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J Herrington

S McKenney

T Reeves

Ron Oliver

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Design-based research and doctoral students: Guidelines for preparing a dissertation proposal

Jan Herrington
University of Wollongong, Australia
jan_herrington@uow.edu.au

Susan McKenney
University of Twente, The Netherlands
mckenney@edte.utwente.nl

Thomas C Reeves
The University of Georgia, USA
treeves@uga.edu

Ron Oliver
Edith Cowan University, Australia
r.oliver@ecu.edu.au

Abstract: At first glance, design-based research may appear to be such a long-term and intensive approach to educational inquiry that doctoral students, most of whom expect to complete their Ph.D. degree in 4-5 years, should not attempt to adopt this approach for their doctoral dissertations. In this paper, we argue that design-based research is feasible for doctoral students, and that candidates should be encouraged to engage in it. More specifically, we describe the components of a dissertation proposal or prospectus that utilizes design-based research methods in the context of educational technology research.

Design-based research and educational technology

Barab and Squire (2004) defined design-based research as "a series of approaches, with the intent of producing new theories, artifacts, and practices that account for and potentially impact learning and teaching in naturalistic settings" (p. 2). This "series of approaches" has been and continues to be labeled in many different ways including "design-based research" (Kelly, 2003), "development research" (van den Akker, 1999), "design research" (Reeves, Herrington, & Oliver, 2005), "developmental research" (McKenney & van den Akker, 2005), "design experiments" (Brown, 1992; Collins, 1992), and "formative research" (Newman, 1990). Regardless of what it is called, design-based research holds great promise for enhancing both the theoretical contributions and public value of educational technology research (Van den Akker, Gravemeijer, McKenney, & Nieveen, 2006).

The impact of educational technology research with respect to contributing to theoretical understanding and/or enhancing real world teaching and learning has long been called into question (Reeves, 2006). Although it still has it defenders, educational technology research has been and continues to be a largely pseudoscientific and 'socially irresponsible' (Reeves, 2000). Typically the research has sought to demonstrate the achievement gains of technology-facilitated learning over conventional methods of teaching with little regard for an understanding of how or why the gains might have been realized. We agree with Barab and Squire (2005) among others who propose that future progress in improving teaching and learning through technology can be realized through design-based research as an alternative model for inquiry in the field of educational technology. Design-based research protocols require intensive and long-term collaboration involving researchers and practitioners. Design-based research integrates the development of solutions to practical problems in learning environments with the identification of reusable design principles. Figure 1 illustrates the differences between the types of predictive research studies that have dominated educational technology research for decades, and design-based research of the kind we recommend.

