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On the theoretical breadth of design-based research in education

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Abstract

Over the past decade design experimentation has become an increasingly accepted mode of research appropriate for the theoretical and empirical study of learning amidst complex educational interventions as they are enacted in everyday settings. There is still a significant lack of clarity surrounding methodological and epistemological features of this body of work. In fact, there is a broad variety of theory being developed in this mode of research. In contrast to recent efforts to seek a singular definition for design experimentation, I argue that methodological and epistemological issues are significantly more tractable if considered from the perspective of manifold families of theoretically-framed design-based research. After characterizing a range of such families, I suggest that as we deliberate on the nature of design-based research greater attention be given to the pluralistic nature of learning theory, the relationship between theory and method, and working across theoretical and methodological boundaries through the use of mixed methods. Finally, I suggest that design-based research—with its focus on promoting, sustaining, and understanding innovation in the world—should be considered a form of scholarly inquiry that sits alongside the panoply of canonical forms ranging from the experimental, historical, philosophical, sociological, legal, and the interpretive.

On the theoretical breadth of design-based research in education

What is the theoretical purview of design-based research in education?

The master question from which the mission of education research is derived: *What should be taught to whom, and with what pedagogical object in mind?* That master question is threefold: what, to whom, and how? Education research, under such a dispensation, becomes an adjunct of educational planning and design. It becomes design research in the sense that it explores possible ways in which educational objectives can be formulated and carried out in the light of cultural objectives and values in the broad.

— Bruner, 1999, pp. 408 (italics in original)

Learning is too complex a phenomenon to be the sole province of any one discipline, theoretical perspective, or research method. Design-based research is premised on the notion that we can learn important things about the nature and conditions of learning by attempting to engineer and sustain educational innovation in everyday settings. Complex educational interventions can be used to surface phenomena of interest for systematic study in order to better promote specific educational outcomes. Given the complexity of these settings, emergent phenomena also regularly present themselves for potential study.

One might expect to find widespread theoretical or methodological coherence among efforts purporting to be design experimentation, but that is largely not the case. I argue that this primarily due to the sensible theoretical breadth of scholarly inquiry associated with mounting a broad variety of complex educational interventions while studying select aspects of the associated learning, cognition, development, and interaction phenomena. Rather than seek some singular definition for design-based research in education, I present a range of research programs in order to depict the theoretical and methodological breadth of design-based research in

education while highlighting some of the associated contours of the work. I believe many discussions about the nature of design experimentation seem to get mired in confusion because these sensible variations are not well recognized. I argue that there is significant methodological coherence in various modes of design-based research once it is recognized that different efforts are focused on developing different kinds of theory, products, and strategies for bringing innovation to scale. I discuss these issues in the body of the paper, but first let us consider issues of theoretical perspective and scientific stance in educational research.

Do universal laws of cognition exist that describe human learning and thinking? Or, is cognitive activity fundamentally bound up in the material places and the cultural groups in which we participate? Are both perspectives warrantable in some fundamental sense? Are they ultimately commensurable—or at least both pragmatically useful? More generally, which theories of learning—among the dozens available to us from the literature—are most useful for understanding how to promote educational outcomes and processes of cultural interest (as suggested in Bruner's master question)? Is design-based research more naturally aligned with a biological, cognitive, or cultural perspective on learning? At this point I simply want to note that scholars disagree on these issues of theory.

Issues of research communication, accumulation, and knowledge are also relevant. Once a research insight has been gleaned about the nature of learning as it occurs in one educational context, is the best 'scientific' move to universally generalize the finding until it is found to *not* hold in other contexts? Or, is the more scientifically productive path one whereby insights are described along with other relevant dimensions of the local context in ways that serve to describe it systemically and contextually? This tradeoff can be seen as a continuation of the historical

discussion summarized by Cronbach (1975, pp. 116) as: "Should social science aspire to reduce behavior to laws?"

Given the interventionist nature of the work at hand, it is also relevant that the range of educational products that can become a focus of educational design-based research is quite broad. Design work might focus on the development of novel learning technologies or software. It might focus on the development and refinement of a semester-long curriculum sequence and associated instructional techniques for a particular subject (e.g., intellectual roles, social norms, activity structures). Or, researchers might wish to promote the development of professional teaching practice through the design of a teacher education program or formation of an extended community of practice that spans the years associated with teacher's induction period. Museum researchers might focus on the creation of a multifaceted exhibit space and educational program. Then again, researchers might design regional or national educational interventions that attempt to shift the health behaviors of citizens. In sum, complex interventions in education amenable to design-based research take many forms.

