International Journal for Educational Media and Technology
2016, Vol.10, No. 1, pp. 45-52

Is Design-based Research desirable and feasible methodology for educational media and technology?

Katsuaki Suzuki
Kumamoto University, Japan
ksuzuki@kumamoto-u.ac.jp

Junko Nemoto
Ehime University, Japan
nemoto.junko.nu@ehime-u.ac.jp

Design-based research (DBR) has been accepted as preferable research methodology from its birth in early 2000's. DBR has such advantages as avoiding novelty effect, ensuring practical effectiveness to be created in a long-term educational practices, and contributing to the advancement of theory base (as design principles), when compared to short-term experimental designs that produce only statistical significance. On the other hand, DBR creates challenges to be adopted as the research methodology, especially toward an advanced degree, due to its long duration, a need for a research team with committed practitioners, among others. This paper explored, by reviewing trends of current literature, the way in which DBR can be adopted in more cases as preferred methodology in educational media and technology studies. As the result, a set of guidelines for directing graduate studies are proposed.

Keywords: Design-based Research, Research Methodology, Desirability, Feasibility, Educational Media and Technology

Introduction

Design-based research (DBR) has been accepted as preferable research methodology from its birth in early 1990's. Special issues in major journals, including *Educational Researcher* , *Journal of the Learning Sciences* , *Educational Psychologist*, and *Educational Technology*, were issued in 2003-2005. *Handbook of Design Research Methods in Education* was published in 2008 (Kelly, Lesh, & Baek, 2008), introducing the latest thinking and current examples of DBR in education, which brought "innovations into real-world practices (as opposed to constrained laboratory contexts) and examining the impact of those designs on the learning process. Designed prototype applications (e.g., instructional methods, technology or materials) and the research findings are then cycled back into the next iteration of the design innovation in order to build evidence of the particular theories being researched, and positively impact practice and the diffusion of the innovation (Kelly, Lesh, & Baek, 2008, p. i).

Some recent works using DBR include Feng, Lu and Yao (2015), where two cycles of DBR were conducted that resulted in a new professional-task based master-level curriculum for distance education in China, as well as a revised curriculum development model, which is capable of dealing multiple roles in the industry with some degrees of prior knowledge and experiences of the target learners. Lay, et al. (2014) designed four solutions to scale up informal learning and tested them out in two different workplaces (healthcare and building-construction sectors), refining the solutions as well as creating an integrative model of scaling informal learning. In November 2013, Netherlands Institute for Curriculum Development has compiled an extensive digital book on "educational design research," freely available on their Website (http://international.slo.nl/publications/edr/). After an introductory section, the book has a total of 51 DBR studies, ranging from (pre-)preliminary education, secondary education, teacher education, and higher education and workplace learning.

Anderson and Shattuck (2012) reported that increasing numbers of studies have been conducted during the last decade, as shown in Figure 1. According to them, over 2000 papers had been published in 10 years, with increasing numbers in recent years, shifting more about educational practices from theories. Majority of papers (75%) were published in US, but papers from other countries were increasing, with multiple iterations of practice and revisions reported in many papers (65%). In a systematic literature

review on design-based research from 2004 to 2013, Zheng (2013) reviewed 162 selected studies in the database of 219 social sciences citation index (SSCI). She found more than half of the reviewed studies were about technological intervention (86%), lasted one year or less (69%), reported some revision of intervention (74%), but reported only one iteration (50%). The last point, the number of iteration, was concluded differently in the two reviews, perhaps due to different selection procedure of target papers.

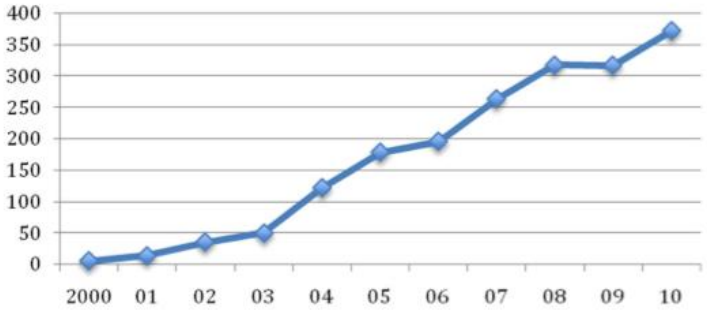

Figure 1. Number of articles using or discussing design-based research (From: Figure 2 of Anderson & Shattuck, 2012)

DBR has such advantages as avoiding novelty effect, ensuring practical effectiveness to be created in a long-term educational practices, and contributing to the advancement of theory base (as design principles), when compared with short-term experimental studies that produce statistical significance, but with little impact in educational practice. On the other hand, DBR creates challenges to be adopted as the research methodology, especially toward an advanced degree, due to its long duration, a need for a research team with committed practitioners, among others.

