frick, 1999). In educational design research, this influence is seen in the iterative cycles of *design-enact-evaluate* that is foundational in educational design research methodology and in the overarching goal of educational design research to improve the delivery of education.

Goals of Educational Design Research

Educational design research has two goals: (a) to solve an educational design problem in a real-world context, and (b) to add to scholarly knowledge (Collins et al., 2004; Gravemeijer & Cobb, 2006). The research must address both goals in order to be considered educational design research. Thus, before deciding to use an educational design research approach, the researcher must examine the research question to ensure that it is both a design problem and that it has a real-world impact. "Design researchers generally target questions central to the design of the intervention itself. Designed artifacts are constructed such that they embody hypotheses about learning phenomena" (Joseph, 2004, p. 236). In addition, the research problem must be general enough in scope to warrant the effort, that is, it must be significant beyond the scope of the local context (Ma & Harmon, 2009).

Educational design research seeks to add to scholarly knowledge in the form of instructional-design theory or design principles. The pragmatic underpinning of educational design research suggests, "theories thus become instruments" (James, 1907, p. 98). The purpose of the theory in educational design research is either to improve the process of designing instruction (Richey & Nelson, 1996) or to improve instruction itself (Brown, 1992; Collins, 1992). In other words, "the theory must do real work" (Cobb,

Confrey, diSessa, Lehrer, & Schauble, 2003, p. 9).

What Constitutes New Knowledge in Educational Design Research

In examining what constitutes new knowledge in educational design research, a scholar's pragmatic perspective stresses the consequences of the research. There are three consequences in educational design research (Akkerman & Filius, 2011; McKenney, Nieveen, & van den Akker, 2006); however, the consequences are described inconsistently. For the purposes of this paper, I describe the consequences of educational design research as: (a) improved educational theory, (b) educational resources, and (c) the professional development of the research participants. In the following sections, I elaborate on each of the consequences for educational design research.

Improved Educational Theory

As noted earlier, educational design research seeks to add to scholarly knowledge by generating either instructional-design theory or design principles. In either case, the new educational theory generated must be useful, in that it must directly support the work of practitioners in ID and teaching (Edelson, 2002; van den Akker, 1999). When the researcher is seeking to inform an ID problem with a general scope, the researcher seeks to improve upon or create instructional-design theory. This theory may include instructional frameworks or models, processes, or resources to support instruction. When the researcher is seeking to inform ID in a specific area or context, the researcher seeks to improve upon or create design principles appropriate to the context. van den Akker (1999) describes design principles as:

[Design principles] are usually heuristic statements of a format such as: **"If you want to design intervention X [for the purpose/function Y in context Z], then you are best advised to give that intervention the characteristics A, B, and C [substantive emphasis], and to do that via procedures K, L, and M [procedural emphasis], because of arguments P, Q, and R."** (p.9)

In summary, depending on the scope and context of the research, educational design research scholars seek to create or improve upon instructional-design theory or design principles.

Educational Resources

The second consequence of educational design research is the creation of educational resources. Kelly (2004) emphasizes that:

Design is not design without some form of designed artifact—even if that goal of the artifact is to advance a different outcome such as a new theory.... Design studies should produce artifacts that outlast the study and can be adopted, adapted, and used by others. (p.116)

Educational resources, or artifacts, may be physical or conceptual. In educational design research, the educational resources created may include program frameworks, instructional-design strategies, and instructional support materials. These must be both innovative and useful (Cole, Puraio, Rossi, & Sein, 2005; Edelson, 2002).

Professional Development of the Research Participants

The final consequence of educational design research is "professional development of participants during the design research process" (Oh & Reeves, 2010, p. 268). Educational design research typically involves practitioners (e.g. instructional designers, instructional developers, teachers) on the research team, and "one of the distinctive characteristics of the design experiment methodology is that the research team deepens its understanding of the phenomenon under investigation while the experiment is in progress" (Cobb et al., 2003, p. 12). As a result of the research process, the practitioners involved develop a deeper understanding of the theory that informs the educational design research project, which in-turn affects their practice.