Once we have developed and studied an educational intervention in a particular setting it is becoming standard practice to bring it to a broader, scaled use. Is the dissemination of educational innovation best accomplished through the distribution of compelling educational materials and mechanisms for standardizing instructional practice around them? Or will we take innovations to scale with greater fidelity to the underlying pedagogical philosophy—and local educational effect—if we focus on promoting the growth of educational cultures that come to be stable over time around a shared set of norms and principles for appropriating locally-tailored educational experiences? As we will see, studying how to diffuse and sustain educational innovation can become a focus of design-based research itself (e.g., Cole, 2001).

I raise these dimensions of theory, design, and diffusion to highlight the ways in which scholars disagree. It seems these differences arise for reasons ranging from their scholarly grounding—and the partisan conventions and commitments that come with such allegiances—to the necessary pragmatics of bounding research and theory work in order to make progress in discrete lines of research given fixed resources and local constraints. Such disagreements also arise due to the fundamental complexity of the educational enterprise itself given broadly divergent assumptions and goals regarding its various purposes in society (e.g., promoting individual rather than social outcomes). These differences of opinion, orientation, and purpose—as a manifestation of research pluralism—seem largely productive given the complexity of the educational endeavor and the state of our theoretical knowledge of learning as it can be applied for diverse educational purposes.

My purpose in this paper is not to bring resolution to any of the differences enumerated above, but rather to wade into some of the details and highlight the breadth of the present and possible scope for design-based research in education in order to bring different faces of learning into focus and to consider unique and shared aspects of these sensible research variations.[1] In other words, I am simply working to put a greater variety of research programs under the design experiment label than is often the case in accounts of that work. I do so in order to develop a more complex and detailed image of design-based research in order to sharpen our meta-conversation about this mode of work.

Scholars came to engage in design-based research in order to better understand how to orchestrate innovative learning experiences among children in their everyday educational

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[1] I am also not presuming to be comprehensive here although I am attempting to present some significant breadth. There is sufficient balkanization within educational research that subsequent, significant broadening of the bounds of design-based research as I present it is more likely than not. This is an argument I revisit at the end of the paper.

contexts as well as to simultaneously develop new theoretical insights about the nature of learning. This intertwining of research and practice—as framed by some as research on educational practice and its effects—fits quite well with the purposes of education given its fundamentally interventionist nature. In this sense, it is difficult for many to imagine how to make practical and theoretical progress without conducting empirical research in naturalistic settings and refining use-centered theoretical knowledge of teaching and learning.

As might be clear given the range of issues referenced above, design-based research in education is increasingly being conducted by groups and individuals who represent a broad variety of theoretical camps and draw upon a variety of intellectual traditions from psychology, anthropology, linguistics, neuroscience, and sociology. Explanatory accounts of learning range between the theoretical poles of culture, biology, and cognition. At this moment in educational history, we do not have one or even just a few dominant theories that seek to depict human learning. We have a multitude of theoretical perspectives frequently drawing upon different methodological traditions and bringing different educational phenomena into focus. For example, design-based research exploring machine cognitivist conjectures about subject matter learning differ substantially from conversation analytic accounts of how a curriculum shifts the discourse of students and teachers. Is it any small wonder that given the breadth of intellectual traditions and the complexity of the educational enterprise that design-based research has not been a singular, coherent body of work with research findings accumulating in neat piles?

It is quite likely that differing accounts of learning could be synthesized if not for the balkanized and divergent nature of the social sciences. However, I want to argue that a plurality of distinct research endeavors do exist that leverage design-based research methods in sensible ways. In the coming sections I highlight some of the structural and epistemological contours of a

subset of these programs to help understand the diversity of research approaches being productively pursued. This is a bit challenging from my role as a participant critic, especially since I am not an intellectual philosopher nor historian. Rooting around in epistemological and methodological matters is complicated enough without trying to surface and juxtapose a diverse variety of research enterprises. And yet, I feel that our conceptions of design-based research have been artificially narrowed without an effort to depict the theoretical bounds of this mode of work.

Design-based research in education as a manifold enterprise

At this stage of development of design experimentation, it seems reasonable to look for dimensions of coherence in the existing body of work. The argument I want to advance is that design-based research is by necessity a manifold enterprise with regard to research focus, practice, and underlying epistemology. Among researchers that affix the "design experiment" label to describe lines of their work—even if we bound this set to those that are pursuing theoretically-framed empirical research associated with the enactment of complex educational interventions in everyday settings—the questions being pursued and the traditions being relied upon are diverse.

