

# The Practice of Design-Based Research: Uncovering the Interplay Between Design, Research, and the Real-World Context

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Recent interest in design-based research as a research and development methodology in education has begun to clarify the goals and commitments involved in this practice. So far, we have limited views into how the work of design and the work of research impact each other in the course of design-based investigations. In this article, I use the experience of the passion curriculum project, in which I person acted as researcher and as educational practitioner to provide a close trace of the interconnections between research and design in this work. I highlight 3 key functions in design-based research: how design considerations provide a focus for developing research questions; how design moves forward on several fronts simultaneously, with some design solutions informed by research investigations and theory and others developed through engineering of locally functional solutions; and how emergent theories inform both the design of interventions and the development of lenses for investigation. Examples from the passion curriculum project expose the operation of these functions in this particular context.

Design-based research approaches research in education by using intervention to provide insight into learning in real-world contexts. As a relatively new approach to research, the boundaries of what constitutes design-based research are appropriately under discussion and negotiation in forums such as American Educational Research Association Annual Meeting, *Educational Researcher* (e.g., Kelly, 2003), and the *Journal of the Learning Sciences* (e.g., Barab, 2004). These kinds of articles begin to reveal a picture of what design-based research is and what can be learned from it. Although many elements of design-based research are still being negotiated, the current discussions begin to build a consensus about design-based research at a high level. The techniques of design-based research have not been well established, however. We have not yet fully articulated the ways that design and research goals intertwine with the goals of real-world practice in this kind of work. By engaging in such articulation, we can provide more guidance and more specificity for design-based research as a methodology. Some authors are beginning to describe how design-based research works on a day-to-day level in their specific work (Cobb, Confrey, diSessa, Lehrer, & Schauble, 2003). In the same spirit,

this article exposes the ways that design, research, and context interacted in one design-based research trajectory: the passion curriculum project.

## DESIGN-BASED RESEARCH

Shavelson, Phillips, Towne, and Feuer (2003) described design research as follows:

Such research, based strongly on prior research and theory and carried out in educational settings, seeks to trace the evolution of learning in complex, messy classrooms and schools, test and build theories of teaching and learning, and produce instructional tools that survive the challenges of everyday practice. (p. 25)

This definition implies three important, deeply intertwined goals for design-based research projects—research, design, and pedagogical practice. As researchers, we want to learn about some aspect of learning by designing an intervention that, through subsequent iterations, gets better and better at activating and supporting that aspect of learning. As designers, we want to use research on the use of the designed intervention, as well as prior research knowledge, to improve the

effectiveness of the design. In addition, we expect to get better at the practice of education—by participating in design and research, educators develop an intimate knowledge of the theoretical and design ideas involved in the intervention.

Many design research projects involve teams that include researchers, designers, and implementing teachers (M. Brown & Edelson, 2003; Cobb, 2000), each of whom is primarily responsible for maintaining the commitments relevant to their particular role. In this article, I focus on a design-based research project in which a single worker had responsibility for design, research, and practice.<sup>1</sup> This context creates a unique opportunity for observing the ways that design questions, research questions, and questions of practice can feed and flow into one another. The passion school project is a developing approach to the design of curricula that use learner interest as the engine for helping learners engage deeply with powerful intellectual and practical ideas. This project uses design-based research as its primary development mechanism. Enactments of the evolving design take place in and around urban schools to ensure that urban learners are the primary beneficiaries of the work and that the project will operate in these contexts.