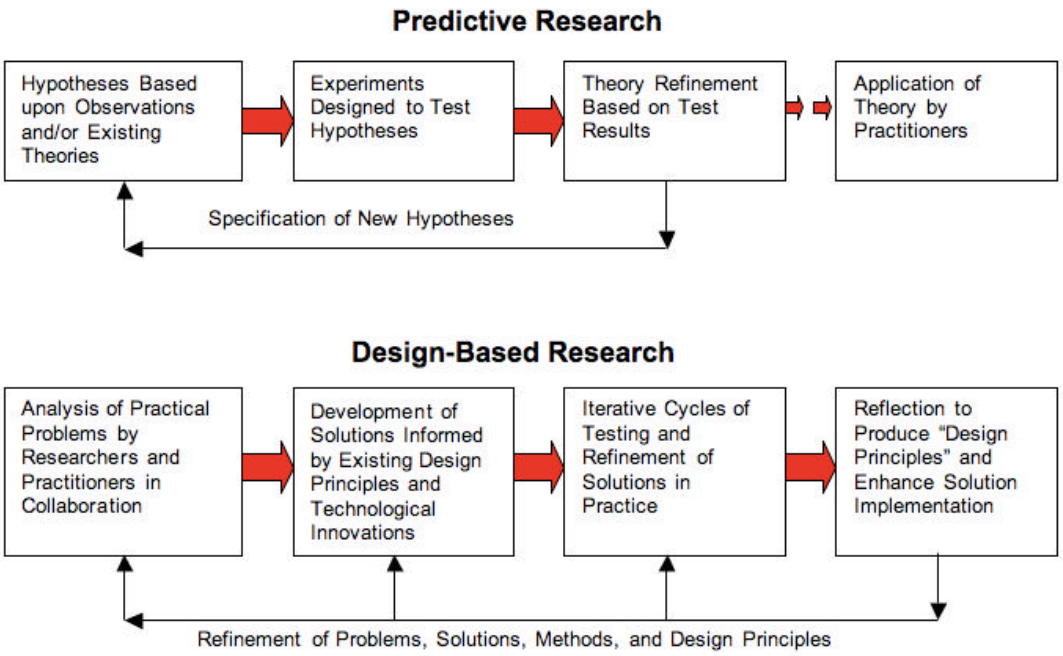

Figure 1: Predictive and design-based research approaches in educational technology research (Reeves, 2006)

Brown (1992) and Collins (1992) are widely acknowledged as early contributors to the definition and activation of design-based research. They described it as a methodology that requires:

- addressing complex problems in real contexts in collaboration with practitioners;
- integrating known and hypothetical design principles with technological affordances to render plausible solutions to these complex problems; and
- conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles.

At first glance, the requirement that design-based research should address complex problems in real contexts in close collaboration with practitioners may appear to be such a long-term and intensive approach to educational inquiry that doctoral students, most of whom expect to complete their Ph.D. degree in 4-5 years, should not attempt to adopt this approach for their doctoral dissertations. But we argue that design-based research is not only feasible for doctoral students, but that stronger students should be encouraged to engage in it by their academic advisors.

Writing in the prestigious journal, *Educational Researcher*, published by the American Educational Research Association, Shulman, Golde, Bueschel, and Garabedian (2006) describe the problems of today's education doctorates as "chronic and crippling" (p. 25). The authors describe how researchers in other fields are shocked when they find out that one of the biggest unmet challenges of education Ph.D. programs is "ensuring that students develop into effective researchers" (p. 26). After all, the Ph.D. is supposed to be a research degree and thus preparing people for rigorous scholarly inquiry should be one thing that doctoral programs do especially well. Nonetheless, the widely acknowledged lack of impact of educational research suggests that something is very flawed with the way many educators currently do research and the ways they currently prepare their students to be educational researchers.

We attribute at least part of the problems of today's Ph.D. doctoral programs to the fact that they often fail to engage students in research from the day they enter the program. For example, the typical path a fulltime Ph.D. student in the USA takes is to spend two years taking courses, many of them focused on various quantitative and qualitative research methods, another year focused on reviewing the literature, taking comprehensive exams, and writing a prospectus, and the last year conducting and writing the actual dissertation. Yet, educational history has shown us that, when it comes to disciplines following an apprenticeship model, early initiation into the field is essential to helping bridge the gap between theoretical understanding and practical applications. There are many alternatives to the course-driven model of doctoral programs. For those interested in learning how to marry the interests of robust design with research results that can be used by a wider audience, design-based research offers promising options, which we are convinced will be much more fruitful for the field of educational technology as well as for the individual students and the practitioners with whom he/she collaborates. We know this can be done. The authors of this paper have conducted forms of design-based research in completing their own Ph.D. degrees (Herrington, 1997; McKenney, 2001) or have supervised doctoral students who have done likewise (Wang & Reeves, 2006; McMahon & Oliver, 2004). But any good research project requires a careful plan, and

because of their nature, design-based studies can be more difficult to map out than other types of research. For this reason, and because we would like to encourage more design research in our field, this paper presents guidelines for preparing a doctoral research proposal or prospectus.