By describing a range of existing design-based research efforts in education, I will argue that we should not be striving to establish some singular research tradition called design experimentation (or one of the other design-based research terms currently in use). Rather, I believe it is more useful to consider design-based research as a high-level methodological orientation that can be employed within and across various theoretical perspectives and research traditions in order to bring design and research activities into a tight relationship in order to advance our understanding of learning-related educational phenomena. Understanding and grouping this work around the theoretical commitments of scholars and the traditions they rely

upon offers a sensible lens by which to understand the nature and status of this work rather than defining some solitary image of design experimentation and mapping that onto a divergent corpus of work—or the equally problematic practice of not considering the full range of research efforts under the same research enterprise label. Within a theoretically-framed family of design-based research, or efforts that string together a similar constellation of theoretical perspectives, it is reasonable to strive for shared commitments or practices that are more uniform, but programs of research from across the different traditions might necessarily look quite different from each another.

Before describing these different families of design-based research, I believe it is necessary to sift out some work that will not be under consideration in this reframing. It is worth mentioning that there are many people who simply misconstrue or misappropriate the term design experimentation. In fact, it has been problematic for researchers to learn about design-based research approaches since the detailed practices and norms have typically been communicated through the everyday activities of research groups engaged in such work. Further, research groups engaged in design-based research often know very little about the details of the work conducted in other such groups. The situation is also complicated by the fact that the design experimentation term is often misapplied to design activities where objects are taken into authentic educational contexts without any coordinated attempt to engage in theoretically-framed empirical research on related educational phenomena. In this form, these research activities are design research, but they are not design experimentation or design-based research. The design research approach, without the theory work and rigorous empirical research, sometimes lead to the design of products that are genuinely useful, but such work does not stand to inform the nature of the specific educational phenomena at hand (e.g., conceptual learning of subject matter,

teacher cognition, identity formation, etc.). This 'theory work' is a defining feature of the design experimentation enterprise.

For the purposes of this paper I narrow the focus of design-based research to those enterprises that involve intentional design coupled to empirical research and theorizing about what takes place in the authentic contexts where the designed objects come to be used. Although somewhat more ambiguous, I also want to narrow the focus of design-based research to *complex* interventions or efforts to effect change. Assuming that the length of intervention roughly correlates with its complexity (cf. Lemke, 2000), I am talking here about design-based research projects that involve educational interventions occurring over the time scale of days, weeks, months, and beyond and not about interventions lasting less an hour. Across these longer time scales, design-based research efforts focus on promoting innovation across different educational phenomena—at individual, social, cultural, organizational, community, and societal levels—and thereby employ corresponding research approaches, practices, and traditions based on these varying units of analysis.

In the next section I provide caricatures for a number of specific families (or modes) of design-based research currently being pursued by researchers. It is worth noting as I do this that if design-based research is an emerging paradigm for educational inquiry, as colleagues and I have argued elsewhere (DBRC, 2003), then the design-based mode of research might be broadly applied to different intellectual corners relevant to the field of education. Since education is an interventionist, designed enterprise by its very nature, the scope of design-based research may continue to expand and prove to be as generative as other established modes of educational inquiry (i.e., experimental, historical, philosophical, anthropological, sociological). To that end, the caricatures I will provide should be interpreted as representative but certainly not exhaustive.

Theoretical modes of design-based research

For each mode of design-based research, I will outline some of the phenomena of interest for that field and summarize the intellectual approach and then discuss the nature of the theoretical and design work associated with the research. In this portrayal of the design-based research landscape I want to begin with a recognized, taken-to-be prototypical mode of work. I will start by delineating some instances and contours of what might be framed as *developmental psychology design-based research*. To this end, Brown and Campione's Fostering a Community of Learners (FCL) project is still considered by many to be the canonical example of this mode of scientific inquiry (Brown, 1992; Brown & Campione, 1998). FCL was an ambitious, multi-faceted enterprise that involved cycles of design, orchestration, and study of systemically-considered, highly-articulated, sustained educational interventions in a number of specific classrooms. In sum, the research sought to understand the formation and educational effects of participant-empowered, learning-focused classroom communities from a socio-cognitive developmental perspective. Brown characterized quintessential features of their research program in her methodological treatise on design experimentation (Brown, 1992). She highlighted the scientific and educational benefits of playing laboratory experimentation off of classroom experimentation in macro-cyles of research activities, and also of juxtaposing nomothetic and ideographic accounts of learning and development derived from multiple methods—both in the interest of better understanding the developmental phenomena at hand and the conditions under which they can be promoted.

Other work of this kind has promoted and explored a range of developmental phenomena including: growth in conceptual understanding as a result of knowledge-sensitive instruction involving experimentation (diSessa & Minstrell, 1998; Linn, 1992; Metz, 1998) and data

analysis (Reiser, Tabak, Sandoval, Smith, Steinmuller & Leone, 2001) involving the appropriation and use of specific inscriptional notations (Bell, 2002, 2004; Penner, Lehrer & Schauble, 1998; Roschelle, 1992), the development of representational competency and conceptual understanding through creative, constructive activity (diSessa, Hammer, Sherin, & Kolpakowski, 1991), and epistemological growth as a result of engaging in argumentation and "going meta" on its nature (Bell & Linn, 2002; Smith, Maclin, Houghton & Hennessey, 1999; Stevens, Wineburg, Herrenkohl & Bell, submitted).

