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DESIGN-BASED RESEARCH

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Abstract

This chapter briefly recounts the emergence and evolution of design-based research (DBR), a type of participatory research in which researchers and practitioners collaborate toward a common goal, namely creating new understanding of an educational intervention or issue through the progressive refinement or improvement of a design. It provides a synthesis of main characteristics of DBR and expected outcomes based on a review of the relevant literature. Computer-assisted language learning (CALL) studies framed within the DBR paradigm illustrate salient aspects of this type of research. The potential of DBR in CALL is discussed in light of its promising application in the context of materials and professional development. The chapter closes by examining challenges presented by the implementation of DBR, including issues pertaining to validity and reliability.

Keywords

Design-based research, design principles, collaborative inquiry, design experiments

Design-based research (DBR) is a type of participatory research in which researchers and practitioners collaborate toward a common goal, namely creating new understanding of an educational intervention or issue through the progressive refinement or improvement of a design. DBR emerged in the early 90s as an approach to research that blurred the distinction between basic and applied research and that focused on promoting and understanding innovation in learning through technology. This chapter provides an overview of the emergence and development of the DBR paradigm based on seminal contributions in the literature that have helped define and refine the goals and main characteristics of this type of inquiry. Connections between DBR and Computer-assisted language learning (CALL) are established through both this seminal work and DBR research in CALL. The chapter concludes by examining challenges presented by the implementation of DBR, including issues pertaining to validity and reliability.

<A> **Origins of DBR**

One of the first descriptive accounts of DBR appears in a 1990 technical report sponsored by the Office of Educational Research and Improvement written by Allan Collins. This report lays out a proposal to construct a “systematic science of how to design educational environments so that new technologies can be introduced successfully” (Collins 1990, 4). Together with Collins’ (1990, 1992), Anne Brown’s (1992) research on Fostering a Community of Learners (FCL) also stands out in the literature as seminal work in DBR. Her piece has had noticeable impact on much subsequent work in DBR since it constitutes one of the first operationalizations of the principles specified in Collins’ (1990) report in an empirical study. Twenty years after these seminal publications, Anderson and Shattuck (2012) reported an exponential increase in

DBR studies as well as a marked increase in international contributions. The researchers selected and analyzed a small group of 47 studies among the most cited DBR articles published between 2002 and 2011 and reported that a high proportion of the interventions described in their sample (68%) involved the use of digital technologies (p. 23).

Although McKenney and Reeves (2013) report that Anderson and Shattuck's (2012) meta-analysis of work in DBR includes only two articles about language education, a growing body of research in CALL within the last decade can clearly be seen as associated with the DBR paradigm. This increase in DBR studies in CALL can be attributed to a natural alignment between what researchers perceive as needs in CALL research and some of the features of DBR. For example, both DBR and CALL research are methodologically diverse and multidisciplinary by nature (Egbert and Petrie 2005) and intrinsically interventionist. Moreover, much CALL research, like DBR entails testing particular learning designs against how well they promote the ultimate goal of the interventions. A research paradigm such as DBR, which is sensitive to the messiness and complexity typical of technology-rich language learning contexts, provides the necessary guiding principles to enhance the connections between CALL research and practice. At the same time it also expands and further defines researchers' theoretical understanding of the many factors that come into play in the development of the language learners' communicative competence, which can typically be considered the ultimate goal of a CALL intervention (Chapelle, 1997, 1999).

The growing body of DBR research in instructional technology and CALL has helped further define and conceptualize DBR. Within the first decade of work in DBR, three special issues in major journals have helped define DBR and shape the conversation. The special issue

of *Educational Researcher* in 2003 started this thread followed by a special issue in the *Journal of the Learning Sciences* in 2004 and a subsequent special issue in the *Educational Psychologist* in 2004. Collectively, these special issues provide a body of knowledge about DBR that highlights its various strengths and identifies aspects in this type of inquiry that are in need of further consideration or refinement and has fueled discussions across disciplines in the use of technology for teaching and learning. In the field of CALL, a *CALICO Monograph* published in 2013 (Rodriguez and Pardo-Ballester 2013) constitutes one such field specific exploration.