In this article, I highlight two early passion curriculum enactments: a weekly summer program for fifteen 8-year-olds around the theme of flight, and the Video Crew, which operated as an after-school program in a public elementary school in a large midwestern city. I was the chief curriculum designer for both the flight project and the video crew, as well as the chief teacher and the chief researcher. This position affords me easy access to the ways that design as embodied in practice interacts with research needs in the passion curriculum context.<sup>2</sup>

### EXPOSING INTERACTIONS BETWEEN DESIGN, RESEARCH, AND REAL-WORLD CONTEXT IN THE PASSION CURRICULUM PROJECT

In this section, I use the passion curriculum trajectory to concretize key issues of integrated research, design, and practice in design-based research. This approach faces a dilemma: On the one hand, design considerations are many—to improve a design, we would ideally understand a large number of phenomena and variables in producing those phenomena. On the other hand, to produce effective research, we

need to focus in on specific questions. Furthermore, the day-to-day needs of real-world practice place constraints and demands on both design and research activities. Design-based research addresses this dilemma by using design needs and contextual demands as a way of determining the specific key questions of interest, and using engineering techniques such as “rapid prototyping” to address design issues and practical issues that are scoped out of the research. As theory and findings emerge from the research, they can shape not only the evolving design, but also the evolving research apparatus. Because this process takes place in a specific real-world context, design choices and research are highly faithful to that context.

### Narrowing the Field of Questions in Design-Based Research

Design-based research often begins with an early version of a design placed into a real-world context. Like any real-world learning context, the design-based research site bristles with research possibilities. Researchers might investigate a myriad of questions, including generic ethnographic questions—What are the norms of local culture? How is power managed and shared?—and generic cognitive questions—What do people learn in this context, and what mechanisms support that learning? Other kinds of psychological questions might arise as well—How does learner motivation operate in this setting? What kinds of affective patterns appear? Design questions are critically important—How are the designed artifacts used? How are they implicated in learning? How do they fail?

Any researcher who studies real-world learning situations makes choices about what to study. In many approaches to research, specification of research questions comes through identification of gaps in research literature—this is an important tool in design-based research as well. This particular approach has an additional tool for pinpointing critical questions: the lens of design. That is to say, 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. For example, a design researcher might hypothesize that a certain kind of representation will help learners develop knowledge about a particular idea or that a certain activity structure will motivate learners in a particular way. The design researcher creates artifacts that embody these hypotheses and places them in the real world for testing. This perspective effectively narrows the set of potentially relevant research questions.

In design-based research, investigations are centered around the evolution of the designed artifact. Design is the central tool for refining research questions, whether they emerge from prior literature or from the design itself. Questions about norms of local culture come into play insofar as they interact with design or the adoption of designed artifacts. The same is true of cognitive and psychological questions. This design perspective helps to reduce the “bristling”

<sup>1</sup>See Lee (e.g., 1993) and Lampert (e.g., 1986) for other examples of teacher/designer/researchers.

<sup>2</sup>In other methodological worlds, the combination of these roles would be impermissible or even impossible. A controlled experiment would face serious challenges if the intervener (teacher) and the evaluator (researcher) were embodied in the same person. Some ethnographic models permit researcher participation in communities under study, but when ethnographers deliberately create contexts or incite change, the practices of intervention and research are generally distinct rather than mutually constituting.

described previously by providing a focus for investigation—design researchers focus on questions that impact the design and even more tightly on questions that address the key hypotheses embedded in those designs.

The passion school project was intended to exploit learner goals in school curricula by organizing students into interest-based (rather than age-based) classrooms. The first problem to solve was designing classroom activities and communities that would make effective use of learner goals to lead to learning on adult terms. Two research-based learning environment design models guided the initial work on this problem: Goal-Based Scenarios (GBS; Schank, 1992; Schank, Fano, Jona, & Bell, 1993) and Cognitive Apprenticeship (J. S. Brown, Collins, & DuGuid, 1989; Collins, Brown, & Newman, 1989). The GBS model places learner goals at the center of design—learning activities in GBSs assign learners to a meaningful role in a realistic simulation. Goals arising from that role lead learners to pursue activities that create opportunities to learn about the role or about other learning objectives designed into the activities.

In 1995, existing GBSs were software programs (Pinkard, 2000) or were intended to serve adults in the context of corporate training (MacPherson, Berman, & Joseph, 1996). Cognitive apprenticeship was seen as a way of creating a meaningful and effective social environment for a passion curriculum. How should we shape live GBSs designated for children in a cognitive apprenticeship setting? The project was centrally intended to address this design question.