For historical reasons perhaps, developmental psychology design-based research has focused on socio-cognitive development—increasingly with a domain-specific or disciplinary character resonant to the broader field (cf. Stevens, Wineburg, Herrenkohl & Bell, submitted). However, my overarching argument about the methodological breadth of design-based research would mean that other human development phenomena could become the focus of complex interventionist research. Specifically, design-based research could well focus on identity formation, moral growth, perceptual learning, or gender development. Indeed, design-based research had recently started to pivot around such developmental phenomena as how to best engineer motivation or interest (Collins, Joseph & Bielaczyc, 2004) and how to promote identity formation through constructive activities (Bers, 2001).

In important ways, these developmental psychology design studies are as different from each other as they are similar. Units of analysis range from the individual to dyads on up to classroom-size social communities—and hybridized, interlocking analyses of individual and social dimensions happen as well. The studies correspondingly focus on microgenetic, sociogenetic, and ontogenetic character of human development in these contexts. Methodological choices—in terms of the design and analysis dimensions of the research—should obviously map

onto these units of analysis, modes of behavior, and timescales of development. What binds these research efforts together epistemologically is this focus of the inquiry on dimensions of human growth—as a diachronic set of phenomenon—in ways that contribute to a causal accounting of the contingencies that influence growth whether the sources of influence are endogenous or exogenous in origin.

Due to this theoretical sensitivity to variation in developmental trajectories, developmentally-inspired instruction is often designed to be more directly responsive to student's developmental differences as they present themselves in a learning situation. This can lead to significantly less emphasis on the reification of uniform instruction in curricular artifacts and instructional approaches (Schauble, 2001, personal communication). In specific efforts, more of the intervention is responsively produced during the course of the intervention itself rather than in advance. This is accomplished through micro-cycles of design (cf. Cobb, 2001); it constrains the range of pedagogical artifacts that might be developed but simultaneously allows for customizing instruction in accordance with the developing capacities of specific children or groups.

Cognitive science research provides us with another image of design-based research. Although cognitive phenomena are often subsumed under developmental frameworks, I believe it is warranted to bring specific attention to what might be considered *cognitive science design-based research*. With much of its dominant forms of research driven by an individual-focused, machine cognitivist epistemology, cognitive science has developed theoretical models of the nature of knowledge and cognitive processing associated with mental phenomena like perception, analogical or schematic reasoning, metacognition, decision-making, and problem

solving. Given their relevance to educational objectives, such phenomena have been the focus of specific design-based research efforts.

More generally, cognitive scientists have long sought to inform the design of everyday artifacts and contexts through their research. The dominant approach pursued throughout the initial heyday of the information processing era was an application of basic knowledge derived from laboratory experiments to real world design problems (e.g., Norman, 1986). There are strong limitations associated with this 'application of findings' model, especially in terms of not being able to attend to the complex interaction effects and vicissitudes of human behavior that present themselves in everyday contexts. As an alternative model, diSessa (1991) outlined a research approach that pulled principled design centrally into a program of scientific research and coupled it to empirical research and theory-building about the localized nature of cognition. This approach blurs the basic and applied research distinction in a way that mirrors the initial framing of design experimentation (Brown, 1992; Collins, 1992).

A prototypical example of cognitive science design-based research in education is the ThinkerTools project. In sum, this research program has investigated how students can best learn general inquiry skills. In one specific line of research they systematically studied the influence of interactive computer simulations on the conceptual learning of physics (White, 1993), the influence of a self-assessment approach to metacognitive scaffolding on learning (White & Frederiksen, 1998), and the growth of epistemological awareness about the nature of scientific modeling (Schwarz, 1998). This work focused on the promotion of individual mentalist phenomena; it informs the growth of student's conceptual knowledge about physics, their epistemological knowledge of modeling, and the role of metacognition in conceptual change.

The educational designs are created to support the cognitive phenomena under study (e.g., scaffolding metacognitive reflection through the design of self-assessment worksheets, making qualitative models of natural phenomena visible through interactive simulations). Analytical work frequently draws upon the nomothetic traditions of cognitive psychology. Specifically, internal validity and generalizability are core commitments. Investigators frequently identify and study the dependent and independent variables through statistical models that are explanatory and predictive. In an attempt to grapple with the inherent complexity of the world in this tradition of work, Collins (1999) has called for the identification of what he refers to as outcome, climate, and system variables associated with design experimentation efforts.