** Defining DBR**

In the first 25 years of DBR, researchers made explicit efforts to further refine and specify the nature of DBR inquiry. As result of those efforts, the following main characteristics of DBR have been identified. Although it is difficult to find representative samples of research that can be held as models of incorporation of all these qualities, the studies presented in Table 1 collectively illustrate the features.

One main distinguishing feature of DBR is the duality of its goal, which entails both the design of learning environments and the development of theory that is relevant to design. Brown (1992) originally referred to this relationship as the “tension” between the goals of concurrently contributing to theory and practice. The dual goals of DBR can then be summarized as the product of two concurrent activities: the activity of designing something and the activity of generating new theoretical understanding. The latter arises from observation of what was designed during its enactment and the identification of emergent phenomena of interest. As

Table 1. A synopsis of empirical DBR studies in CALL (*in chronological then alphabetical order*)

Study	Research Context and Technology	What was designed and why	Theory, Methods and Data
Lund (2008)	EFL, high school <i>Wikis</i>	Wiki-based language learning activities to investigate emergent activity types in collective language production.	Interaction Analysis; corpus of videotaped interactions, learner responses to questionnaires.
Pardo-Ballester and Rodríguez (2009)	Intermediate Spanish, university level <i>Online glosses</i>	Elaborated readings and multimedia glosses to scaffold domain-specific materials (engineering & business).	SLA (elaborated input); learner perceptions questionnaires, video screen captures.
Wang, Song, Stone and Yan (2009)	EFL <i>Virtual Worlds (Second Life)</i>	To investigate learner perceptions and readiness to use SL for language learning and how the affordances of the environment might mediate EFL learning.	Social constructivism; evaluation research approach; mixed methods; pre- and post-program surveys, interviews, learner blog postings.
Pardo-Ballester and Rodríguez (2010)	Intermediate Spanish, university level <i>Reading and gloss interfaces</i>	Reading interface featuring multimedia glosses to scaffold comprehension of domain-specific materials (engineering & business).	Agile interface development, SLA (elaborated input); learner perceptions questionnaires.
Hung (2011)	EFL, university level <i>Video</i>	A pedagogical design with a focus on tailoring digital video technology to support reflective tasks for language learning in multimedia environments to enhance reflective tasks in multimedia environments.	Cognitive theory of multimedia learning and multimedia learning principles drawn from SLA theory; data triangulation using field notes, audio and video recordings, learner reflections in the TL, course evaluations and teacher/researcher field notes.
Wong, Boticki, Sun & Looi (2011)	Chinese, elementary school <i>Mobile game</i>	Mobile Computer-supported Collaborative Learning (mCSCL) application to learn Chinese characters in a collaborative game environment.	Mobile Computer-supported Collaborative Learning (mCSCL) design and SLA; Video and audio recordings while learners played game, software logs of learner interactions, and focus group interviews.
Zheng (2012)	Chinese <i>Virtual Worlds</i>	Virtual Quest that provides problem-solving spaces to apply knowledge gained in the classroom.	Ecological and dialogical perspectives to language education; multimodal analysis of video screen captures, video transcription, audio and text chat recordings.