This paper explored the way in which DBR can be adopted in more cases as preferred methodology in educational media and technology studies. Therefore, our research question was to examine the trends and opinions on DBR in the literature so that a set of guidelines would be proposed to make DBR a feasible alternative in directing graduate studies. We first examined the trends of DBR by searching in ERIC (http://eric.ed.gov), CiNii (http://ci.nii.ac.jp/), and Google scholar (https://scholar.google.co.jp/), using "Design Based Research" as the keyword. We then explored related articles from the references of the identified studies. To summarize the results of our exploration, DBR and related other methods are compared, which will be followed by tips that were found from the literature in conducting DBR. Finally, our ideas of directing graduate studies will be proposed as a set of guidelines.

.

What is Design-Based Research?

Table 1 summarizes a comparison between traditional experimental design with DBR, as known as "design experiment," made by Allen Collins in 1992, one of the pioneers in the movement of DBR. Whereas a traditional experiment is conducted in a laboratory situation, with a control group, to test pre-determined hypotheses, DBR is taking place in a naturalistic environment where multiple factors interact each other. A simultaneous comparison group is not used in DBR; the comparison usually made with practices in previous years, to check if any improvement has been accomplished by changing the way the classroom was taught before.

Table 1.
Collins' Comparison between traditional experimental design with design-based research

	Traditional experimental design	Design-based research (*aka*. Design experiment)
Place	Laboratory	Complex situation (e.g., classrooms)
Factor	Change one factor	Deal with multiple factors
Experimental situation	Researcher control with purpose	A specific situation with no control

Procedure	Fixed	Flexible with alterations
Relation to society	Disconnected	Interactive
Research style	Validate hypotheses	Develop framework
Stance	As an experimenter	As a co-participant in design and analysis

Note: Based on Masukawa, 2011, translated by the first author

Table 2 summarizes characteristics of DBR to be pragmatic, grounded, interactive/iterative, integrative, and contextual. It is important to notice that DBR is pragmatic in the sense of refining both theory and practice. DBR not only addresses complex problems in real contexts in collaboration with practitioners, but it also integrates known and hypothetical design-principles with technological affordances to render plausible solutions to these complex problems, and conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design-principles. That is to say, DBR tries to produce not only better practices using theory, but also to improve theory through practice.

Table 2.
Characteristics of design-based research

Characteristics	Explanations
Pragmatic	* Design-based research refines both theory and practice. * The value of theory is appraised by the extent to which principles inform and improve practice.
Grounded	* Design is theory-driven and grounded in relevant research, theory and practice. * Design is conducted in real-world settings and the design process is embedded in, and studied through, design-based research.
Interactive, iterative	* Designers are involved in the design processes and work together with and flexible participants. * Processes are iterative cycle of analysis, design, implementation, and redesign. * Initial plan is usually insufficiently detailed so that designers can make deliberate changes when necessary.
Integrative	* Mixed research methods are used to maximize the credibility of ongoing research. * Methods vary during different phases as new needs and issues emerge and the focus of the research evolves. * Rigor is purposefully maintained and discipline applied appropriate to the development phase.
Contextual	* The research process, research findings, and changes from the initial plan are documented. * Research results are connected with the design process and the setting. * The content and depth of generated design principles varies. * Guidance for applying generated principles is needed

Note: From Wang & Hannafin (2005), Table 2, p. 8

Figure 2 depicts the process of DBR, as compared with predictive (traditional experimental) research. While traditional predictive research produces refined theory, as a result of hypothesis-driven experiments with limited impact on educational practices, DBR starts with challenges in educational practices. Solutions are then sought in collaboration with practitioners using existing theory and hypothesized design-principles. Multiple iterations of cycles of testing are required, as it has no control group to compare, before a refined set of design-principles can be proposed as a part of expanded/refined theory. However, as described in Introduction, mixed findings were observed in two reviews as to how many iterations have been actually reported in previous studies.