Educational Design Research Chain of Inquiry

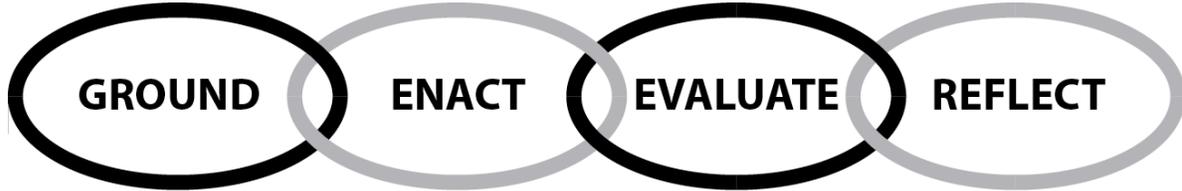


Figure 1 Educational Design Research Chain of Inquiry (c) 2012 Rebecca J. Hogue.

Educational design research scholars often focus on the specific processes of conducting research, and fail to describe how the processes of educational design research are related to inquiry. Based upon a synthesis of the literature, I visualize the stages of inquiry in educational design research as a linked chain, with each link providing information to the next. All links must be sufficiently strong to ensure sound research. In Figure 1, I illustrate my educational design research chain of inquiry with four links: (1) *ground*: the researcher must inform the design with theory; (2) *enact*: the researcher must implement the design in a real-world context; (3) *evaluate*: the researcher must assess and judge the enacted design; and finally (4) *reflect*: the researcher must retrospectively analyze the research project at its end. Although the illustration shows the links in a linear fashion, the process of inquiry is not linear. Educational design research scholars are consistently revisiting each link throughout the research process. In the next sections, I describe each of the links in the educational design research chain of inquiry in more detail.

Ground

Ground, the first link in the chain of inquiry represents the need for scholars to base the new design upon what is already known. The researcher must go beyond a traditional literature review, seeking to define the preliminary instructional-design theory or design principles that are used to inform the initial designs (Gravemeijer & Cobb, 2006). In addition, the researcher must gain an understanding of the context where the research will take place because organizational structures will also influence the design (Park & Zhang, 2011).

Enact

Enact, the second link in the chain of inquiry, represents the need to implement the design in a real-world context. Collins et al. (2004) emphasize that in education, it is not possible to completely specify a design and that only a particular implementation of the design can be evaluated. In the field of instructional design, the instructional designer captures the design in an instructional design document, which is used by an instructional developer to create educational resources, which in-turn are used by teachers to assist in the act of teaching. Together, the creation of educational resources and the act of teaching represent the enactment of the design.

The design itself is not a thing that can be evaluated; rather, it is only the enactment of a single instance of the design that can be evaluated. In other words, the thing you are evaluating is the enactment of the design not the design itself. Even though a developer may try to be faithful to the intent of the design when enacting the design instance, it cannot be said that the enactment is the design (Sandoval, 2004) because the enactment will necessarily vary according to the real-world context in which it is enacted. A design can never truly be evaluated: the best that can be done is to enact the design either multiple times or in multiple settings in order gain an understanding of which aspects of the design are reproducible or applicable across different settings. As a result, educational design research emphasizes the need for *multiple iterations* of enactment.

Evaluate

Evaluate, the third link in the chain of inquiry, is the means by which educational design research uses the act of design and development to help formulate better theories (Edelson, 2002). As noted above, multiple enactments are necessary in educational design research. Hoadley (2004) highlights this:

Implementation is one of the core challenges because the design-based researcher recognizes that

any findings are composed of the interaction between design and enactment, between the general and the local. Iteration and replication are not checks against dishonest researchers or chance coincidences, but rather the fundamental mechanism for exploring how local and global interact, for probing the edges of design-oriented understandings. (p.211)

The evaluation of the enactments of design contribute to the knowledge and professional development of the research team, because the process of enacting a design is a form of inquiry (Barab & Squire, 2004; Richey & Nelson, 1996; van den Akker, 1999), and this form of inquiry is both informed by theory and informs theory (Brown, 1992; Edelson, 2002; Oh & Reeves, 2010).