Bush & Sorensen (2013)	ESL <i>Social networking tool</i>	Social media platform to explore student perceptions toward CALL materials.	Analysis of learner and instructor survey and instructor interviews.
Caws (2013)	French as second language, higher education <i>Web-based library of videos and transcripts (FrancoToile)</i>	A web-based library of videos and transcripts and tasks associated with the library aimed at developing learners' critical and electronic literacies and improving the web interface.	Educational ergonomics; pre- and post-task questionnaires, activity sheets, video screen captures, recordings of focus group interviews.
Johnson, Khoo & Campbell (2013)	Teacher education course on CALL <i>Moodle, Google Docs & Sites, Panopto</i>	Curricular redesign to improve the use of ICT within CALL teacher education.	Case study; constant comparison approach using evaluative (quantitative and qualitative) data, including student interviews, teacher interviews, instructor's reflective journal, notes from the regular teacher-researcher team project meetings, and group reflections; interpretations within and across findings in each iteration.
Martinez-Alvarez & Bannan (2013)	Bilingual education (English/Spanish) in elementary schools in U.S. and Peru <i>Web-based CALL system (GoInquire)</i>	An instructional sequence (Instruction in Science Reading: INSCIREAD) combined with a web-based system (GoInquire) to support emergent bilinguals and their teachers in the acquisition of domain knowledge (water erosion) and language.	Integrated Learning Design Framework (ILDF) model; Pre/post instruction elicitation, field notes, learner work on computers (text and drawings), final group discussion and interviews with learners, meetings notes with practitioners.
Pardo-Ballester and Rodríguez (2013)	Intermediate Spanish, university level <i>Virtual Worlds</i>	Instructional activities for synthetic environments to formulate design principles to guide language learning activity design in virtual worlds.	Sociocultural theory and SLA; screenshots and researcher notes, synchronous chat transcripts with NSs, learner perception questionnaire, pre/post oral proficiency test (Versant test), virtual world notecards, instructor notes, and video screen capture of in-world meetings.
Sumi & Takeuchi (2013)	EFL in Japan	Implementation and further refinement of an instructional model (Cyclic Model of Learning) to improve language teaching and learning.	Ecological perspective; interviews, quizzes, blogs, video recordings, questionnaires, classroom observation notes.

Table 1 illustrates, DBR studies in CALL always connect the activity of designing with the activity of theorizing.

The synergies between the activities of design and research afford opportunities to generate new understanding in various ways. In his analysis of the potential of DBR in educational research, Edelson (2002) explored this concept in depth and argued that decisions that need to be made to determine a design outcome fall into three categories: design procedure decisions, problem analysis decisions, and design solution decisions. The processes that involve these decisions create opportunities to develop three types of theory: domain theories (e.g., a theory that describes the general principles to design learning experiences for heritage language learners of less-commonly taught languages), design frameworks (e.g., a collection of design guidelines to achieve particular goals), and design methodologies (specifications to create types of designs). Also from the perspective of educational research, McKenney and Reeves (2014) further refine the idea of theoretical understanding by specifying types of knowledge generated by DBR, which they classify into declarative (for example, descriptions of products, concepts or theories); procedural (for example, specification of design or implementation protocols); or observable (empirical findings).

Iteration is also an essential feature of DBR since it is through recursiveness that knowledge is generated and refined (Barab and Squire 2004; Cobb 2001). The distinctive presence of iteration in DBR further gives the research process both a longitudinal and cyclical quality. DBR undertakings typically involve more than one instantiation of a (re)design and subsequent analysis and revision, often extending for prolonged periods of time and encompassing the analysis and report of the same variable under different conditions.

This type of embedded longitudinality in DBR is difficult to find in CALL research. Arguably, much of the research in CALL appears to follow Cobb's (2001) model for theory testing: (1) theory is developed; (2) principles or models for design are drawn from theory; (3) principles are incorporated in the design, and (4) the design is enacted and evaluated. In a CALL research context, this sequence can be illustrated as follows: (1) interactionist SLA theory emerges; (2) Doughty and Long (2003) draw principles from interactionist SLA theory for optimal less commonly taught language (LCTL) psycholinguistic environments for distance foreign language learning; (3) Freiermuth and Jarrell (2006) incorporate Doughty and Long's principles to the design of LCTL tasks; and (4) Freiermuth and Jarrell (2006) implement the design and evaluate it. In this model, as Edelson (2002) points out, the research and design processes are distinct, often performed by different people, and occur in sequential fashion. Further, the design processes are not expected to generate or refine theory but rather apply it. In contrast, DBR is deeply integrated with practice and such integration occurs through cyclical rather than sequential processes.

The methodological stance of DBR, which can be described as methodological pluralism or mixed methods, also constitutes one of its salient features. The application of mixed methods of enquiry can be associated with American pragmatism, which recognizes the need for multiple perspectives to solve educational problems and is reflected in the writings of philosophers such as John Dewey and Richard Rorty. The DBR approach to research is pragmatic in nature, so the pervasive use of mixed methods in DBR is not coincidental (Anderson and Shattuck 2012; Confrey 2006). Table 1 illustrates the range of methods and approaches used in DBR research in

CALL. They include case studies, focus groups, surveys, interviews, and corpus analyses, to name a few.