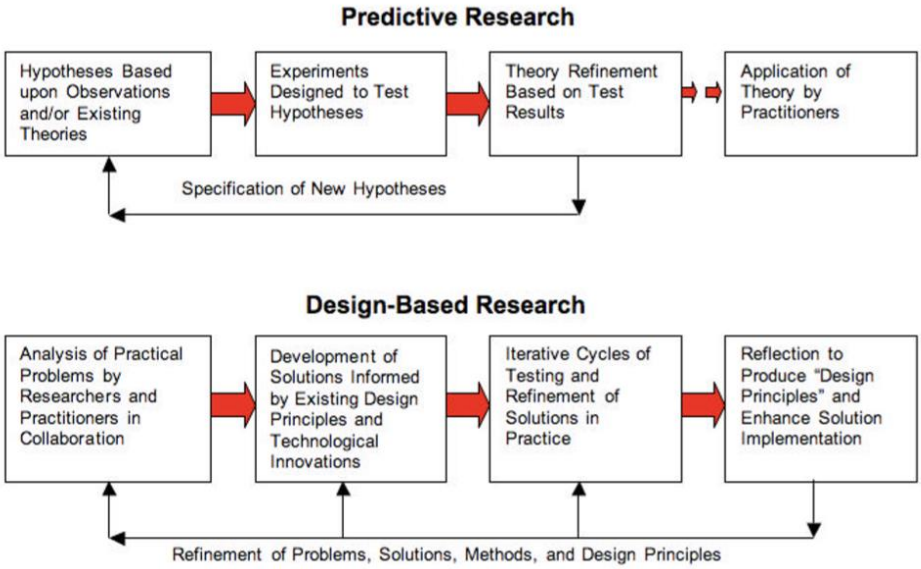

Figure 2: Predictive and Design-based Approaches in Educational Technology Research (Reeves, 2006)

What is *Not* Design-Based Research?

DBR is different from traditional experimental approach as we discussed in previous section. Table 3 summarizes how DBR can be compared with other similar research approaches that have been adopted in the field of educational media and technology, namely Grounded Theory Approach (GTA), Action Research, and Formative Evaluation. GTA has been widely employed as a substitute for traditional experimental approach to produce qualitative explanations of educational practices, but it is not design-oriented. It focuses on understanding what is happening; not on how to improve the current practice. Action research, on the other hand, focuses on how to improve own practice, thus considered to be design-oriented, but not putting much emphasis on theory building. Formative evaluation is also design-oriented, but not interested in theory building, whereas DBR aims for both improving practice and refining theory. Although there are some differences in emphasis or aims in each approach, they can represent variety of alternatives to the traditional experimental studies.

Figure 3 compares DBR with other research approaches by placing it in a spectrum of reform/individuality description vs. causal/rule establishment, using the researcher's stance as first, second and third person. DBR is place in the middle, representing the second person stance, because DBR is usually carried out in conjunction with practitioners (thus, you and I relationship), whereas traditional experiment requires objectivity of the researchers (thus, third party view). Action research is conducted to improve own practice (thus, always subjective using the first person view). The spectrum also consider whether or not any development occur in the research (vertical comparison). DBR is always involves creating a new methodology in educational practice, whereas interview is a second person methodology with no intervention (i.e., just collecting second person data).

Table 3.

Comparison of Research Approaches

Approaches	Design-based Research	Grounded Theory Approach (GTA)	Action Research	Formative Evaluation
Purpose	Improvement of Practice and Construction of Theory ＜design-oriented＞	Explanation of Phenomena and Construction of Theory(Not General, but Domain specific= Grounded Theory) ＜descriptive＞	Improvement of Specific Situation ＜design-oriented＞	Improvement of Practice(Class Instruction or Instructional Material) ＜design-oriented＞

