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# DESIGN-BASED LEARNING IN INFORMATION SYSTEMS: THE ROLE OF KNOWLEDGE AND MOTIVATION ON LEARNING AND DESIGN OUTCOMES

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## ABSTRACT

This research explores use of Design-based Learning (DBL) in an IT education as a means of improving knowledge of the design process, design outcomes, and student motivation. This study involved the implementation of Design-based Learning strategies in IS classes. Students were assigned a team-based design project with Design-based Learning approach. Then they were assessed in terms of their knowledge of the design process (Gentili et al. 2005), level of motivation (Mykytyn et al.

2008), and learning approach (deep vs. surface) (Cope et al. 2002). The results show that the design process knowledge is significantly correlated with design outcomes indicated as peer design rating and peer usability rating. The study also finds that using Design-Based Learning pedagogical approach has the potential to increase IS students' understanding of the design process through engaging in active and authentic learning projects.

## KEYWORDS

Design-based learning, web design, peer evaluation, learning outcomes, design process knowledge

## INTRODUCTION

One of the biggest challenges facing IS educators is to provide learning experiences within an academic context that prepare students for complex, open-ended challenges found in the IS profession. In the past, IS education has received unfavorable critique for the disconnect between IS curriculum and professional practice (Cohen 2002; Lee et al. 2002; Trauth et al. 1993). Research indicates that IS practitioners place a greater emphasis on creative and critical thinking than educators (Lee et al. 2002), and that the ability to plan and design strategic IS solutions is a crucial skill for IS managers (Wu et al. 2007). There exists a need for learning that incorporates deep (vs. surface) learning (Cope et al. 2002) into understanding process by which effective solutions are identified and designed. Among the many pedagogical approaches best suited to address this gap between the academic and practitioner worlds is design-based learning (DBL). This research explores use of Design-Based Learning in an IT education as a means of improving knowledge of the design process, design outcomes, and student motivation.

## DESIGN-BASED LEARNING

Design-based learning (DBL) is a educational approach that incorporates hands-on, authentic, multidisciplinary design tasks (Doppelt et al. 2008; Wijnen 2000). Design-based learning is rooted in a constructivist pedagogical approach in that it relies on learning that emerges through experimentation in authentic contexts (Duffy and Jonassen 1992; Fosnot 1996). While similar in origins to Problem-based learning (PBL), DBL differs from PBL approaches in that with PBL students are focused on a pre-determined complex, authentic problems that students are challenged with solving ((Duch et al. 2001; Savery and Duffy 1995). By contrast, design-based learning places emphasis on the integration of scientific knowledge, interdisciplinary teams to create authentic artifacts (Gómez Puente et al. 2011). In addition, PBL has received criticism for the tendency for instructor defined problem context to become outdated and less relevant to students (Wells et al. 2009). Also, research has shown that students often experience anxiety and confusion over the minimal guidance inherent in the PBL process (Kirschner et al. 2006). A design-based learning approach addresses these issues because students play a larger role in defining the design problem and therefore the resulting projects remain topical and relevant to the current class of students. DBL also has the general tenets of the design process to serve as a guide for students through all stages, from conceptualization to development to evaluation.

While, PBL has previously been applied extensively, in the medical field (Kilroy 2004; Schwartz et al. 2002), engineering (Jackson et al. 2012; Mills and Treagust 2003; Perrenet et al. 2000), and Information Systems (Bentley et al. 2002; Chiang 2005; Mykytyn et al. 2008), there has been very little research on DBL and information systems. This research uses DBL approach to improve IT student's knowledge of the design and the design process through the creation of authentic

artifacts.

Design-based learning engages students in design activities that reflect authentic contexts and guide students through generating specifications, outcome prediction, artifact creation, evaluation and communication. As students step through iterations of each stage they develop reasoning and critical thinking skills needed to address open-ended design challenges in the real world. DBL incorporates the following key features open-ended design assignments, hands-on experience, real-life scenarios, and multidisciplinary content (Puente et al. n.d.)