As with other design-based research, these intellectual commitments influence the research and analytical methods employed as well as the nature of the resulting cognitive theory and design knowledge constructed. Researchers from this tradition are more willing to reify the results of their research as design products to be used widely (e.g., software, curriculum) and generalized design knowledge (e.g., design principles and case studies) (cf. CTVG, 1992). Perhaps this is due to its assumptions about the universal qualities of cognitive processing or its focus on synchronic phenomena (e.g., the coupling of metacognition and conceptual learning) relative to the aforementioned individual developmental differences. Theory-building in this machine cognitivist tradition typically involves a 'move toward generalizing' whereby theoretical findings and design knowledge are often framed as if they span a broad variety of contexts; the scientific approach taken often assumes that findings should carry across varied contexts before each variation has been individually studied. Unlike other design-based research traditions, the cognitive science design-research approach more frequently pursues the identification and application of universal laws of mind.

By engaging in design-based research, how can we better understand the cultural mediation of mind—the influence of interpsychological activities on intrapsychological processes? This form of work might best be labeled *cultural psychology design-based research*. In this view, culture—or more precisely micro-culture—comes into being wherever people engage in joint activity over an extended period of time (Cole, 1996). Put technically: an ideoculture is "a system of knowledge, beliefs, behaviours and customs peculiar to an interacting group to which members refer and employ as the basis of further interaction" (Fine, 1983, pp. 123). Then, cultural psychology design-based research attends to the local cultural-historical foundations of development and learning as it is promoted and transacted through patterned interactions between individuals and artifacts.

The Fifth Dimension is a prototypical research program for cultural psychology design-based research (Cole, 1996, 2001; Newman, Griffin & Cole, 1989). Through the theoretical lens of cultural historical activity theory (CHAT), this work has involved the cultivation of a variety of different learning communities in after-school club contexts involving both K-12 and university students. The communities are quite different with regards to how they are locally constituted, but they try to attend to a number of organizing principles that have developed through this work. In other words, there is 'appropriate local variability' in contrast to assuming that all of the communities should be identically constituted and regulated. These communities are less focused on specific, shared educational outcomes, but rather they involve design-based efforts to promote sustainability and generative learning activities that are compelling to participants. Cognitive development can still be investigated as it occurs within these contexts. Significant attention is given to the social and cultural/historical processes that mediate such outcomes.

Design-based research in this theoretical tradition takes responsibility for promoting specific educational micro-cultures—for "culturing" children through the design and enactment of activity systems (e.g., the orchestration of cross-age interaction around a problem-solving or game task). Derived from a theoretical grounding in Vygotskian sociocultural theory, the focus is on the transformation of mediated action for members of a community which guides this work (Cole, 1996; Wertsch, 1998). The work has also focused on the cultivation of sustainable learning communities that persist over long periods of time. Sustainability of these Fifth Dimension communities over 15 years has become an object of the design-based research itself in addition to the activities on the everyday timescale.

In contrast to the generalizability commitment driving much of the cognitive science design-based research, this construal of a cultural psychology family focuses on the formation and sustainability of educational micro-cultures where variation and localization is promoted because it has been found to be absolutely necessary in order to attain local customization and sustainability. Theoretical knowledge can be applied across contexts (interpretively and pedagogically), but it is clear that cultural psychology design knowledge is not thought to be uniform nor fully specified. Principles guide the endeavor but they must be locally constituted in a manner appropriate for each micro-culture—and it is likely that they can never be entirely comprehensive (Cole, 2001). The cultivation of each micro-culture is largely a unique endeavor based on the particular histories, purposes, and resources of the people and institutions involved. To cite Cole on this issue: "design experiments involving educational activity are complexly constructed social systems in which it is simply not possible to be sure at all times what combination of factors is at work to produce the phenotypical appearances. All such systems are emergent products not only of factors identified as internal to the system, but factors that involve

the necessary openness of such systems to the social systems in which they are embedded"
(Cole, 2001, pp. 8). Cultural psychology design-based research recognizes the profound
influence of the surrounding social context in which the work takes place—which characterizes
our next mode of design-based research as well.

Frequently in design-based research, epistemic authority has been given over to specific
theoretical accounts of human growth (e.g., development of metacognitive capacities) or
normalized images of disciplinary or domain-construed expertise (e.g., engagement in specific
forms of mathematical problem solving). Such images of desired human behavior, which are
often generalized, sweeping accounts of intelligent action, become a driving influence both in the
design of the intervention and in the framing of the analytical lenses by which design researchers
understand whether or not educational progress is being made. An alternative to this strong
theory-driven (etic) orientation of the inquirer's perspective is a folk (emic) research orientation
that investigates the manifested meaning of an intervention from the point of view of the
participants of the research as interpreted through their activity and their accounts. Thusly
framed, this latter form of work might be labeled *cultural* or *cognitive anthropology design-
based research*.

