

# Unpacking the Design Process in Design-based Research

Mingfong Jan, Yam San Chee, Ek Ming Tan, National Institute of Education,  
Nanyang Technological University, 1 Nanyang Walk, Singapore 637616  
Email: mingfongjan@gmail.com, yamsan.chee@nie.edu.sg, ekming.tan@nie.edu.sg

**Abstract:** Characterizing the design process is critical for design-based research as a research method. In this study, we propose that the design process of design-based research may be perceived as a dialogic process among four major design components—frameworks for learning, the affordances of the chosen instructional tools, domain knowledge presentation, and contextual limitations. It is essential for researchers to align these design components based on the frameworks for learning.

## Developing Design-based Research as a Research Method

Designing and studying a learning context is an emerging method employed by many learning scientists in transforming learning practices with new approaches of learning. This method in studying how learning occurs in *designed* environments is often coined as design experiment (Brown, 1992; diSessa & Cobb, 2004), design research (Edelson, 2002), or design-based research (Barab & Squire, 2004).

As an emerging research method, design-based research has yet developed itself as a comprehensive research method like ethnography or case studies. Though there are some key features many design-based researchers would identify as core elements of design-based research, researchers have not reached general agreements on certain key constructs of design-based research, such as issues of validity, appropriate units of analysis, and the concept of context (Sandoval & Bell, 2004).

Examining the design-based research literature, we find that efforts in developing design-based research as a research methodology contribute mostly to (1) how theoretical constructs may inform design (e.g., diSessa & Cobb, 2004), (2) what the design-based research method may contribute to in terms of theory development (e.g., Edelson, 2002), and (3) how design-based research differs from other research approaches that investigate learning (e.g., Sandoval & Bell, 2004). Based on the research literature, we argue that the following features are key constructs for design-based research as a research method:

1. The design in design-based research is informed and guided by theoretical constructs of learning.
2. Design-based research engineers the learning context in order to transform current learning practice.
3. Design-based research studies learning in the *designed* context, which is also shaped by the local social-cultural-material environment.
4. Design-based research seeks to improve design and develop context-laden theories via iterative design and enactment.

Such broad strokes about design-based research not only help us identify the major research orientations toward developing design-based research as a method, but also help us articulate the missing pieces in the puzzle. In this puzzle, little has been argued about the design *process* through which a design-based research project takes shape. Arguments have been made mostly on the theories that inform design, designing and engineering the learning context, and the theories to be developed. Little, however, is theorized when it comes to the process that shapes design-based research. We maintain that the design process in a design-based research demands more attentions than it is currently receiving. Characterizing the design process constitutes an important step toward the development of design-based research as a research methodology.

## Research Method

One way to explore how the design process may be characterized is to build cases along design challenges. Design challenges reflect the gaps unforeseen by researchers and issues hard to resolve using conventional methods. Situating the analytic primacy in design challenges provides a pragmatic approach in understanding a key aspect of the design process in design-based research.

We employ a method akin to participatory action research (Kemmis & McTaggart, 2000) to examine the design challenges of a game-based learning project *The Legends of Alkhimia*, an inquiry curriculum designed for secondary Chemistry in Singapore. To clarify what, when and how major design challenges turn into design decisions and curricular activities, we analyze the following data: (1) major design documents such as the game design narratives and flow charts, (2) finalized game products, and (3) a reflective account of the design process among key project participants.

## Design of the Legends of Alkhimia Game

In a ten-day chemistry curriculum (20 hours), young people role-play as teams of four apprentice chemists to solve six levels of game challenges presented in the *Legends of Alkhimia* game. The game engage young people in cycles of scientific inquiry. In order to defeat monsters made of unknown substances, players propose hypotheses, conduct virtual experiments and test the effectiveness of their hypotheses and weapons in virtual combats. The scientific inquiry is situated in a personal narrative in which young people describe their experiences in the *Legends of Alkhimia* curriculum.

## Findings and Discussion

Our efforts in unpacking the design process suggests four major design challenges in this game-based learning project: (1) conceptualizing theoretical constructs that informs learning, (2) reframing chemistry domain knowledge, (3) transforming theoretical constructs as game design features and curricular activities, and (4) situating curricular design in local school culture. The following describes how these challenges emerge in the design process.

We initiated the design process with the goal to transform the content-mastery learning paradigm with game-based learning approaches. Therefore, we asked what it means to learn and why learning chemistry is important to young people. Our questions eventually boiled down to the mantra “situating the inquiry of self in the inquiry of science.” We drew from Dewey (1938) and scientific inquiry literature (White & Frederiksen, 1998) as our orienting frameworks for learning, but these frameworks do not inform game and activity design as directly as domain-specific instructional theories (diSessa & Cobb, 2004). The situation was further complicated by the need to rethink how chemistry might be learned without foregrounding chemistry contents. We classify the above challenges as “theoretical challenges” in design-based research. The other two major challenges fall into design category. Not only did we have to transform the orienting frameworks into concrete game and activity design decisions, but also situate the design decisions within the constraints of local school culture and curricular structure. We classify such challenges as “practical challenges.”

The theoretical and practical challenges above are the major stumbling blocks in the design process of this design-based research project. To further thematize these design challenges, we conclude that a design-based research project aiming to transform learning with technologies requires appropriate alignment of four major design components: *frameworks for learning*, *the affordances of the chosen instructional tools*, *domain knowledge presentation*, and *contextual limitations*. In our design practice, these design components are deeply intertwined. Ideally, *frameworks for learning* is the core based on which the other components of design are aligned with in a dialogic process. In reality, however, the *contextual limitations*, such as the underlying culture and structure of schooling, often dominate the other design components.

## Conclusion

In this paper, we argue that it is critical to unpack the design process in design-based research in order to develop design-based research as a research method for learning. This explorative study is our initial attempt at characterizing the design process in a game-based learning project. We maintain that depicting design process along design challenges affords researchers a beneficial way to unpack the design process in a design-based research. We present two types of challenges that emerge in the *Legends of Alkhimia* game-based learning project: theoretical challenges and practical challenges. Four core design components are derived from the design challenges. We believe that these are also core design components shared by many other design-based research projects. The success of a design-based research depends largely on the alignment of these core design components and it is critical to align the design based on the *frameworks of learning*.

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