Target Domain	Educational Practice	Humanities and Social Science in general	Humanities and Social Science in general	Educational Practice
Research Process	Theory-driven Practice→ Assessment of effect → Revision of Practice →Assessment of effect →Proposal of Design Principles →Improvement of Theory	Collection and Analysis of Interview data (Coding)→Concept Extraction →Theoretical Sampling and Saturation	Status-quo Analysis→ Revision suggested based on theory →Implementation →Assessment (→Consideration of Generalization and Limits）	Development based on theory or model →One-on -one evaluation →Small group evaluation →Tryout
Character-istics	・Making both practice improvement and paper submission possible ・More and more recognized	・Process already established ・Many reference books available ・Hypothesis finding	・Many studies conducted in nursing field, with ample directions/ suggestions, easy to imitate ・Not apt to generalization	・Pass/fail on posttest ・Necessary step before implementation, but ignored or skipped in many occasions

Note: From Suzuki & Nemoto (2013), Table 1, translated by the first author

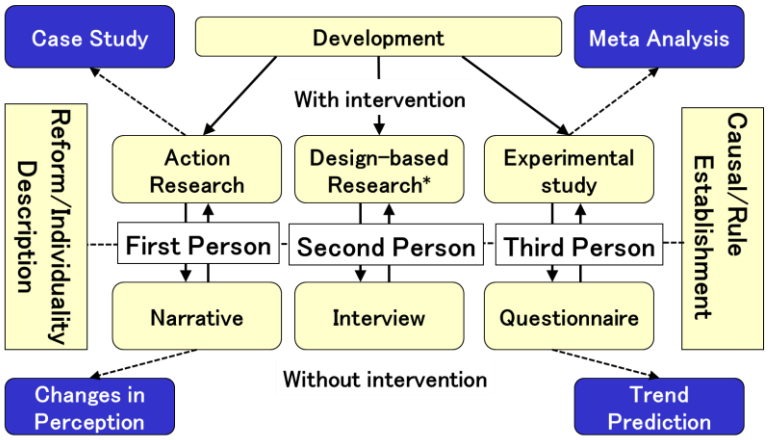

Figure 3: Representative Research Methodologies placed in Methodology Spectrum
(From: Kogo, 2013, Figure 11-1, p. 210, translated by the first author)
Note: *Original word is “Design Experiment”

How Should Design-Based Research Be Conducted?

Ma & Harmon (2009), when reporting a DBR case study, proposes a set of suggestions as to how to conduct a DBR study. They added sub-steps in each of 4 DBR steps proposed by Reeves (2000) shown in Figure 2 (bottom) to make points of emphasis. In Step 1, they consider topic selection is important to avoid using DBR to a problem limited to a local situation, as DBR takes much effort in aiming at theory building. In Step 2 of developing solutions, they recommend selecting focused research questions that fit a particular iteration to avoid overdoing beyond getting answers to the questions. They also suggest to identify a complex problem with no clear solution available, that calls for collaboration with practitioners. For Step 3 of evaluation, they caution that deciding evaluation methods itself require some time for try and error. For Step 4, they recommend to reflect and document the methodology used in research, in addition to proposing design-principles, as methodology for DBR is still not mature.

Easterday, Lewis, & Gerber (2014) identified that one of the problems arising from the ill-definition of DBR was the uncertainty of DBR process, and proposed a design process model, consisting of 6 iterative phases: focus, understand, define, conceive, build and test. They suggest that the design phases are not carried out in a linear sequence but rather iteratively, and rapid iteration is a tenet of modern human-centered design. To protect against the risks of designing interventions that are over-budget and behind schedule by quickly testing the designer's assumptions, they recommend for quickly building low fidelity prototypes, testing them, and re-designing so that gradually evolving the intervention over time, rather than design an entire intervention and discover only at the end that it does not work.

Herrington, et al. (2007) suggested guidelines for preparing a dissertation proposal for doctoral students. Using the four phases of DBR by Reeves (2006) illustrated in Figure 2 (bottom), they mapped each phase against the typical requirements of a research proposal as shown in Table 4. They recommend that educational researchers who supervise doctoral work are engaged in design-based research themselves, so that their students begin to play active roles in that research agenda from the first day. If the supervisor already be involved in long-term, meaningful coactive engagement with practitioners, their students will be able to enter as apprentices to this ongoing collaboration, just as so-called "natural" or "pure" science (such as physics and chemistry) students are not expected to start their research projects on their own.