DBR is interventionist by nature (Cobb et al. 2003). Because DBR seeks to generate knowledge by looking into the processes and outcomes generated by the enactment of a design, research tends to occur in authentic, naturalistic learning settings, which are typically dynamic, messy, and extremely challenging to capture and replicate. The naturalistic quality of DBR results in at least two concrete methodological consequences: heightened awareness of contextual factors and responsiveness to the local dynamics of the context. DBR researchers strive to account for the interplay of multiple factors in the interventions they report as well as to provide rich descriptions of the context (DBR Collective 2004). With regard to the latter consequence, DBR is concerned with the local impact of interventions and is expected to inform local practice (see Barab and Squire, 2004, for further discussion of this topic).

DBR was originally conceived as a type of research that could effectively explore innovative learning designs. In order to do this, DBR was engineered to facilitate the identification of emergent properties in the designs it explores. This feature can then be associated with DBR's methodological plasticity and responsiveness to context. When emergent properties are identified, adjustments are made to procedures and measurements. This type of principled adjustment allows the researchers to fine tune aspects of the intervention that are likely to confirm a hypothesis or generate further insights. This quality of DBR is illustrated in Lund's (2008) study, which uses DBR to identify emergent language practices across cultures and contexts using technology tools for collective language production (Wikis). The practitioner and researcher realized that understanding how learners perceived a transition from a local and private activity

to a distributed and collective one was important to explain the learners' experience the process that is the focus of the research. An open-ended response instrument is created and used to gather additional data points which are incorporated into the ongoing analysis. Although principled adjustments in DBR provide flexibility to adjust processes, researchers have warned it should be applied with caution. O'Donnell (2004), for example, has pointed out that this flexibility can lead to "reactive adjustments to local events that are not central to the overall implementation" (258), which may result in a loss of focus.

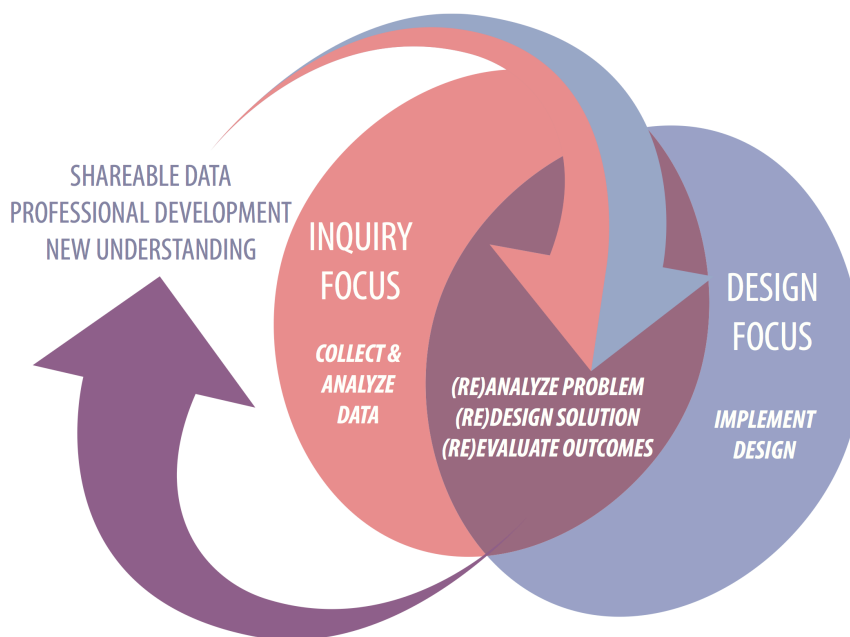
DBR inquiry is also characterized by collaboration. DBR projects often become a collaborative endeavor in which the researcher and implementer both seek to make meaning out of the experience and fulfill complementary roles. The researcher becomes a participant observer and the implementer provides insights that inform the processes of research and design. This type of participatory enquiry does not occur in paradigms where practitioners and, by extension, their knowledge, are not part of the design process and are simply expected to be consumers of the research upon its completion. The role of the researcher in DBR is also distinct since DBR scholars assume the role of both the researcher and designer and draw from methods in those two fields when they engage in DBR.