What is gained in design-based research by analytically interpreting and privileging the
social worlds constructed by children and teachers? I can foresee three beneficial consequences
of giving a significant degree of epistemic authority during research to the micro-cultures of the
participants: (1) as a way of promoting the local appropriation of designs by microcultures
(perhaps even through participatory design), (2) as an analytical way to compare the constituted
activities of school with reference communities in order to better understand how they can be

better articulated, and (3) as a means of understanding the limitations of a particular theoretical projection about human learning or activity.

The first consequence examines how we might be able to deeply attend to and learn to shape the cognitive activities and social interactions constituted by participants in everyday settings during complex interventions. In addition to designing from essentialized images of disciplinary work or theoretical accounts of cognition and development, we might elect to make culturally grounded improvements in specific settings through our interventions once we come to better understand the people and places. Historically, educational anthropology research has produced rich descriptive accounts of everyday action in settings without foregrounding the designed nature of these contexts or activity structures (Bereiter, 2002; Pea, 1993). However, it is increasingly common to actively link ethnography to design. This methodological approach came into prominence with research conducted in workplace settings (Suchman, 1995) and has more recently become a methodological approach to aid in the development of commercial products (Salvador, Bell & Anderson, 1999). It is also the case that design ethnography has increasingly been pursued in educational settings (Barab, MaKinster, Moore, Cunningham & the ILF Design Team, in press; Polman, 2000; Stevens, 2000). Recognizing the systematic rigor and ecological validity associated with well-executed ethnographic work, this form of design-based research can be understood as attending to the alignment of designs with their ultimate embedded contexts-of-use as understood and mediated by those engaging in the activities.

In order to link ethnography to design necessarily implicates someone (or some group) serve in the role of a 'change agent' (Blomberg, Giacomi, Mosher & Swenton-Wall, 1993). With the multiple stakeholders involved in education, it is necessary to decide in whose interest does the designer/anthropologist operate? One approach for resolving trade-offs in interests and

alternatives is to employ methods of participatory design in order to understand and develop designs that knowingly navigate the tensions and harmonies held by the stakeholders involved with the dealings of a particular setting (Bødker, Grønbæk & Kyng, 1993). In this sense anthropologically driven design-based research seeks to understand the nature of the introduced changes and their consequences from the perspective of the participants, and often it provides them with a voice and as a source of influence on shaping changes to their settings.

Similar to the cultural psychology approach, the cultural anthropology perspective places significant emphasis on the localized nature of the practices and norms of the social groups investigated as they actually occur in their specific settings. Such a focus allows for detailed study of how new designs are appropriated, resisted, or even re-purposed by groups that are assumed to already have significant cultural momentum before any intervention begins. This form of work involves careful observation and documentation of the everyday practices of participants in the setting before, during, and after the introduction of new designs. Analysis often documents unanticipated consequences or emergent practices that derive from the cultural worlds of participants never anticipated by the educational designers.

The second consequence of this anthropological mode of work is that it allows for a coordinated account of the informal logic of actual life as it occurs across settings in ways that can provide insights about the nature of school and suggest improvements for the educational enterprise. In that theoretical and methodological primacy is given to the interpretation of human activity and its meaning to participants, comparisons across settings and subjects—between the social worlds of school and home or between school and work—become possible in order to investigate the manner in which the work gets materially and socially constituted and how it is understood by the participants in different venues that we might wish were similar or different in

principled ways. For example, Stevens' (2000) study of architectural design work of middle

school children actively juxtaposed with similar sorts of work in an architectural firm shows

parallels between human activity (e.g., how labor is divided along technologies) as well as sheds

light about the institutional norms associated with each setting (e.g., the unique disconnect

between student performance on the actual task and a subsequent formalized assessment in the

school setting).

As a third beneficial consequence of this mode of work, a research focus on the local

social worlds provides a means of understanding how an imposed theoretical view—as

communicated through the educational enactment—is interpreted by the participants, opening up

the possibility that new theoretical insights can be gleaned about where projected theory falls

short through systematic, emic examination of the participant's engagement in an intervention

(Cronbach, 1975; Pomerantz & Fehr, 1997). This could be seen as an instance of engaging in

theory development through design-based research that actively tries to bridge from an academic

theoretical account to a folk theoretical account (cf. Bruner quoted in Shore, 1999). As this kind

of analysis hinges upon a systematic interpretation of the social world of the participants, this

kind of analysis is not possible in a lab-based experimental paradigm.