Prior to enacting the initial passion curriculum design, a large variety of research questions appeared to be important and of interest for our purposes—for example, how might students and teachers interact in a passion curriculum? What might students learn, and what mechanisms might be responsible for that learning? How might learner motivation ebb and flow as learners engaged in the designed activities? What would be effective instructional strategies in this setting? We did not have the resources to formally investigate all of these questions simultaneously. We therefore initiated design and enactment, allowing the enactment itself to tell us which research questions would be critical for ongoing research and development.

We chose a theme that designers believed would be interesting for students, as had been done in prior software GBSs, and developed learning activities linked to that theme. Activities were to be placed in a cognitive apprenticeship context: meaningful activities; cognitive and metacognitive learning objectives; learning from peers with different skill levels; and conscious modeling, scaffolding, and fading on the part of instructors.

We selected flight as a theme we believed would be interesting for learners, and we created a variety of small-scale GBSs around this theme. Enactment took place in an urban summer education-through-the-arts program, offered free of charge to families in an ethnically diverse mixed (low-to-middle) income neighborhood, for a full day each

weekday over 5 weeks. The passion curriculum project took responsibility for the five Friday afternoons for a group of fifteen 8-year-olds. I designed and taught the sessions,<sup>3</sup> and a small team of researchers joined me in collecting pre- and postinterviews about learner interests and knowledge about flight, video documentation, learner-created artifacts, and field notes.

Analysis of the flight curriculum yielded results that were disappointing. We did not see the powerful, extended engagement with activities that we had initially hoped for. It appeared that the theoretically required linkage between learner goals and the theme of flight simply was not salient in the enactment—in short, none of the children engaged deeply with the notion of flight. We developed three candidate explanations: (a) flight as a theme was simply a bad choice for a passion curriculum for children—at least in this particular setting; (b) five afternoons, separated from each other by a full week, did not provide enough time to build the kind of engagement we had hoped to see; and (c) the activities we had developed needed more motivational affordances than a simple link with the theme.<sup>4</sup> In some research paradigms, the proper role for research would be to tease out the power and relative weights of these factors in causing the phenomenon of interest. In design research, we have another option—to treat all of these paths as simultaneously productive for design.

Each explanation raises theoretical as well as design questions. Concern about the quality of flight as a passion curriculum theme raises the question of how themes ought to be chosen. Prior guidelines on GBSs at that time did not support theme selection. Even a later attempt to document GBS design knowledge for the internal purposes of a GBS producing institute stated only, “GBS designers should start their designs with some idea of the domain about which they want to teach something” (Neaman, Krema, Wolfe, & Berman, 2000). The passion curriculum project thus exposes an important gap in the GBS design theory. Filling that gap would be one important role for research in this context. Concern about lack of complex motivational affordances in activity design suggests a second path—to develop richer understandings of how to design for motivation in learning. Still a third path would be to develop knowledge about what kind of time is needed to produce engagement. These three paths are not orthogonal; they are simultaneously productive paths for design. Moreover, all three represented outstanding concerns from a practice point of view. The context of implementation of the design was the determiner of next steps in the design-based research project. If we had implemented another context where children were in-

<sup>3</sup>This was my 3rd year working as a teacher in this program, and my 1st year with students of this age.

<sup>4</sup>A fourth explanation—that my teaching skills were simply lacking, was seriously considered as well. Because we intended the passion curriculum framework to help teachers with developing skills as well as highly skilled teachers, we used this possibility as an element of the context rather than as an explanatory tool.

terested in flight before we began, concerns about motivation might not have been salient at all, and the project might have taken an entirely different route.

### Developing Designs Through Formal Research and Through Locally Functional Solutions

Design-based research allowed us to make use of all three candidate explanations for the poor effectiveness of the design implementation, unconfirmed as they were. We addressed one of the explanations not through theory making or formal investigation, but through designing a solution: We chose a different theme, this time based on experience watching children choose activities and surveys of children's interests. Improving theme selection in passion curriculum design remains an important theoretical goal, but we chose to make progress by choosing a theme we could warrant as being interesting to our specific participants and therefore effective for the local setting. In other words, we temporarily suppressed the problem of understanding theme selection for passion curricula in general by providing a locally effective solution. The question of theme choice in interest-based design remains important for future research, but simply choosing a better theme is an effective short-term solution that permits the project to move forward.

