Supporting Practice, Integrating Research in Immersive Technologies into Educational Designs (SPIRITED): Teachers as Designers

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Abstract

This paper presents in-progress research on how and what teachers learn when they design projects and specifically focuses on how they incorporate immersive technology into their designs. The paper reports preliminary analysis from a course for in-service teachers, *Project Based Learning* (PBL), in which they design and implement 4-8 week projects. Readings focused on design practices, foundational work on PBL, and technologies for learning and assessment. Assignments scaffolded teachers through design process, including identifying "customer needs," ideation activities, and evaluation. This research investigates how teachers take on identities as designers, and specifically examines how technologies are incorporated. Case studies, under development at the time of writing, will focus on how teachers incorporate immersive projection technology—similar to that seen in a planetarium--to reconfigure classroom activity and to provide contexts for inquiry.

Introduction

This paper presents on-going research examining teachers designing inquiry projects with technologies. Various technologies are embedded in this process, but here, we focus on 1) how technology supports teachers as they design; and 2) how teachers plan to incorporate immersive, interactive projection into their designs.

Teachers as designers of learning experiences

Little is known about teachers using projects of their own design (Thomas, 2000). Research on teachers as designers in more general terms has resulted in mixed findings. Teachers' design work has been considered in terms of when and where it might occur. Such design work has been framed in terms of out-of-class planning (Carlgren, 1999) and as a reflective process embedded in practice (Schön, 1983). In the former, this has typically occurred in one of three ways: professional development, formal coursework, or (semi-) professional curriculum development teams. As part of curriculum development teams it has been reported that teachers struggle to think like designers (Reiser et al., 2000). In courses and seminars (Koehler & Mishra, 2005a, 2005b; Koehler, Mishra, Hershey, & Peruski, 2004), success has been found when pedagogical problems are authentic and design process is iterative (Koehler & Mishra, 2005a, 2005b; Koehler et al., 2004).

In professional development approaches, there is evidence both that redesign of existing materials confers a benefit over design (Penuel & Gallagher, 2009), and that it does not (Cviko, McKenney, & Voogt, 2012). Related work has yielded the concept of *pedagogical design capacity* (M. Brown & Edelson, 2003), tying adaptations teachers make to instructional success.

When teachers adapt existing curricula, their adaptations do not necessarily align to the intent of the original designs (Penuel & Yarnall, 2005), though this is not de facto a negative. Teachers struggle to design authentic assessments and to integrate technology effectively (Marx, Blumenfeld, Krajcik, & Soloway, 1997).

There is evidence across contexts suggesting that design principles can help teachers to design successfully (Bybee, 1997; Edelson, 2001; Schwarz & Gwekwerere, 2007), but that if the principles are too general, providing curricula to adapt paired with professional development or educative materials can also be successful (Ball & Cohen, 1996; Connelly & Clandinin, 1988; Davis & Krajcik, 2005; Fishman, Marx, Best, & Tal, 2003; Schneider & Krajcik, 2002).

A role for technology: immersive projection

Little research has explored the use of immersive projection technologies for learning (Apostolellis & Daradoumis, 2010). In one study of student learning of factual recall and conceptual learning of architecture, immersive displays led to significantly better performance, especially for those with lower visual reasoning skills (Jacobson, 2010). Another study, involving a portable immersive theater, demonstrated significant learning gains of earth science concepts (Sumners, Reiff, & Weber, 2008). In a study comparing students learning chemical reactions with a standard computer screen to projected 3D display, researchers found that students using the projected 3D display performed significantly better on an assessment testing their understanding of the chemical reactions studied (Limniou, Roberts, & Papadopoulos, 2008). They also reported that students were better able to explain the molecules from different angles. Similar findings have emerged in other types of immersive learning environments; they enhance learning because they offer a situated experience and they provide options for multiple perspectives (Dede, 2009).

Current fulldome systems (e.g., a digital planetarium) can now use a three-dimensional star database that can be flown through to create journeys through the galaxy. However, current fulldome systems have limited interactivity (i.e., one person controls the system and the audience is passive). The addition of multi-user interactivity (Figure 1) opens up a wealth of new possibilities both for research on learning (Emmart, 2005; Wyatt, 2005).

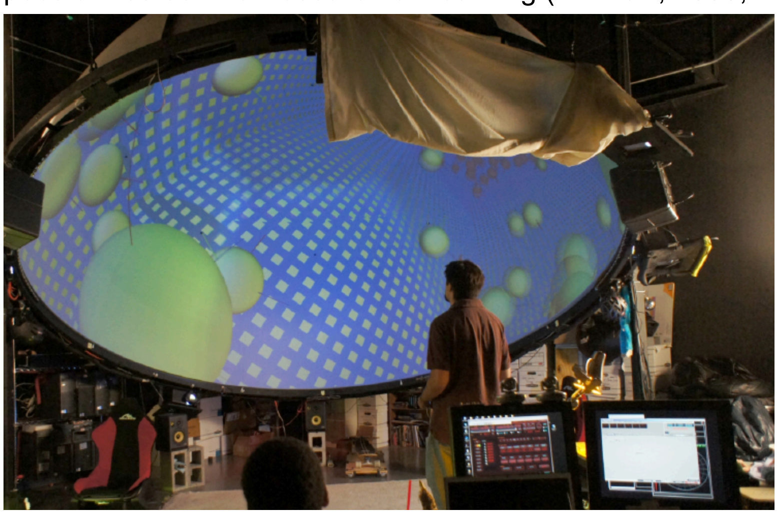

Figure 1. The university has a small dome and builds on recent innovations in interactive and immersive digital environments developed under the auspices of an NSF PFI grant *Consortium for Fulldome and Immersive Technology Development* (Sen, PI, 2009-2012)