The research proposal

Nearly all universities provide guidelines to students on the preparation of research proposals. Both the process and the product of a research prospectus are critical in ensuring that the proposed research is sound, feasible and will contribute to knowledge in its field. The *process* is important because the writing of a research proposal requires deep and reasoned thinking about an area of enquiry, and a systematic analysis of the requirements of the research, that is, what is needed to make it happen. The requirement to specify a methodology is useful because of the practical nature of the task, and the need to think through the actual conduct of the research in detail. The *product* of the proposal document itself is important because it becomes a blueprint for the conduct of the research—a reference point for all decisions and actions regarding the research. A proposal document is a useful means to persuade supervisors, advisory committee members, funding reviewers, and other stakeholders that the researcher is not only familiar with the literature of the problem area, but also that the proposed research is worthwhile, viable, sufficient, and will meet the standards required for a doctoral degree.

Guidelines on preparing the design-based research proposal

A research proposal for a doctoral study using a design-based approach must include a practitioner-oriented focus as well as degrees of collaboration that are not necessarily required for more traditional predictive research designs. Phillips (2006) noted that 'One of the very great virtues of the DR [design research] community is that its members take the whole of the scientific research cycle seriously' (p. 95), and this is reflected in the details required throughout the entire design-based research proposal.

Using the depiction of the four phases of design-based research by Reeves (2006) illustrated in Figure 1, each phase can be mapped against the typical requirements of a research proposal. While differences between institutions and disciplines do exist, a typical proposal would include elements such as *aims and objectives, rationale, research questions, significance, literature review, methodology, data collection, data analysis* and *anticipated outputs*. Additional elements may be required such as *ethical considerations*, a *timeline* and a *budget*. In Table 1 below, typical elements of a proposal or prospectus are matched to the design-based research phases, together with suggested placement in the document itself.

In the sections below, each phase of design-based research is listed, followed by typical section headings required, and brief guidelines and considerations are given for doctoral students preparing the proposal. These guidelines are a suggested starting point and should not be considered prescriptive. Every research proposal is different, and doctoral students should be encouraged to vary these sections as required to suit their own purposes, and the nature of their research.

Table 1: Phases of design-based research mapped against typical elements of a research proposal

Phase	Element	Position
Phase of design-based research (Reeves, 2006)	*The topics/elements that need to be described*	*Position in a research proposal*
PHASE 1: Analysis of practical problems by researchers and practitioners in collaboration	Statement of problem	Statement of problem *or* Introduction *or* Rationale *or* Background
	Consultation with researchers and practitioners	
	Research questions	Research questions
	Literature review	Literature review
PHASE 2: Development of solutions informed by existing design principles and technological innovations	Theoretical framework	Theoretical framework
	Development of draft principles to guide the design of the intervention	
	Description of proposed intervention	Methodology
PHASE 3: Iterative cycles of testing and refinement of solutions in practice	Implementation of intervention (First iteration)	Methodology
	Participants	
	Data collection	
	Data analysis	
	Implementation of intervention	

Phase	Element	Position
	(Second and further iterations) Participants Data collection Data analysis	
PHASE 4: Reflection to produce "design principles" and enhance solution implementation	Design principles Designed artefact(s) Professional development	Methodology

PHASE 1: Analysis of practical problems by researchers and practitioners in collaboration

As noted by Bannan-Ritland (2003): 'The first phase of [design-based research] … is rooted in essential research steps of problem identification, literature survey, and problem definition' (p. 22), but while these processes are common to most research approaches, they have a particular significance for design-based research.

Statement of problem

Many research proposals begin with an introduction to an area of study, and a description of what the study will do. However, for design-based research in education, the identification and exploration of a significant educational problem is a crucial first step. It is this problem that creates a purpose for the research, and it is the creation and evaluation of a potential solution to this problem that will form the focus of the entire study. Many research students begin by thinking of a solution—such as a technology-based intervention, an educational game, or a technology tool—before they consider the educational problem it could solve. Problems then arise when the solution is revealed to be a project of interest or 'pet' project, rather than a genuine attempt to solve an educational problem. The statement of the problem in design-based research should identify an issue or an opportunity, explore its history or background, and provide a convincing and persuasive argument that this problem is significant and worth researching. This includes articulating both the practical and scientific relevance of the study.