<A> The expected outputs of DBR

The expected outputs from DBR result from processes including the following four activities in relation to what is designed and researched: (1) analysis, (2) prototyping or development, (3) enactment or implementation, and (4) evaluation and (further) refinement (Plomp and Nieven 2010; Reeves and McKenney 2013). Figure 1 presents a schematic view of

DBR activities highlighting the two foci of the process: inquiry and design. The activities associated with each and both lead to the expected outputs, namely refinement of theory or generation of prototheories (new understanding), documented processes connected with outcomes of interest (shareable data), and professional development of the practitioners involved.

Figure 1. A schematic view of Design-Based Research



An important aspect of DBR is to produce research that yields those tangible outputs. According to Amiel and Reeves (2008), DBR radically changes the focus of research from that of research asking “what works?” to such questions as “how can we make a particular design work and why?” In order to be able to answer the latter, researchers must carefully document processes, connect them with outcomes of interest, and make them available to researchers. The idea of documenting processes in DBR extends beyond reporting on particular data and methods of analysis. DBR studies often include rich descriptions that also document the rationale for changes in the designs or adjustments in the conjectures that are being tested. Wang and

Hannafin (2005) described this feature of DBR as *contextual*, in reference to the deep connections that DBR studies elucidate between the design processes and the locus of research. Akin to this characteristic is the idea that DBR processes are expected to lead to the production of contextually relevant and usable knowledge. DBR studies often document contexts in ways that allow other designers to create parallel contextual conditions (Wang and Hannafin, 2005).

Another expected output of DBR is the creation or further refinement of theory. The concept of theory-building has been discussed extensively in the DBR literature and remains one of the areas that enjoys the most diversity of opinions. Researchers have interpreted this concept in two distinct ways, namely as the refinement of existing theory and the creation of new theoretical understanding. The latter notion has been described as the generation of “prototheory” (DBR Collective 2004), “design guidelines” (Amiel and Reeves 2008) or as “local theory” (Ormel et al., 2012).

Finally, professional development of the practitioners involved is also considered an important output of DBR. As DBR has evolved, the need for professional development to be part of the process has been acknowledged by many researchers. In contexts where practitioners work with researchers seeking solutions to complex problems, it becomes necessary to infuse professional development in order to ensure the designs are implemented and understood as they were meant to be. For example, in a large-scale DBR study in sheltered language instruction, teachers involved in the research of an innovative model (Sheltered Instruction Observation Protocol) spent one or two years learning about the model and participating in 3-day professional development summer institutes every year of the research program (see Echevarria, Powers, and Short 2006).

<A> The potential of DBR in CALL

DBR promises enormous potential to advance research in CALL, especially with regard to cyclical design processes that could potentially inform theory and practice. A growing number of CALL studies to date have been framed as DBR endeavors. Table 1 presents the empirical work in CALL marking the nascent efforts to use DBR research in this field. These studies were identified through searches in main language and instructional technology publications, such as *CALICO Journal and Monograph Series*, *Computers in Human Behavior Journal*, *Language Learning & Technology*, *Language Sciences Journal*, *ReCALL Journal*, etc. Only studies that are explicitly identified as DBR studies by their authors were included. Collectively, these studies illustrate the breadth in research contexts, technologies, and the types of designs involved. Although all of them are framed around improving a design through an iterative processes of refinement with the purpose of solving a problem and further advancing theoretical understanding, they are markedly different in terms of the theoretical and methodological approaches they embrace. In a way, they represent the multiplicity of ways of knowing about language teaching and learning without necessarily limiting theoretical options to those that are prevalent in second language acquisition (SLA). In fact, many of these studies tend to bring in multidisciplinary perspectives that enrich the profession's understanding of CALL by borrowing relevant knowledge from a range of fields such as Computer Science, Educational Technology, Educational Psychology, Instructional Design, etc.