Reflect

Reflect, the final link in the educational design research chain of inquiry, is important at each iteration but also after the final iteration, when the researchers consider the project in its entirety. This retrospective analysis provides an opportunity for researchers to reflect both on the goals of the project and on the research process itself. The researchers use the information to revise the initial instructional-design theory or design principles used to inform the research design (Gravemeijer & Cobb, 2006). In addition, the retrospective analysis usually includes:

A narrative account (which is story-like, including actors, actions, intentions) of learning and how it can be supported and organized. And, to establish generalizability, the narrative analysis places the study in a broad theoretical context to show if and how the study is a paradigmatic case of the phenomenon under investigation. (Shavelson, Phillips, Towne, & Feuer, 2003, p. 27)

Educational Design Research Methodology

Educational design research is underpinned by the philosophy of pragmatism and, as such, takes a mixed-methods approach to research methodology (Collins et al., 2004; The Design-Based Research Collective, 2003). Although the methods are drawn from both quantitative and qualitative research, Reigeluth & Frick (1999) caution, "the purpose is different here, and hence we must consider additional methodological concerns" (p.634). The researcher must choose research methods based upon their ability to answer the specific questions for the given design cycle (Collins et al., 2004; Herrington, McKenney, Reeves, & Oliver, 2007). In other words, the researcher must identify the goals and specific research questions to be addressed in each phase of the educational design research project and the methods to be used to address the specific research questions.

Design Research

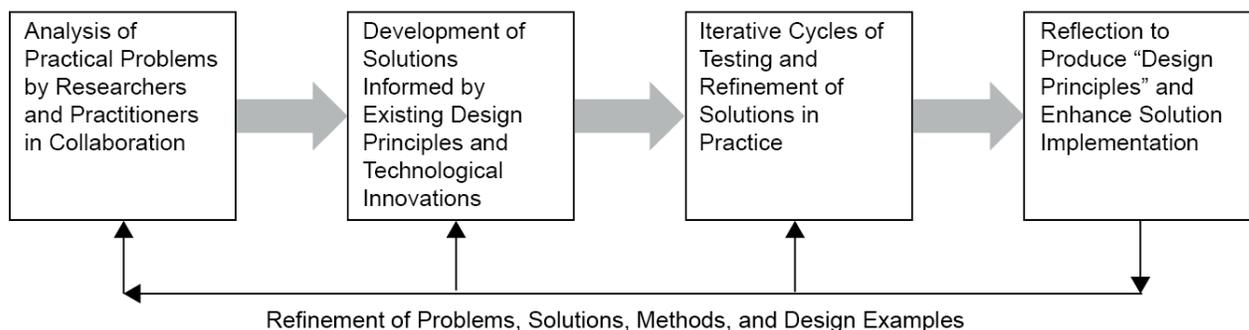


Figure 2 Reeves' Design-Based Research approach for educational technology research. Adapted from (Reeves, 2006, p. 59).

Although the goal of educational design research is shared among scholars, the methodological approach differs. Educational design research seeks to solve a real-world problem; therefore, the approach must necessarily be adapted to the real-world context in which it is situated. The approach also varies based upon the type of new knowledge the researcher is emphasizing. For example; Middleton, Gorard, Taylor, & Bannan-Ritland (2008) describe a process that is heavily influenced by engineering which places emphasis on the testing of educational resources; and Gravemeijer & Cobb (2006) use a process that supports classroom interactions, which places an emphasis on the professional development of the research team. On the other hand, Reeves describes a four-phase process (see Figure 2) that aligns well with the systematic processes used by instructional designers and allows the researcher to determine which aspects of

educational design research are emphasized. Reeves' approach also has symmetry with the four stages in the chain of inquiry: ground, enact, evaluate, and reflect.

In addition to the process of educational design research, researchers must address the following methodological considerations: (a) the role of the researcher, (b) how to define better, (c) the boundaries of iteration, and (d) how to establish validity. In this section, I describe how each of these concerns affects educational design research methodology.