Consultation with researchers and practitioners

A particularly challenging aspect of the problem definition process is the extent to which it is undertaken in close collaboration with a defined group of practitioners. Purists may argue that a study does not really involve design-based research if the problem is not defined in close collaboration with practitioners. We recognize close collaboration as an ideal for design-based research that is sometimes simply not feasible. At the same time, we hope that this will become less of a challenge, especially as research supervisors themselves become more active in design-based research. In the so-called "natural" or "pure" sciences such as physics and chemistry, doctoral students are not expected to start their research projects on their own. Instead, they typically apprentice themselves to a scientist who is already pursuing a well-defined, robust research agenda. They begin to play active roles in that research agenda from the first day they become doctoral students. In the best of all possible worlds, educational researchers who supervise doctoral work would have similarly robust research agendas. If those supervisors are engaged in design-based research themselves, they will already be involved in long-term, meaningful coactive engagement with practitioners, and thus their students will be able to enter as apprentices to this ongoing collaboration. (The issue of collaboration is further discussed below.) Design-based research places much value on the input of practitioners and researchers working in, or investigating, the problem area. While consultation with these key people is important—in some cases essential—in the exploration phase of the study, it may prove unfeasible for some doctoral students to achieve this collaborative goal at the time of the proposal presentation. It may be advisable instead to factor these discussions into the methodology part of the proposal, as they will involve data collection and approval by ethics review boards and doctoral committees. The current requirements of some *Human Subject Review* or *Ethical Review* processes will typically require doctoral students who desire to pursue a design-based research agenda to identify and acknowledge the impact of the research on their human subjects. In such instances the human subjects review and research protocol approval is usually obtained as part of the acceptance process of the research component of the doctoral program. An alternative approach would allow the new doctoral student to be accepted into an approved design-based research project already underway under the aegis of the major professor.

Research questions

Research questions emerge from the stated problem rather than the stages of design-based research, that is, the focus of the research should remain with the problem area, rather than be written as reflections of the research approach itself. For examples, some students attempt to write a research question for each of the phases described in Figure 1. Questions with forms such as: What problems are associated with the teaching of literacy in Year 1 classrooms? (Phase 1); What does the literature say about literacy problems in Year 1 classrooms? (Phase 2); What impact does [the intervention] have on literacy problems in Year 1 classrooms? (Phase 3); What

principles can be derived to advise teachers of literacy in Year 1 classrooms? (Phase 4) do not truly reflect the problem of the study. Such questions focus too overtly on the process of the research and cannot guide the investigation of the more significant educational problem.

In line with the exploratory nature of design research, driving questions should therefore be open in nature. Edelson (2006) commented on the assumptions of design-based research, pointing out that:

> It begins with the basic assumption that existing practices are inadequate or can, at least, be improved upon, so that new practices are necessary. The underlying questions behind design research are the same as those that drive innovative design:
>
> - What alternatives are there to current educational practices?
> - How can these alternatives be established and sustained? (p.103)

The "basic assumption" that drives design-based research should not be plucked out of thin air ("iPods will make students more motivated") nor should it be only derived from the literature ("learning communities enhance learning"). Instead, the assumptions that direct DBR are derived from the definition of the research problem in close collaboration with practitioners, and fine tuned through literature that serves to (a) help flesh out what is already known about the problem and (b) to guide the development of potential solutions. In such instances, the inquiry that forms the basis of DBR serves the researcher to help understand the underpinning processes and variables and how they impact on the learning and learning outcomes.