We also created a more extended, more intensive context for the activities—a single experience constructed of multiple intertwined activities operating every day for several weeks, rather than several, small-scale GBSs operating only once a week. This was another short-cutting venture—rather than pursue a complete investigation of why the several small-scale GBSs had not worked, we simply moved away from that tactic. The third conjecture—that we needed more motivational affordances—became the centerpiece of the passion curriculum design-based research project, described in the next section.

The context of implementation was the determiner of which of the three key concerns would be addressed locally and through more extensive research. In this particular context, we had excellent access to the learners who would be participating in the project prior to the start of each cycle of implementation. This meant that we could easily observe and interview participants prior to selecting a theme for curriculum design. It was a relatively straightforward matter to choose a theme that most of the likely participants would enjoy. It was not necessary in this particular context to develop a theory of theme choice to proceed.

The context also made it relatively easy to create an extended GBS rather than investigate the problem of small-scale GBSs. If the implementing classroom had permitted access only once per week, we would have needed to find a way to make small-scale GBSs work, and that might have led to new principles of design. Because we could simply increase the number of sessions per week in this context, we engineered a solution to the problem rather than organiz-

ing a program of design research to address it. The question of motivational affordances could not be addressed through a local solution—we simply did not know how to address it. We needed a design theory to proceed, and we surmised that other designers and design-based researchers could benefit from such a theory as well.

This process is akin to prototyping in software engineering in which

... early usability evaluation can be based on prototypes of the final systems that can be developed much faster and much more cheaply, and which can thus be changed many times until a better understanding of the user interface design has been achieved. (Nielsen, 1993, p. 93)

In the context of the passion curriculum work, the “interface” consists of the activities with which learners interact. It would be prohibitively resource-demanding to perfect the design prior to bringing the activities to learners. More important, such perfection is unattainable because much of the refinement process depends directly on how learners interact with the design. It was imperative, then, that we come up with some way of bringing a design, although unfinished and unproven, to a real-world group of learners. We therefore short-cut the serious, in-depth process of researching and refining every aspect of the design for the next enactment cycle: Although some elements of design were developed through theory and research, others were simply “hard-coded”—in other words, a locally effective solution was applied to the problem without waiting to develop a deep theoretical understanding. The next design cycle brought into focus the notion of developing a design-based theory of learner motivation.

### Emergent Theory Simultaneously Drives Design and Research

Based on groundwork from the exploratory investigation described previously, we developed and tested a new design for passion curricula through repeated design cycles. The most intensive implementation took place between March 1997 and June 1998 (apart from school holidays). The prototype curriculum, called the Video Crew, was organized as a community of students who expressed a common interest in video making. Activities were of four major types:

- *Projects*—significant works in the domain of the theme (video, in this case).
- *Certifications*—performance assessments in the domain of video, with embedded academic ideas, that allowed learners to earn new rights, responsibilities, and titles.
- *Community life*—activities in which students took responsibility for key aspects of classroom management.



- *Professional life*—activities that highlighted the ways that professionals in the domain of video making conduct their work.

These activities were organized and linked so that the teacher (the author) and learners negotiated how time would be spent. The curriculum operated in an after-school format in an urban public elementary school. Ten fifth-grade students were identified by their regular classroom teacher as eligible for the Video Crew in early 1997. These students were asked whether they would be interested in making videos in an after-school program. All accepted the invitation. Four students transferred to other schools in the summer of 1997. In March of 1998, 4 more students were invited to join as newcomers, working with veteran students in mentor roles. In late spring of 1997 and late spring of 1998, students organized “film festivals” in which they presented their work to their families and favorite teachers.