Two CALL research areas that are particularly well positioned to take advantage of DBR are materials development and professional development. DBR provides a valuable conceptual foundation to develop not just research-informed but also evidence-based instructional materials,

tools or practices. The necessity to anchor designs to relevant, existing theory (O'Donnel 2004) (research informed development) and to provide evidence of the impact of such designs in naturalistic contexts (DBR Collective 2004), DBR creates unique opportunities to test, refine or generate new theoretical understanding grounded on actual practice. In other words, DBR makes it possible to generate situated theoretical knowledge of learning and teaching through the principled development of materials and language learning experiences. Utilizing DBR in this area could help generate design principles for materials development that are anchored to research on practice rather than “creative intuition” (Tomlinson 2013), so that rather than developing materials by anticipating what learners might do and what might be desirable learning outcomes, materials can be designed and revised based on what learners actually did and how well learning outcomes were met. Furthermore, DBR could be used to create, refine and formalize frameworks for materials development that are informed by such design principles.

DBR also holds promise for contributing to the field through the perspective of making CALL materials development the locus rather than the object of research. Typically, when materials are addressed in language learning research, they are often perceived as something to evaluate. Tomlinson and Masuhara (2010) affirm that the “aspect of materials development which has received the most attention in the literature is evaluation” (7). Although this is a useful perspective, the impact of materials is better understood when the processes that created them are also taken into account when they are studied. A DBR approach in CALL can help reveal how the design decisions underlying instructional materials, tools or processes impact learning experiences. By focusing on the design decisions involved and their impact on language learning

researchers may also be able to elucidate new theoretical understanding in relation to language learning, thus creating a much stronger tie between materials development, research and theory.

One way to bridge research with materials development in CALL has been the formulation of CALL design principles based on inferences drawn from theory and empirical research. For example, Plass (1998) put forward a hybrid model for the design and evaluation of multimedia software interfaces derived from cognitive and educational psychology. Following a similar approach, Hoven (1999) proposed a model for listening and viewing comprehension for self-access CALL environments drawing from research in listening and viewing framed within sociocultural theories of language learning. Doughty and Long's (2003) methodological principles for distance foreign language task design provide a further example of deriving CALL design principles from theory. Drawing extensively from empirical research, they propose "universally desirable instructional design features" (51) informed by cognitive and interactionist SLA theory.

DBR embraces the concept of designing from existing theory but offers an alternative approach to the one described above to establish a link between research and practice. This alternative approach can be described as having more depth and less breadth than the studies mentioned above and differs from more traditional ones in four main ways. First, although DBR designs and interventions are also expected to be grounded in the existing relevant research, the resulting theoretical understandings are drawn from evidence of how well actual designs that are operationalized in authentic instructional environments perform. In other words, claims drawn from the existing research need to be substantiated with appropriate evidence, and evidence becomes the foundation of the new understanding.

Second, DBR researchers participate in the whole process, that is, they create a design by drawing from theory, implement it, measure its outcomes, and synthesize principles derived from the evidence. According to Hoadley (2004), a higher degree of methodological alignment can be achieved by having the same people engage in the entire process, which may provide DBR a strength lacking in other research paradigms. Hoadley (2004) asserts that “forcing individuals to carry ideas all the way from explanation to prediction to falsification to application seems like the missing link in educational research that will ensure our theories have practical implications” (205). Several DBR studies illustrate this process applied to the development of tasks (e.g., Caws 2013), instructional tools (e.g., Pardo-Ballester and Rodríguez 2010; Wong et al. 2011), instructional methods (e.g., Hung 2013; Sumi and Takeushi 2013), and curriculum redesign (e.g., Johnson, Khoo, and Campbell 2013).

Third, designs for learning are expected to be put through iterative cycles of evaluation and refinement, which presents opportunities to revisit theoretical claims or conjectures based on evidence gathered during implementation. As a consequence, it is common for DBR studies to report on multiple iterations. Although not all DBR studies necessarily report multiple iterations, many of them do (e.g., see Bush and Sorensen 2013; Caws 2013; Pardo-Ballester and Rodriguez 2010; Wong et al. 2011).

Finally, although one of the dual goals of DBR is to generate or refine theory, there is no claim of universality in the principles or models that emerge. In other words, knowledge generated through DBR is not intended to prescribe but rather guide practice, and theoretical knowledge is not understood as a universal truth but rather a conceptual understanding that can be constantly revised as new knowledge is generated.