Literature review

In describing the characteristics of design-based research, van den Akker (1999) noted that: 'A more intensive and systematic preliminary investigation of tasks, problems, and context is made, including searching for more accurate and explicit connections of that analysis with state-of-the-art knowledge from literature' (p.7). A literature review in design-based research performs not only the usual functions associated with a review—such as, the identification, location and analysis of documents relating to the research problem (Gay, 1992), or the building of a logical framework for the research, and identification of gaps in research (Marshall & Rossman, 1999). The literature review process is critical in design-based research because it facilitates the creation of draft design guidelines to inform the design and development of the intervention that will seek to address the identified problem. In most studies, and especially in design-based research, the literature review is a continual process. Findings from an iteration of review often promulgate further literature study as well as fine-tuning of the principles guiding the design. Inherent in the literature review is the identification of the conceptual underpinnings of the problem in order to assist the researcher to understand and predict the elements of a potential solution.

PHASE 2: Development of solutions informed by existing design principles and technological innovations

Theoretical framework

The theoretical framework for any research is reflected in the literature used to inform the study. This section of a research proposal should summarize the 'lens' through which the problem will be investigated, and it is also the place where the theoretical foundation of the proposed solution will be explained. After explaining the problem situation, it is often the case that students propose a technology-based solution that has weak or no links to theory. A well-described theoretical framework provides a sound basis for the proposed solution, because theory can inform practical design guidelines. Barab and Squire (2004) stated that 'design-based research suggests a pragmatic philosophical underpinning, one in which the value of a theory lies in its ability to produce changes in the world (p. 6). In the words of Cobb, Confrey, diSessa, Lehrer, and Shauble (2003), 'the theory must do real work' (p. 10).

Development of draft principles to guide the design of the intervention

Even though they are largely based on the literature, it is unlikely that draft principles will be complete at the time the proposal is presented, but they could be offered as a work in progress or draft list. At the very least, the process of deriving them should be described and examples given.

Description of proposed intervention

The proposed solution to the nominated educational problem is developed from consideration of relevant literature, consultation and collaboration with researchers and practitioners, and as an instantiation of the principles derived from these sources. As such, it is unlikely that any accurate description of the intervention or learning environment can be given at the proposal stage. Nevertheless it is important to describe in the prospectus or proposal the process of how the intervention will be conceptualized and developed.

PHASE 3: Iterative cycles of testing and refinement of solutions in practice

Once a learning environment or intervention has been designed and developed, the next phase of design-based research encompasses the implementation and evaluation of the proposed solution in practice. Design-based research is not in itself a methodology, but a research approach. While both qualitative and quantitative methods may be used, it is worth noting that: 'Design researchers do *not* emphasize isolated variables. While design researchers do focus on specific objects and processes in specific contexts, they try to study those as integral and meaningful phenomena' (van den Akker, Gravemeijer, McKenney, & Nieveen, 2006, p. 5). A research proposal would include details of the methodology of the implementation and evaluation of the proposed solution, as it largely constitutes the data collection and analysis stages of the study. The proposal should also include acknowledge of the likelihood, even the desirability in some case, of significant modifications being required in the data collection and analysis phases of the ongoing study.

Implementation of intervention (First iteration)

The iterative nature of design-based research means that a single implementation is rarely sufficient to gather enough evidence about the success of the intervention and its affect on the problem situation. A typical design-based research study would have two or more cycles, where after the first implementation and evaluation, changes are made to the learning environment to further improve its ability to address the problem. This is in keeping with the focus suggested by Reeves (1999) who maintained that 'our research and evaluation efforts should be primarily developmental in nature … the purpose of such inquiry should be to improve, not to prove' (p. 18). In DBR the context of the inquiry must be seen as a means to an end rather than an end in itself. The intention should be to use the setting to gain an understanding which will have meaning beyond the immediate setting.

Participants

In a research proposal, the description of participants and the method of their selection provide important information for reviewers about the potential for bias in the proposed study. Using quantitative methods, random sampling is often necessary to ensure representation of a larger population. In qualitative studies, the choice of participants always relate to the purpose or goals of the study, and are usually individuals who reflect the characteristics or are influenced by the issues being considered by the investigation. Because of the highly situated nature of design-based research, participants in a design-based research study in education are central to the investigation. Reeves (2006) noted that "Design research is not an activity that an individual researcher can conduct in isolation from practice" (p. 59). Most often, participants are students in the researcher's (or cooperating practitioner's) own practice, or teachers, parents, support personnel or other people involved in the educational community that is the focus of or context for the study. The description of the research process identifies the qualifications that need to be recognized in interpreting findings.