### Importance of Design Process Knowledge

Graduates of IS programs must have expertise in applying a systematic process to translating technological innovation to create value-added solutions. In order to meet this requirement, the IS 2010 Curriculum guidelines states that IS students must develop skills in the process of designing new solutions (Topi et al. 2010). These design skill include designing and implementing solutions that provide a high-quality user experience. Indeed, students who are competent in the design process should possess a greater ability to provide solutions for dynamic, non-linear problems and anticipate unintended consequences from interrelated system components (Moazzen et al. 2013).

### DESIGN-BASED LEARNING OUTCOMES

#### Design and Peer Assessment

Traditional methods for assessing design include observation of design activities, interviews, and analysis of design documents (Moazzen et al. 2013). The advent of the internet and web-based tools for providing feedback has led to a rise in the use of peer assessment as a tool for evaluating student work. Recently, peer assessment of IS student work has received considerable attention (Sitthiworachart and Joy 2003; Tsai et al. 2002; Tseng and Tsai 2007). Peer assessment is not only valuable for the recipient of the feedback, but also provides a vehicle for learning for the student providing feedback. Students develop judgments about what constitutes effective, quality design through reviewing and providing feedback to peers (van Zundert et al. 2010). In addition, research indicates that peer feedback can be highly correlated with that provided by experts (Tseng and Tsai 2007).

#### Student Motivation and Deep Learning

When students are engaged in projects that involve real-world scenarios and authentic learning, research suggests that student motivation is greatly increased (Cohen 2002). In addition, actively involving students in peer project evaluation has also been recognized as a factor to increase student motivation (Tseng and Tsai 2007). As the level of student motivation increases, students began to take ownership of learning, develop an intrinsic interest, and shift from surface to deep learning. When IS students adapt a deep learning approach they seek a deeper understanding by developing a holistic view of the relationship between the design tasks, technology skills, and content-related concepts (Cohen 2002)

Our hypotheses are modeled in Figure 1 and are stated as follows:

1. Design Process Knowledge will be positively correlated with DBL pedagogical approach
2. Motivation will be positively related with Deep Learning
3. Motivation will be positively related with Design Process Knowledge
4. Deep Learning will be positively related with Design Outcomes
5. Knowledge of Design Process will be positively related to Design Outcomes

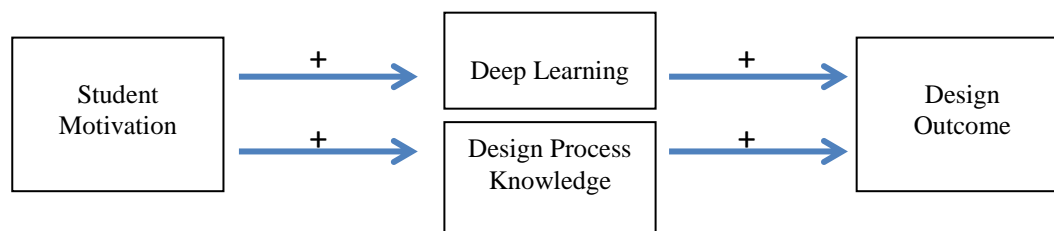


Figure 1: Design-based learning model

## METHODS

This study involved the implementation of Design-based Learning strategies in an IS course of Digital Media. For this research students were assigned a team-based design project. Specifically, students were required to create a prototype for a web site designed to communicate an original concept or product. In keeping with Design-based Learning pedagogy, the design assignment was left intentionally vague and open to individual team interpretation. The project teams consisted of an interdisciplinary mix of students with a range of technical skills and background. Throughout the course students were required to complete individual training and projects to develop their own technical competency so that each team member was prepared to contribute to the team project. In addition, students were given a lecture on the design process, and required to complete a design plan in advance of beginning work on their prototypes.

At the end of the term, students used a web-based evaluation tool to evaluate and provide feedback on peer prototypes. Feedback was provided via a Likert scale rating of design and usability criteria. In addition, students were allowed to provide open text feedback. Aggregate design and usability ratings as well as all free text comments were compiled for each team. Each team received their feedback scores and comments along with class average design and usability scores. The sources for all feedback remained anonymous to the recipient teams.