The Role of the Researcher

Within an educational design research project the researcher may be placed in multiple roles, such as investigator, designer, developer, implementer (teacher), and evaluator (Hoadley, 2004; Wang & Hannafin, 2005). The researcher can gain insight by acting in multiple roles, providing he or she is aware of these different roles as they shift (Joseph, 2004). However, some scholars caution that it is not possible for the researcher to be so objective when evaluating their own designs (Collins, 1992; The Design-Based Research Collective, 2003) and, as such, the design and evaluation should not be performed by the same person. A first step in mitigating this concern is in "acknowledging the inevitable impact of researchers (especially those donning multiple, even conflicting roles) on the context in which understanding is sought" (McKenney et al., 2006, p. 83). Scholars planning to act in multiple roles must seek out additional means of mitigating this potential source of bias, such as having a second researcher analyze the data to identify potential areas of bias.

How to Define Better

A key aim of educational design research is to improve what works, or determine which method is *better*. Reigeluth & Frick (1999) describe the major methodological concern for educational design research as that of "preferability: the extent to which a method is better than other known methods for obtaining the desired outcome" (p.634), and define better using the categories of: (a) *effectiveness*: how well the implementation meets the design intent, (b) *efficiency*: the scalability and usability of the implementation, and (c) *appeal*: how enjoyable the results are to the research participants. It is common in evaluation research and teaching practice to focus primarily on effectiveness and appeal. In educational design research, on the other hand, there is an added emphasis on efficiency "so that interventions continue to impact educational practices of practitioners in the local context without the support and the presence of researchers" (Oh & Reeves, 2010, p. p.271).

The Boundaries of Iteration

At the foundation of educational design research is the need for iteration, that is, multiple cycles of enactment. In a typical educational design research study, the focus of study changes with each enactment of the design (Collins et al., 2004; Hoadley, 2004). The emphasis shifts from effectiveness to efficiency (van den Akker, 1999). For each enactment of the design, the researcher must determine the focus of that particular enactment. When developing the research strategy, the researcher defines the specific boundaries for the beginning and ending of each cycle as well as the project as a whole (O'Donnell, 2004). One challenge with the "evolution through multiple iterations is...that it is difficult to know when (or if ever) the research program is complete" (Anderson & Shattuck, 2012, p. 17).

A challenge not mentioned in the literature to date, is the scale of the educational design research projects. It is difficult to plan multiple iterations if the program is long; for example, multiple iterations of a six- or fourteen-week course provide a daunting challenge for researchers. Educational design research may be more appropriate for programs that involve shorter interactions, such as professional development workshops, which typically run from one hour to half a day.

How to Establish Validity

Validity is the extent to which the conclusions and interpretations of the research can be justified by the research methods employed. Scholars classify validity into different types; however, the classification is not consistently applied. It is more useful here to outline the general challenges of measuring validity. Thus educational design research methodology must consider: (a) how well the enactment represents the intended design (Reigeluth & Frick, 1999); (b) "how the various components of

the intervention are consistently linked to each other" (van den Akker, 1999, p. 10); (c) how well "the research and the inferences drawn from it inform the questions that motivate the research in the first place?" (Hoadley, 2004, p. 205); and (d) "how sustainable the design is after the researchers leave" (Collins et al., 2004, p. 36).

The process of iteration and analysis involving multiple organizations can lead to the collection of large amounts of data for analysis. With large amounts of data, there is a risk that the researcher will select only the data that specifically support his or her theory. Known as the Bartlett effect, "this problem of the theorist selecting those segments that prove his or her point is endemic in research that depends on transcripts or protocols culled from a large data base" (Brown, 1992, p. 162). In educational design research, this challenge can be mitigated if the researcher clearly defines the scope and goals of each design enactment and he or she ensures that the data collection and analysis methods are in alignment with the research scope and goals.

Conclusion

Educational design research provides an approach to research, based on pragmatism, that both solves real-world problems and provides guidance to educators in the form of instructional-design theory or design principles. The educational design research process can be used to produce theory and educational resources, and provides professional development that helps instructional designers create effective, efficient and appealing educational programs.

In this paper, I discussed the epistemological foundations of educational design research. A quote by Sophocles can be used to summarize the epistemological foundation of educational design research: "one must learn by doing the thing, for though you think you know it, you have no certainty until you try" (as cited in Rogers, 2003, p. 168). As researchers, we cannot truly know if an instructional design is effective until we develop it, teach it, and evaluate it. In other words, we must learn about the design by doing it. It is through this enactment of the design that we will gain a deeper understanding of the principles that make the design successful.

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