Data collection and analysis

The method of data collection in design-based research can involve the collection of qualitative and/or quantitative data, and it may be collected in cycles of several weeks or semesters, or even years. Types of data collected are likely to vary along with the phases. For example, data contributing to contextual understanding are more likely to be emphasized in earlier stages of the study; whereas data on prototype characteristics or user reactions are more likely to be collected later on. When it comes to more summative evaluations, "In view of the wide variation of possible interventions and contexts, a broad range of (direct/indirect; intermediate/ultimate) indicators for 'success' should be considered" (van den Akker, 1999, p. 8). Given the pragmatic aim of this kind of research, it is rarely possible to specify a finite minimum of data collection activities through which the research questions can be satisfactorily answered. Rather, research design decisions tend to be influenced by the goal of meeting triangulation criteria (cf., Krathwohl, 1993), such as:

- Data sources: varying time, location and participants
- Methods: varying formats (interviews, observations, etc.)
- Investigators: varying researchers (or assistants)

Depending on the types of data to be collected, related techniques should be specified. For example, pattern coding and sequential analysis (Miles & Huberman, 1994) may be used with some qualitative data; and certain tests (e.g. Mann-Whitney or T-test) may be run with quantitative data. In design-based research, methods and analytical procedures are selected and applied because of their utility for furthering the research project rather than because of their abstract "power" or refinement.

Implementation of intervention (Second and further iterations)
Although it is impossible to describe the nature of the second and subsequent iterations of the intervention, because they are so totally dependent on the findings of the first iteration, it is useful to describe the process that will be undertaken in the proposal. The cyclic nature of the data collection and analysis cannot be described in great detail in the proposal, but the process of *data collection, analysis, further refinement, implementation* and *data collection* (and so on) of the learning environment should be explained as a method in the proposal.

PHASE 4: Reflection to produce "design principles" and enhance solution implementation

Design-based research implies outputs in the form of both knowledge and products. While these outputs are difficult to specify in advance in the research proposal, it is useful to be able to describe the process of their development.

Scientific outputs: Design principles
The knowledge claim of design-based research, and one that sets it apart from other research approaches, takes the form of design principles, that is, evidence-based heuristics that can inform future development and implementation decisions (cf., Linn, Davis & Bell, 2004; van den Akker, 1999). Design principles contain substantive and procedural knowledge with comprehensive and accurate portrayal of the procedures, results and context, such that readers may determine which insights may be relevant to their own specific settings. In the traditional sense, generalization of design-based research findings is rather limited; instead, use of design principles calls for a form of analytical generalization.

Practical outputs: Designed artifact(s)
As a design field, the dominant research goal in educational technology should be solving teaching, learning, and performance problems. In design-based research, the product of design is viewed as a major output. Design artifacts in this field may range from software packages to professional development programs. Often these products are designed by the researcher and developed by programmers and resource specialists. It is not necessary for the researcher to be the developer.

Societal outputs: Professional development of participants
The collaboration that is so integral to the process of defining and accomplishing a design-based research project has an additional benefit to the extent that it enhances the professional development of all involved.

Timeline
Design-based research requires frequent and prolonged periods of fieldwork, off-set by periods of review, reflection and re-design. These intervals should be clearly taken into account in any timeline accompanying the research proposal. A major strength of design research lies in its adaptability, the commitment to adjusting a study's course based on findings from the field. But, a research design that keeps changing is weak. The evolutionary planning approach that is necessitated by most design studies can only be successful within a sound framework that sets limits and allows freedom within certain temporal and conceptual boundaries. Table 2 below offers a hypothetical sample timeline for a 4-year design research project. While oblivious to the requirements of particular institutions and local regulations, it nevertheless demonstrates an example plan for adaptability in the design and implementation of iterations of interventions.