Concurrently with this work, and partially through this work, I collaborated with Daniel Edelson to develop a design-focused theory of motivation called the Interest-Driven Learning (IDL) framework (Edelson & Joseph, 2004). Both Edelson and I were drawn to this work by problems we had observed in our learning environment designs. In my case, the failure of flight as a theme was a direct inspiration to learn more about motivation and learning.

We began the development of our design theory by investigating learner motivation in the psychology literature. We began with resources designed to interpret motivation research for teachers (e.g., Stipek, 1993)—reviews of motivation literature (e.g., Eccles, 2002). We looked especially at literature regarding interest as a motivational construct (Schiefele, 1991) and the work of other learning environment designers considering issues of motivation (Blumenfeld, Soloway, Marx, Krajcik, Guzdial, & Palincsar, 1992). We used these resources as jumping-off points for deeper investigation of the motivation literature, and we used what we learned to sketch out a theory of how motivation ideas could be effectively applied in learning environment design.

The IDL framework places the personal interests of learners at the center on the grounds that cognitive and motivation psychology support interest as an especially powerful motivator for learning (Renninger, Hidi, & Krapp, 1992; Schiefele, 1991). At the same time, the IDL framework recognizes that interest is a relatively unstable motivator, wavering over periods of extended work, temporarily collapsing in the face of overly challenging tasks, and shifting with social tides. The IDL theory therefore proposes that designers consciously consider other motivational constructs as they develop activities—for example, closure motivation (Bruner, 1966), self-efficacy (Bandura, 1977), social motivations (Ford, 1992), and so on. We group these constructs under the heading “context-based motivation” because, from a design point of view, they can be addressed through adjustments to contextual factors in the environment—social groupings,

role assignment, adjustable difficulty levels, strategic placement of milestones, and so on. Motivation is thus divided for design purposes into two major constructs: interest, which is tied to the specific content and procedures learners engage in a learning environment; and context-based motivation, which is tied to contextual factors such as social arrangements, scheduling, and other constraints in the learning environment. The IDL framework represents an “ontological innovation” that can serve to “do useful work in generating, selecting among, and assessing design alternatives” (diSessa & Cobb, 2004, p. 77). IDL is not intended to compete with existing theories about human motivation—rather, this categorization makes use of existing descriptive theories of motivation in a prescriptive framework.

This developing design theory of motivation, arising in part from the passion curriculum work itself, informs both research and design going forward: From a design point of view, the passion curriculum model shapes activities according to the IDL framework. That is, interest is the organizing principle for the learning environment and context-based motivation (social motives, reward, challenge, progress, etc.) is positioned to support interest. Specifically, projects are designed to serve interest in the theme of the curriculum and to address learning objectives that tie easily to that interest. Social arrangements and progress structures such as deadlines are used to support learners in pursuing their interests. Certifications are designed to use authentic rewards and social motives to help learners address learning objectives that adults identify as important but that do not fit easily with personal interest in the theme. Certifications are related to the theme and thus continue to support learner interest, but they deliberately exploit other powerful motives to help learners focus on less attractive learning objectives. Community life engages social motives to focus on social learning objectives.

From a research point of view, the IDL framework was incorporated into the investigative apparatus. The central goal of this work is to create an effective model for designing interest-centered progressive learning environments that help students engage intellectually with powerful ideas. How can the real-world enactment of the design be made to produce data that identifies specifically what needs improvement in the design and suggest ways of improving the design? We need a research methodology that produces design ideas.

In the case of the passion curriculum work, we developed a methodology that used the IDL framework as a tool for understanding how three design elements—projects, certifications, and community life—might be improved (Joseph, 2000). We collected qualitative data, including field notes, videos, and audiotapes documenting learner behavior during the passion curriculum enactment, as well as interviews of learners about what usually motivated them. We used this data to construct motivational profiles of learners in IDL terms. We coded episodes of activity and learner statements from the data sources according to three categories: indicators of interest in video making (interest aligned with the

theme of the curriculum), indicators of interest in something other than video, and indicators of a motivation stemming from something other than an interest (i.e., context-based motivation). We used these codes to assign each learner a profile, and we supported our determination of profiles with interview data and about learner's lives outside the passion curriculum.