As mentioned earlier, in addition to the area of CALL materials development, research on CALL professional development is also well positioned to take advantage of DBR. The way the field has typically construed professional development as *teacher training* betrays the assumptions implied in the role of the teacher as a passive agent to be instructed in the *finite right ways* of using technologies to support instruction. DBR departs from this notion and involves instructors in two meaningful ways: in an externally referenced and in a self-generating fashion. The former arises from the need to provide the instructor with the relevant background so that the instructional processes are aligned with theoretical assumptions. For example, a DBR study that focuses on project-based learning would provide the instructor professional development that would include referential information on PBL. Several DBR studies point to this need (e.g., Bush and Sorensen, 2013; Echevarria et al. 2006; Reeves and McKenney 2013). The latter arises out of the DBR expectation that the instructors will be involved in the creation and evaluation of what is designed. This process itself creates professional development opportunities through the discussions and decisions that instructors and researchers are bound to have. This type of self-generating professional development can become an enriching experience for both instructors and researchers add a necessary reflective quality not just to teaching but to research.

<A> Some challenges of DBR

DBR researchers strive to make their findings meaningful and useful and in doing so, are confronted with a number of challenges. Some of the challenges that have surfaced in the early DBR literature include (a) the difficulties in comparing across designs (Collins et al. 2004); (b)

the consequent call for standards (e.g., Bell 2004; Collins et al. 2004; Dede 2004; O'Donnell 2004); (c) the call for specification in the reporting of DBR, especially in terms of the strategies used to generate new theoretical understandings through design (Ormel et al. 2012); and (d) the lack of guidelines to identify minimum criteria to begin an intervention (O'Donnell 2004) or at which point an intervention should be abandoned or considered to merit further exploration (Dede 2004). Despite the eclecticism of the challenges presented in the literature, many of them fall into four main areas of concern: data availability, validity, rigor, and reliability.

As mentioned earlier, Brown's (1992) vision was to create repositories of DBR data that researchers can share and reuse. Collins et al. (2004) called for the creation of common DBR data repositories to enable sharing and collaborative analyses. Although large scale data repositories are now common in other disciplines, such as in the natural sciences, and the technology necessary to enable such data banks is available, DBR research has not lived up to its promise to provide this type of resource. Anderson and Shattuck (2012) reported they found no evidence of this type of undertaking in their analysis of a decade of research in DBR.

Validity is always a concern in any kind of research enterprise. Four main types of validity are frequently mentioned in the DBR literature: a) ecological validity, b) treatment validity, c) systemic validity, and d) consequential validity. Because DBR research is bound to occur in naturalistic settings, researchers often claim that DBR studies have strong ecological validity (Barab and Squire 2004; Bell 2004). Treatment validity refers to the extent to which interventions align with the theories they embody and has been proposed as a way to assess and describe the validity DBR studies (Hoadley 2004). Systemic validity has been defined as the

extent to which DBR research informs theory and practice (Hoadley 2004). That is, it refers to the extent to which DBR research produces what Lagemann (2002) described as *usable knowledge* or the Design-Based Research Collective described as *outcomes of interest*. Finally, consequential validity refers to the extent to which the intervention results in a benefit to those involved in the experience. Barab and Squire (2004) affirm that DBR “offers a model of inquiry that embraces this notion of consequential validity, but design-based researchers need to be clear about the kinds of claims they make from design experiments and the limitations of their findings” (8).

Related to the notion of validity in research is the idea of rigor. DBR researchers have explored ways to augment rigor in DBR. One of the concepts that has been proposed is the notion of defining “embodied conjectures” (Sandoval 2004). This concept is related to the idea that learning or teaching designs are influenced by preconceptions of how people learn that emerge from existing theoretical knowledge. Sandoval (2004) argues that it is possible to increase the rigor of DBR by purposefully mapping conjectures to the design and then design studies that test them. In her critique of Sandoval’s (2004) study, O’Donnell (2004) agrees and adds that it is of key importance that the original conjecture be grounded on an understanding of the relevant research literature.