Table 4.
Phases of design-based research mapped against typical elements of a research proposal

Phase of DBR (Reeves, 2006)	Element: The topics/elements that need to be described
PHASE 1: Analysis of practical problems by researchers and practitioners in collaboration	Statement of problem
	Consultation with researchers and practitioners
	Research questions
	Literature review
PHASE 2: Development of solutions informed by existing design principles and technological innovations	Theoretical framework
	Development of draft principles to guide the design of the intervention
	Description of proposed intervention
PHASE 3: Iterative cycles of testing and refinement of solutions in practice	Implementation of intervention (First iteration)
	Participants
	Data collection
	Data analysis
	Implementation of intervention
	(Second and further iterations)
	Participants, Data collection, Data analysis
PHASE 4: Reflection to produce "design principles" and enhance solution implementation	Design principles
	Designed artefact(s)
	Professional development Methodology

Note: From Table 1 of Herrington, et al. (2007), omitting "Position" column

Conclusions and Suggestions

This paper tried to collect useful guidelines of DBR so that DBR can be adopted in more cases as preferred methodology in educational media and technology studies conducted by graduate students. DBR is a strong methodology to have impacts not only educational practices, but also theory itself. During a DBR study, a long involvement of researchers is required to gradually formulating educational practice to reflect theory into practice, as well as practice informs the theory. Although DBR has become a widely accepted research methodology, and although Reeves (2006) has standardized procedures of DBR, it requires longer duration and deeper collaboration with practitioners, which may be a barrier especially for graduate students. As Easterday, Lewis, & Gerber (2014) have pointed out, it may become necessary to pinpoint relevant aspects within an educational practice, to lower the risk of research in iterative activities required in DBR. Also needed in conducting a DBR study is high-level skills as a practitioner, which may be expected for a graduate student with rich experiences as a teacher. However, those who has limited teaching experiences, just being a part of the

DBR team may place him/her a burden of catching up with everyday challenges of the practice, without leaving enough mental capacity for research aspects of the DBR.

On the other hand, many reported studies deals with one iteration only, but with suggested revisions of intervention, as shown by Zheng (2013). The fact that such DBR studies with only one iteration have been accepted as referred journal paper can be a good news for our students. As we experience ourselves in conducting DBR studies (Nemoto, Shibata, & Suzuki, 2011), we realize that DBR requires much time to examine the effects of revisions from previous iterations. It requires more time and effort to propose design guidelines in a reliable and generalizable manner. We may need to speed up the study by adopting a notion of rapid prototyping to shorten the required duration for DBR studies, as suggested by Easterday, Lewis, & Gerber (2014).

Our suggestions that were drawn from this review may be summarized as the following guidelines.

Guideline #1: *To advise a master's student engage in a formative evaluation study by incorporating a model or theory to try to invent a solution to their own challenges in their setting.*

It has been our recommendation in our graduate program to try to "make somebody happy" by conducting a formative evaluation study (see Table 3) in their own setting. It is to make the research practical and useful to the educational practices of their field, rather than learning a "proper way" of conducting a research. It can be regarded an action research, because they are engaging in from the first person viewpoint (see Figure 3). By incorporating an existing model or theory to solve their own problems, it may also be considered as the first step in DBR. It may be regarded, when they move up to doctoral level, to be the first iteration of DBR.

Guideline #2: *To provide our graduate students opportunities to participate in an on-going DBR of their supervisors, NOT as a part of their thesis, but as a part of their coursework.*

It may be contrary to the advice that Herrington et al (2007) has suggested to let them engage in an on-going DBR of their supervisors as a part of their theses. Yet, we do not want take away an opportunity to think deeply what study our students should be engaged in as their own research, by giving them a topic from the on-going research. We may use our own DBR and ask our students to play an active and increasingly important role, even if it were a part of their coursework. We think it is a good idea to have a course in which our students are to be exposed to DBR to understand what DBR is all about. Then, they become more capable in conducting their own study, on their own practices.

Guideline #3: *When our master's student goes up to doctoral program, advise them to sum up their study for master's degree, as the first iteration of DBR study to be submitted to a journal.*

This study identified the fact that many DBR studies have been published with only the first iteration. Therefore, we can advise our students not to wait until completing multiple iterations in their study, but just go ahead to submit their findings from the first iteration. They then can continue their DBR for the second phase and more, in a remaining period in their doctoral program. This may be one of the plausive ways to see more DBR studies conducted in our field by graduate students.