Table 2: Sample research timeline

	Year 1	Year 2	Year 3	Year 4
1	Working with practitioners to define best scenarios for research	Data collection (design 1)	Data collection (design 3)	Dissertation writing
2	Literature review (continuing)			
3	Refining theoretical framework		Data analysis Planning final round	
4		Analyzing findings	Paper writing, participation in international conference	
5	Drafting detailed research plan	Literature review Redesign of innovation	Data collection (evaluation 1)	
6		Planning & implementing intervention		

7	Creating instruments for analysis	Data collection (design 2)		Literature review Dissertation writing
8	Data collection (needs and context analysis)			
9	Analyzing initial data Begin dissertation writing		Synthesize findings, revisit literature	
10	Literature review Mutual adaptation & refinement of research plan	Literature review Analyzing findings, redesign of innovation		
11	Designing intervention and data collection instruments	Planning and implementing intervention	Data collection (evaluation 2)	Final publication, preparation for defense, if required
12	Planning & implementing intervention			Defense

Light grey = Time primarily spent at university with mentor/advisor/supervisor
White = Time primarily spent in field

The structure of a design-based research proposal

In preparing the design-based research proposal itself then, it is necessary to move beyond the conceptual phases of the approach to a sequential and practical description, and to a sequence that is in keeping with the expectations of a traditional research proposal document. In keeping with these requirements, a typical structure might use the following headings or topic areas:

Title of proposed research

1. Statement of problem *or* Introduction *or* Rationale *or* Background (in consultation with researchers and practitioners)
2. Research questions
3. Literature review (preliminary)
4. Theoretical framework
    a. Draft principles to guide the design of the intervention
5. Methodology
    a. Description of proposed
    b. Description of proposed intervention
    c. Implementation of intervention (First iteration)
        i. Participants
        ii. Procedure/Data collection
        iii. Data analysis
        iv. Revisions to intervention
    d. Implementation of intervention (Second and further iterations)
        i. Participants
        ii. Procedure/Data collection
        iii. Data analysis
        iv. Revisions to intervention
    e. Development of design principles and products
6. Ethical considerations
7. Timeline
8. Budget

Using such a structure, there is a great deal of scope to provide a clear and convincing case that the research will be conducted with rigor and responsibility, and it helps design-researchers to clarify their role. This is extremely important, as design-based researchers often cope with the methodological challenges brought forth by serving as designers, advisors and facilitators while working on one design project.

Conclusion

We have to appreciate that design-based research is inherently exploratory and speculative. At the same time, it is a socially responsible enterprise because it puts the concerns and problems of practitioners in the forefront of the research and development process. Various educational technologies have often been predicted as having the power to revolutionize teaching and learning, but

virtually all have crashed on the hard rocks of the classroom. Some blame the lack of impact on teachers or the school or academic administrators, but design-based researchers do not seek to find blame in others. Instead, design-based researchers perceive that everyone involved in the project, researchers and practitioners alike have much to learn from one another.

In addition, there are numerous benefits for Ph.D. students with respect to preparing them for a lifetime of professional contributions. Following a design-based research study, doctoral students will be seen by practitioners as partners with whom they do research, as opposed to hypothetical beneficiaries of their research. They also learn from the earliest days of their doctoral programs that education is not a form of human activity that is susceptible to natural laws in the way that some other more biologically based practices are. They also learn how important that local context is to the entire research enterprise. In describing education as the "hardest science" of all, Berliner (2002) wrote:

> Our science forces us to deal with particular problems, where local knowledge is needed. Therefore, ethnographic research is crucial, as are case studies, survey research, time series, design experiments, action research, and other means to collect reliable evidence for engaging in unfettered argument about education issues. (p. 20)

We maintain that it is time for educational technologists to begin to engage more fully in the hard science of education. Fostering a whole new generation of design-based researchers focused on educational technology would be a great advance in this direction.

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