DBR researchers are also concerned with issues related to reliability, which is defined here as the extent to which the implementation of a particular design solution repeatedly yields anticipated outcomes. One strategy proposed is the use of *micro phases* or prototyping phases in design-based research to ensure reliability of the design before the final field work study. As DBR aims to establish how and why a particular intervention works in a certain context, micro

research phases provide researchers with an opportunity to refine the design and to gain a more informed understanding of why an invention may (or may not) work in that context (Plomp and Nieveen 2010). Micro phases involve a series of small-scale design studies that result in the subsequent reevaluation of the materials before the final product is used in a school-based study. The use of micro phases is part of what Plomp and Nieveen (2010) refers to as the prototyping stage: “each cycle in the study is a piece of research in itself (i.e. having its research or evaluation question to be addressed with a proper research design)” (25). Each phase should be presented as a separate study as there may be different research questions, population groups, data samples and methods of data analysis. This approach was used by Mafumiko (2006), who undertook a micro-scale investigation to improve the chemistry curriculum in Tanzania, and Squire (2005), who conducted three cases in the use of the computer game *Civilization III* with different student groups in different settings in order to refine his design.

<A> Conclusion

The growing body of DBR research in CALL presented in this chapter demonstrates how the qualities of DBR can enrich CALL research and provide a principled approach to integrate research and practice. DBR also has yet unrealized potential in connection with the integration of technology into complex language learning experiences, that is, prolonged and sustained learning sequences such as those arising out of project-based, service learning or study abroad learning experiences. At a macro level of technology integration, DBR offers a framework to analyze and improve technology use at the program level. For example, in the field of foreign language education, there are numerous yet untapped opportunities to look into technology integration

within language programs with specific, unexplored needs, such as full and dual-immersion language programs. Similarly, curricular implementation of pedagogical approaches such as project-based learning, whose success relies on the successful of technology, provide rich opportunities for DBR endeavors. At a micro level of technology integration, the design of innovative learning experiences also presents opportunities for DBR. Learning experiences designed for contexts that incorporate emerging technologies or innovative pedagogical processes that are not yet well understood are often built upon theoretical knowledge that needs to be refined or expanded upon. These are fertile grounds for DBR. More specifically, mobile language learning (Hoven and Palalas 2011) and digital game-based language learning (Sykes and Reinhardt 2013) are areas that have emerged in the last decade that might benefit from further development of theoretical understanding. These are just a few examples of the potential for DBR in CALL today, where its potential still remains largely untapped.

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Resources

ThinkerTools Research Group

<http://thinkertools.org/Pages/research.html>

A PEER Tutorial for Design-based research

<http://dbr.coe.uga.edu/explain05.htm>

Interviews with Design-based Research Experts

<http://dbr.coe.uga.edu/expertinterview.htm>

Biographical note

JULIO C. RODRIGUEZ, (Ph.D., Iowa State University) directs the Center for Language & Technology and the National Foreign Language Resource Center and co-directs the Language Flagship Technology Innovation Center at the University of Hawai‘i at Mānoa. Within the broad area of instructional technology, he is primarily focused on faculty development, project-based learning, materials development, online course design, and design-based research. Rodriguez leads several design-based research projects and has published and presented extensively in this area.

Please double-check the revised info for Anderson and Shattuck (2012) is correct. In addition, please check if the year of publication. – 41, no. 1 is correct – 2012 is the correct publication year.

Please format Figure 1 as an image according to the guidelines attached in the email. This includes ensuring the image is 300 dpi, is saved as a separate file and is accompanied by a document listing the figure(s) is also included. - done

Plass (1998), Hoven (1999), and Hoadley (2004), Hung (2013), which you mentioned on p.13 and p.14, respectively, are missing in the references list. – added in references

For the references highlighted in blue, please reformat them by spelling out the names of the authors and editors as the following example shows: Cummings, Michael. 2010. "Chapter Title: Subtitle." In Book Title: Subtitle, edited by Danielle Smith, Abi Jones, and Nigel Porter, 00–00. Place of Publication: Publisher. – added names.

In the references list, for, Squire, Kurt D. 2009., volume and issue number information is needed. – fixed it

The biographical note needs to be reduced slightly to no more than 75 words. It is currently 91. – done

I have not seen Table 1.