Guideline #4: *To admit the values of research study by our graduate students from wider aspects than traditional way, to make them of more practical value.*

DBR has been thought of a powerful way to bridge the gap between academics and professionals. Wilson's (2014) criteria, such as relevance (does it relate to compelling problems currently faced by educational practitioners?), usability (does it lead to actions?), and impact (does it make a real difference in improving valued educational outcomes and practices?) should be considered in addition to traditional expectations of rigor and internal validity of educational research.

The above guidelines have not yet empirically validated, but rather experientially drawn from our own practice, as well as logically extracted from our review of literature. It is our hope that by following the above mentioned guidelines, more professors would feel comfortable in directing DBR studies at graduate school level. We then will become capable in leading our graduate students to challenge to improve the quality of educational practices in their field, by engaging in a DBR study. The more DBR study will be conducted in graduate schools, the more guidelines shall be proposed to better guide future practices. This is exactly what DBR is striving for; gradual elaboration of design guidelines by iterative and continuing practices.

References

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in educational research? *Educational Researcher, 41*(1), 16-25.

Easterday, M. W., Lewis, D. R., & Gerber, E. M. (2014). Design-Based Research process: Problems, phases, and applications. *International Conference of the Learning Science (ISLS) 2014 Proceedings* (Vol. 1), 317-324.

Feng, X., Lu, G., & Yao, Z. (2015). Professional task-based curriculum development for distance education practitioners at Master's level: A design-based research. *International Review of Research in Open and Distributed Learning*, *16* (2), 288-310.

Herrington, J., McKenney, S., Reeves, T. C., & Oliver, R. (2007). Design-based research and doctoral students: Guidelines for preparing a dissertation proposal. In C. Montgomerie & J. Seale (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2007*, 4089-4097.

Kelly, A. E., Lesh, R. A., & Baek, J. Y (Eds.) (2008). *Handbook of design research methods in education: Innovations in science, technology, engineering, and mathematics learning and teaching*. Routledge.

Kogo, C. (2013). Research methodologies of educational technology (Chapter 11). In Japan Society for Educational Technology (Supervision), *Methodologies of research in educational technology* (Educational Technology Series, Vol. III). Minerva-shobo, 200-206 [In Japanese].

Lay, T., Cook, J., Dennerlein, S., et al. (2014). Scaling informal learning at the workplace: A model and four designs from a large-scale design-based research effort. *British Journal of Educational Technology*, *45* (6), 1036–1048, DOI: 10.1111/bjet.12197.

Ma, Y., & Harmon, S. W. (2009). A case study of design-based research for creating a vision prototype of a technology based innovative learning environment. *Journal of Interactive Learning Research*, 20(1) , 75-93.

Masukawa, H. (2011). Learning sciences. In The Institute of Electronics, Information and Communication Engineers (IEICE) (Eds.), *Knowledge Base*, S3-11, 2-4, 20-32. [In Japanese] Available online: http://www.ieice-hbkb.org/files/S3/S3gun_11hen_02.pdf.

Nemoto, J., Shibata, Y., & Suzuki, K. (2011). Design-based research to improve learning design and learning contents. *Japan Journal of Educational Technology*, *35*(3), 259-268 [In Japanese].

Reeves, T. C. (2006). Design research from a technology perspective. In J. van den Akker, K. Gravemeijer, S. McKenney & N. Nieveen (Eds.), *Educational design research* (pp. 52-66). London: Routledge.

Suzuki, K., & Nemoto, J. (2013). Toward managing both educational improvement and research accomplishment: Let's write a design-based research (Review). *Competency Development of Healthcare Professionals*, *2*(1), 45-53 [In Japanese].

Wang, F., & Hannafin, M. J. (2005). Design-based research and technology-enhanced learning environments. *Educational Technology Research and Development*, *53*(4), 5-23.

Wilson, B. G. (April, 2014). Knowledge creation in design-based research projects: Complementary efforts of academics and practitioners. A paper resented at the meeting of the American Educational Research Association, Philadelphia, Available online: http://www.academia.edu/ 6311234/