The modes of design-based are quite diverse, theoretically and methodologically, given

their varying commitments and purposes. I believe this manifold set provides a better lens

through which to conduct a meta-conversation about the nature of design-based research in

education.

Next steps for design-based research in education

If we accept this identification of multiple modes of design-based research, our field

needs to become clearer in differentiating the various forms of the work and highlighting salient

differences so that work in each tradition can be appropriately understood, assessed, built upon, and coordinated. At a very pragmatic level, our nomenclature for the details of this work needs to be made clearer. Using the same "design experimentation" term to describe this pluralism of research efforts is confusing and fails to surface the internal logic of each mode of work.

Although I am arguing that there are different modes of design-based research relevant to education, this is not to say that further work on formalizing the associated methods is unnecessary. Design-based research methods in education are still quite young, even though much of the work does draw upon more historically established traditions. Different traditions focus on different phenomena and use different forms of knowledge to render the results of research efforts. Theoretical and design knowledge is likely to accumulate quite differently within the various design-based research families. We need to be appropriately sensitive to these differences as we attempt to formalize these methods of inquiry. After bringing such clarity into view, we then need to make progress on issues of research infrastructure and communication (Collins, 1999) with some sensitivity to each of the design-based research families and find mechanisms by which the results from such work might be synthesized appropriately. Attending to such details will allow us to understand the kinds of research being conducted in the field and to better accumulate knowledge without homogenizing the findings and knowledge resulting from these efforts that are naturally quite different from one another.

Conclusions

Validity is subjective rather than objective: the plausibility of the conclusion is what

counts. And plausibility, to twist a cliché, lies in the ear of the beholder.

— Cronbach, 1982, pp. 108

Over the past few years there has been a significant degree of what the sociologist of science, Thomas Gieryn (1995), would call "boundary work" focused on design experimentation. These are efforts to impose definitions of what should and should not be counted as being scientific—to draw boundaries around what is science (also see Bourdieu, 1975/1998 for a characterization of this sort of sociological process). Arguments have been mounted to establish specific forms of design-based research as being valid scientific enterprises (DBRC, 2003; Cobb, 2001; Cobb, Confrey, diSessa, Lehrer & Schauble, 2003; Collins et al., 2004) while there has also been significant critique of specific characteristics of the work that frames it as being non-scientific, only weakly scientific, or methodologically troubled (Shavelson, Phillips, Towne & Feuer, 2003; Kelly, 2004; Levin & O'Donnell, 1999).

I have been a party to many face-to-face discussions about the nature of design experimentation. I am struck by two characteristics of these conversations and arguments. First, there is an overwhelming tendency to assume that what we need to be doing to pursue a solitary methodological definition for design experimentation—that we should be devising some singular syntax and epistemological core—which will map onto the complexity of design-based educational endeavors or at least show the way. Although I fully agree that existing modes of design-based research deserve further deliberation and refinement, I am doubtful that there is a single methodological form to be identified that spans across them all. We should not expect methodological unity across timescales ranging from seconds and days to that of years and decades, or across phenomena involving the necessarily diverse units of analysis associated with a comprehensive understanding of learning and education—individuals, dyads, small groups, classes, families, institutions, and so on.

I am additionally persuaded by the methodological arguments surrounding the nature of science that there is no unity to be found in method (Feyerabend, 1978/1999; Hacking, 1996), and surely the situation is only more complex for the social sciences. Issues of methodological coherence and epistemological integrity associated with the nature of evidence, logic of inquiry, threats to validity, and warrant need to be pursued within the theoretical modes of design-based research. We should be wary of critiques that are abstract, theory-less considerations of method because: (a) they are unlikely to raise issues that span across the variety of modes of design-based research, and (b) such issues are insensitive to deeply held research commitments that come from specific lines of theoretical inquiry (e.g., studying the meaning of interventions from the perspective of the participants). Although methodological paradigms do not perfectly map onto properly framed theoretical accounts, the strong relationship between theory and method should guide our further elaboration of design-based research.

This brings me to the second feature of these 'boundary' conversations. I have often found them to be less about design experimentation proper than about the competing accounts of the nature of social theory and the methodological commitments held by the individuals. In one breath an individual will dismiss all research involving ethnography or narrative forms of knowledge; in the next, somebody else will proclaim that design experimentation cannot be conducted in a quantitative psychological mode. . Cronbach's quote at the start of this section reminds us that the construction and assessment of validity is an act of interpretation. As researchers piece together their theoretical accounts, some give primacy to issues of *generalizability* while others attend to issues of *particularizability* (cf. Erickson, 1986). This conceptual dyad—actually representing a continuum of methodological and theoretical possibility—represents a reoccurring trade-off made by researchers as they constitute an