Learners with a very strong, clear motivational pattern were construed as highlighting times when the design served that pattern motivationally. In other words, a learner who was driven by interest in video making, far more than by other motives, would exhibit choices that could identify the ways that the Video Crew passion curriculum connected with that interest. A learner who was driven by social motives far more than by interest would expose ways that the Video Crew passion curriculum served social motives. In our population of learners, three strong profiles emerged, along with several balanced or ambiguous profiles.<sup>5</sup> The strong-profile learners were MaryAnn, who was passionate about video making; Charles, who exhibited passions that became the content of videos and a merely instrumental attraction to video making; and Melinda, who was strongly driven by social goals and tended not to pursue or express her personal interests.

Centrally, the design goal was to create a learning environment model that used interest as a driver for placing learners in a position where they had to grapple with powerful ideas. In the research, we therefore looked for identifiers of such grappling in the artifacts (proposals, treatments, planning documents, screenplays, storyboards, videos, props, costumes, etc.) that learners produced. By looking carefully at the body of work produced by learners with strong motivational profiles, we were able to see how their grappling patterns varied across the design elements.

Theoretically, we would have expected MaryAnn and Charles—the two passionate students—to prefer doing project work and to grapple with ideas most in project work. We would have expected Melinda to prefer community life and certifications and to grapple most in one or both of those categories. The findings varied from these expectations in three major ways: First, certification production was very limited across all of the students. Second, Charles' grappling patterns were balanced across projects, certifications, and community life. Third, Melinda engaged with projects and grappled in the project setting just as much as MaryAnn.

*The certification problem.* What does this mean? Limited production of certification artifacts is a serious concern. If the passion curriculum model is to address learning objectives that go beyond what is already for learners, if the model is to challenge learners to think outside their personal interests, then the certification function needs to be stronger.

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<sup>5</sup>In future work with a larger population, we would expect to see many more kinds of strong profiles and to develop a better understanding of the balanced and ambiguous profiles.

This suggests we look more closely at the causes of trouble in the certification work—how do teachers “market” certification work? Is something wrong with the rewards involved? Are the key learning objectives associated with certification so unpalatable to learners that they cannot be addressed in an interest-centered context? To decide how to develop the certification structure, we returned to the reflective field notes I produced as a teacher. Having identified certifications as an underutilized mechanism in the Video Crew, I could now go back to field notes about certifications with a mindset shaped by the research. This new lens on the field notes suggested that a key trouble lay in the lack of standards for certification—learners simply did not know when they had achieved a skill at an acceptable level and could not accurately assess the difficulty of achieving certification. An additional problem seemed to be that the teacher's explanation of certifications was not sufficient to help learners understand that skills developed through project work or under any other circumstances could be applied to certification. The research thus produced specific ideas about the design of certifications. The next generation of certification design included clear standards. We continue to refine this structure through field research and through engineering solutions.

*The Charles problem.* With a bit of further analysis, we found that Charles grappled as expected in projects that he led or sought to join and did not grapple at all in projects that someone else (the teacher or other students) asked him to participate in. MaryAnn and Melinda grappled equally with self-selected and assigned projects. From a design point of view, this highlights the importance of permitting choice in project work: Free choice of projects would have helped Charles and would not have hurt MaryAnn or Melinda.

*The Melinda problem.* Why did Melinda show a project engagement pattern similar to MaryAnn, when the Video Crew design should have served MaryAnn more effectively? Two key possibilities come to mind: Perhaps the Video Crew had sufficient hooks for social motivation that it was able to serve even students who preferred social motives over personal interest. Another possibility is that Melinda simply likes to follow instructions. If this is the case, we need to understand more about how her work in Video Crew differed from her work in the regular classroom. Melinda might be a student who is able to benefit effectively from the traditional classroom, where following instructions is central to student practice. On the other hand, she might be a student who, for social reasons, wants to appear engaged. If that is the case (indeed, in any case), we need better measures of the outcome of engagement.