In addition, a second web-based survey was sent to students relating to their knowledge of the design process (Gentili et al. 2005), level of motivation (Mykytyn et al. 2008), and learning approach (deep vs. surface) (Cope et al. 2002). These items were taken from existing scales used in previous studies.

In addition to peer assessments from classmates participating in the Design-based Learning study, students enrolled in another section of Digital Media being taught by a different instructor were also asked to complete the same web-based evaluation tool and the second survey as a control group. Students in the control group were not exposed to the design process knowledge.

## RESULTS

A total of 98 students participated in the study with 47 students taking part in courses utilizing Design Based Learning pedagogy. The variables from the survey were computed as follows. Motivation was calculated as the average Likert response to the 4 scale items. Design Process Knowledge (DPK) was calculated as the number of correct answers in sequencing the steps of the design process divided by the number of incorrect answers. Deep Learning Approach was calculated as the average of the student's response to 4 Likert scale. Finally, the Design Outcome was calculated as the composite peer rating of the team's design artifact.

Comparing the DBL to the control group, the mean DPK score was .59 compared to .48. A one-way ANOVA was used to test the DPK differences among the control and DBL students. The DPK differed significantly across the groups with  $F(1,96)=6.597$ ,  $p=.012$ .

Among the other variables, spearman's correlation was used to examine the relationships between Motivation, DPK, and Deep Learning. The results indicated that Motivation is significantly and positively correlated with DPK and Deep Learning.

		Motivation	Design Process Knowledge (DPK)	Deep
Motivation	Correlation Coefficient	1.000	.172*	.439**
	Sig. (1-tailed)	.	.045	.000
	N	98	98	98

**Table 1: spearman's correlations (motivation, design process knowledge, deep learning)**

\*\* . Correlation is significant at the 0.01 level (1-tailed). \* . Correlation is significant at the 0.05 level (1-tailed).

In order to analyze the effect of the variables on Design Outcomes, the group scores were calculated for each variable.

For example, the Group DPK score was the average of all team member's individual DPK Score. The results show that higher Group DPK about the design process and higher Group Deep Learning scores are positively and significantly correlated with Design Outcomes indicated as Peer Design Rating and Peer Usability Rating in TABLE 2.

		Peer Design Rating	Peer Usability Rating
Group Knowledge (DPK)	Correlation Coefficient	.814**	.814**
Group Motivation	Correlation Coefficient	.164	.493
	Sig. (1-tailed)	.336	.089
Group Deep Learning	Correlation Coefficient	.695*	.973**

**Table 2: spearman's correlations (knowledge, motivation, deep learning, peer design ratings)**

\*\* . Correlation is significant at the 0.01 level (1-tailed). \* . Correlation is significant at the 0.05 level (1-tailed). c. Listwise N = 9

## DISCUSSION

The results show support of the hypothesis outlined in this study. Specifically, using a Design-Based Learning pedagogical approach has the potential to increase IS students' understanding of the design process through engaging in active and authentic learning projects. In addition, student motivation, individually and collectively in teams is a strong determinant for deep learning and perhaps the desire to engage more fully in developing knowledge of the design process. Finally, our study shows that increased knowledge and deep learning yield more favorable design outcomes.

While this study provides a number of insights implementing Design-based learning in IS course, there are some limitations. The size of this study was relatively small with data from 6 courses taught by 2 instructors. Future studies that involve more sections of the same course with multiple instructors would provide additional detail. In addition, it would be valuable to examine the factors influencing student motivation in the context of IS courses given that student motivation is strongly associated with knowledge acquisition and deep learning

## CONCLUSIONS

Design-based Learning pedagogy provides an effective way to engage IS students in authentic learning activities that prepare them for real world design problems. In addition, because DBL allows students to apply creativity to generate their own design plans and specifications, students have a vested interest in project outcomes and can explore complex solution spaces. At the same time, the design process provides guidance to students on how to successfully apply their technical skills to meet design requirements and produce functional artifacts. These artifacts can then be evaluated and refined by students to further understanding the design process cycle.

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