empirical/analytical stance adequate for the theory work at hand. This issue can be interpreted as a conceptualization of how much of the contextual detail is necessary in a particular study. To consider a couple of extreme cases: does one need to spend a months or a year living among a specific group before one can start attempting to understand the details of their educational activities and to frame an intervention, or rather: does one need to immediately work to constitute a large, representative sample in order to steer clear of statistical threats associated with anticipated data analysis? Although some might view these abstract poles as a dichotomy—praying to different gods as it were—many design-based researchers realize that there is a great benefit to crafting theory from both nomothetic (law-seeking) and ideographic (individualistic) accounts (see Brown, 1992 for a more detailed discussion) and from etic and emic orientations. There is a great need for mixed methods work that crosses traditional 'boundary' lines in order to advance our understanding of learning across the various theoretical lenses. It is unfortunate that much of our 'boundary time' has been spent on a continuation of the wasteful paradigm wars that seem rooted largely in partisan critique and positioning, rather than focusing on how best to understand and orchestrate the complex educational phenomena under study

The reconciliation I have promoted in this paper is that the field consider looking for and promoting methodological coherence within the manifold families of theoretically framed design-based research that have been or might be pursued—and that these families be considered complementary enterprises. It is important to realize that individual scholars frequently work across theory/family boundaries over time. For this reason it is typically problematic to pigeonhole particular scholars into single theoretical perspectives (cf. Geertz, 1983). The range of theories do different sorts of intellectual work for us—at different timescales and units of

analysis—and the development of more comprehensive accounts of learning and competence will need to leverage upon multiple theoretical perspectives, and thereby different research traditions, in order to develop rich, composite accounts (see Rose, 2001 for a recent example of this sort). In this way learning is influenced by individual biological influences, developed cognitive strategies and acquired habits of mind, socially and materially-mediated practices of communities of practice, the sociological and political nature of the institutions in which it happens, activity structures that bleed across the contexts of school, home, and play, and so on. Design-based researchers often elect to work across the paradigms if it will benefit the educational outcomes and the theory at hand. Here I am arguing for a theoretical pluralism with regards to human learning in ways that have proven to be difficult to accomplish in the past although such a view still holds promise for the future (Bruner, 1991; 1996).

Across these design-based research families there are different scientific research programs driving the various enterprises—not everyone is seeking to identify relationships between dependent and independent variables, and not everyone is conducting ethnographic observation in order to study the local appropriation of a design. It is not surprising then that people might perceive a lack of coherence with design-based research, because there is no single form of *this* kind of research—nor should we expect, or attempt to create, just one design-based research method at any point in the foreseeable future. Different kinds of educational phenomena call for the use of different research and design methods and associated forms of knowledge in order to orchestrate and understand them. That is, the boundary around design-based research needs to be drawn more broadly than what is typical.

I believe we should be open to the possibility that design-based research is a fundamental mode of scholarly inquiry that is useful across fields of the academy. In some sense, this

establishment of design research was the driving motivation for Simon's (1981) case for an academic "sciences of the artificial." Sensible and important forms of design-based research might be constituted across the field of education and the broader academy with theory from cultural geography, organizational behavior, social work, public health, and so on. It is also likely that existing work within these perspectives might lend themselves easily to being interpreted as design-based research. This leads to the suggestion that we might consider design-based research—the theoretical and empirical study of complex human interventions as they can be used to promote and sustain innovation in everyday settings—a distinct mode of scholarly inquiry that should sits alongside the panoply of canonical forms ranging from the experimental, historical, philosophical, sociological, legal, and the interpretive.

To take this argument further, I want to focus on a central defining characteristic of design-based research, no matter the form: design-based research is focused on the development of sustained innovation in education. On this very issue Bereiter (2002) reminds us that the predominance of research models that exist in education do *not* contribute to educational innovation. Most researchers do not adopt a heavily interventionist, transformative stance in their endeavors, either out of personal choice or methodological constraint, and the other modes of research only weakly inform how to promote and sustain innovation in the world. As I have laid out in this paper, we do have a theoretically broad corpus of research enterprises that focus on promoting and sustaining innovation in everyday educational contexts and that methodological choices cohere with aspects of the theoretical commitments. At a time when many efforts that are reviewing the status of educational research seem to be operating under the working assumption that our theoretical and methodological complexity should be reduced, I would argue that rigor and utility can be actively pursued through pluralism—a coordination of different theoretical

views on learning and education. Given the inherent complexity associated with learning as it comes to occur in its variety of forms in sundry cultural settings—mediated in specific ways by biological, mental, social, and material means across a variety of timescales ranging from reaction times on up to those associated with societal change—we might be best served by exploring how far theoretical and methodological pluralism will carry us in better understanding, promoting, and sustaining innovation in education.

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