This investigation shows how a design theory emerging from the research—the IDL framework—shaped both specific design work and specific development of research apparatus. The IDL framework was central to clarifying motivational considerations. The IDL also provided a set of

categories from which to develop the motivational profiles that became key lenses into the functioning of activities.

Although the passion curriculum research has some intriguing and useful design implications, it also raises many questions: We need to work with many more students to generalize the findings. We need deeper and more reliable measures of learning outcomes. We need to test the validity of the motivational categories in the IDL. We need to understand the role of the author's personal instructional style in the Video Crew experience—which aspects of activity design and instruction properly belong to the model and which should be subject to the preferences of individual teachers? Furthermore, how will the model operate in different schools with different students and different circumstances? If the model is useful, how can it spread to new teachers and new schools?

In the 2000–2001 and 2001–2002 academic years, redesigned Video Crews have been taught at two different schools in addition to the one described in this article by four different teachers. We have also instantiated a second passion curriculum—Multimedia Design studio. This phase of design research has helped to zero in on how the model differs across the practice of different practitioners (Joseph, Edwards, & Harris, 2002) and to continue investigation of how to make use of complex learner motives (Joseph & Nacu, 2003). At the same time, we have begun to develop techniques for sharing the model with new adopters—in the summer of 2003, 30 urban public school teachers participated in a professional development course regarding the design of web-based materials, emphasizing passion curriculum concepts (Cunningham & Joseph, 2004). A particular research goal going forward will be to develop more effective measures of learning outcomes relevant to this kind of complex learning environment.

## CONCLUSION

Design-based research provides opportunities for researchers to deeply understand problems of practice and for practitioners to deeply understand the goals and implications of research. My struggles as a teacher led to key developments in the design and in the research approach. At the same time, my research and design perspective provided a strong intellectual resource for my decision making as a teacher.

Overall, this research trajectory exposes the operation of three important characteristics of design-based research: Design-based research creates opportunities for focusing on key questions, as in the case where the passion curriculum pilot work identified a need for more intensive theorizing of motivation in real-world learning environments. Design-based research supports design progress with both formal research backing and rapid prototyping, as when we solved certain problems without attempting to understand them deeply. And, in design-based research, emergent theory shapes research methods as well as design. The conjoined goals of developing effective designs and contributing to basic under-

standings create through their interactions a powerful engine for driving innovative work in education.

Larger projects, in which research, design, and practice are led by different people, also need to develop ways to intertwine these activities intensively. The Information Infrastructure System project, a combined effort of Northwestern University, University of Chicago, University of Washington, and several elementary and high schools in various states, has begun to develop technological tools and social practices to bring research and design into high fidelity and collect ongoing documentation of design decisions (Joseph, Bryk, Bransford, Gomez, & the Information Infrastructure Project, 2003). Designers populate a database with records of each decision, whether motivated by literature review, field research, or the demands of practice, and these records are reviewed by a team of researchers from a diverse range of disciplines. This effort is intended not only to serve the usual needs of design research projects for documentation (Cobb et al., 2003), but also to guide communication and coordination across distance, discipline, design tasks, and research questions in a particularly complex project. At the same time, this detailed trace of design decision making may offer more extensive insight into still unarticulated techniques of design research. In addition, design records may ultimately represent a way of extending the warrants available for design research.

Some key issues regarding research in this paradigm are not yet effectively illustrated: When and how does summative evaluation proceed? When and how do we generalize our findings? Collins, Joseph, and Bielaczyc (2004) called for the development of a national infrastructure to support summative evaluation of educational innovations. Such an infrastructure would allow the field to observe and jointly investigate a large number of innovations across a variety of specific goals. This is an important development in bringing design-based research to maturity as a methodology.

The tightly intertwined research and development efforts in projects like the passion school work represent an important set of opportunities in methodology: Design-based research can be a powerful engine for exposing crucial research questions and for constructing incisive research apparatus around design questions. This work happens most powerfully in the field—in real-world implementations and interactions between research goals (and researchers), design goals (and designers), and practice goals (and practitioners).

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