Open questions about the role of immersive environments for learning remain; in particular, Dede (2009) highlights that more research is needed on supporting transfer by blending learning across virtual and real settings. One of the affordances of immersive learning environments is the provocation of problem finding and posing activities, (Dunleavy, Dede, & Mitchell, 2009), but this finding is not well understood, suggesting an avenue for further research. *Supporting Practice, Integrating Research in Immersive Technologies into Educational Designs* (SPIRITED) places a focus how we might support teachers to design and implement inquiry in which context is provided and scientific activity structures are provoked using immersive technology.

Participants

Participants include in-service teachers seeking a masters degree and enrolled in a spring 2012 course, *Project Based Learning* (n=9) and computer science faculty and students (n=5), at a Hispanic-serving research institution located in the southwest of the United States. The teachers are supported in their design work by an interdisciplinary team with expertise in design learning, teacher education, and immersive media design; and by two technologies: edWeb.net provides an open community in which participants reflect on and post design work; and a shared googledoc provides a space for (a)synchronous collaborative note-taking.

Data and Analysis

Pre and post-tests were given at the beginning and end of the course; this assessment includes a challenging design question, as well as questions probing knowledge of and experience with design process. Design work is documented primarily through artifacts. They began work as part of an in-class performance assessment, in which the project was described and initial design work (ideation) begun. In order to facilitate their designs, they were given a tour and demos in the dome. Their inquiry units will incorporate existing programs, and extend them in ways that support learning. All of the projects are being designed with the intent to implement. Initial analysis focuses on artifacts of teachers' design processes and the pre-test. A coding scheme (Table 1) was developed (Svihla, 2009).

Table 1. Design schema for coding design artifacts

Design Dimension	*Components*
Design occurs under constraint	Cost – price of final product; does not include unrealistic resources Regulations—conforms to state/government standards
Design involves form and function. A customer may select a design based on form, even if function is inferior	Materials—durability, biocompatibility, ethical, feasible to use Style—reflects the style of the designer Ambiguity – no single right answer exists, and many alternatives may suffice
Designs address diverse customer or client needs, some of which may be implicit	Roles—multiple customers or clients named Needs—multiple needs are considered and evaluated / ranked Implicit/False—Customers may provide misinformation
Design is an iterative process that requires evaluation and optimization across tradeoffs	Tradeoffs-- Names tradeoffs between variables Improvement—iterative plans to evaluate/improve the design Coevolution—problem and solution co-evolve during design

A design-based approach (A. L. Brown, 1992; The Design-Based Research Collective, 2003) will leverage findings for refinements, leading to design guidelines. The second phase will comprise pilot testing of the inquiry lessons with UNM undergraduate students followed by refinement and implementation with secondary students. Implementations and refinement will be documented through interviews, video records, and artifacts.

Preliminary Findings

Design Skills Test

On both pre- and post-test, participants reported that design was relevant to their practice. When asked to describe steps in design process, seven of the nine teachers referenced lesson planning, "Steps involving designing include: 1. Look at the concepts that students need to cover within the specific time that you are working with. 2. Plan various lessons plans based on whatever concepts you would like students to understand at the end of the unit. 3. Plan various activities that students can participate so they're engaged and working with the material that was taught. 4. Assess the students to see what information was obtained and what information needs to be reviewed."

They were also asked to describe an experience, either in or out of school—in which they designed something for someone else to use, and what was challenging about it. In their responses, most included specific references to single types of customers (e.g., students or substitute teachers) but only vague references to customer needs, with the most specific being "groups can work on their own with no help from the teacher." On the post-test, most referenced multiple customers (students and substitute teachers), and considered their needs from customer perspectives ("I have to put myself in the position of a stranger coming into a classroom and not knowing any of the daily routines").

Artifacts: Customer needs

The teachers read about design process (Jonassen, 2000; Wiggins & McTighe, 2005) and were introduced to the concept of customer needs. They interviewed members of the workplace to learn more about what schools need to do to prepare students for real world jobs, and ranked these based on their prominence across their interviews. They did the same for their own beliefs, and for those as found in a data set given to them relating the needs as expressed by students at a project based school (Table 2).

Table 2. Customer needs identified in three data sets, and their prevalence

Customer Needs, as expressed by:	*PBL Students (n=4)*	*Voices from Workplace (n=9)*	*Teachers (n=9)*
Collaboration / group work	4	9	8
Critical thinking / problem solving	0	8	7
Dependability / professionalism	0	8	2
Authenticity	1	3	4
Communication	2	7	3
Active / hands on learning	3	4	1

Artifacts of design work: Ideation

Participants began their designs for immersive media prior to visiting the dome. They had access to video demos of the projections, and were asked to engage in ideation related to how they might incorporate immersive media, with the constraint that they not change the media. The activity was challenging, and they spent two hours discussing the media, trying to come to a consensus as to which to select. Their initial designs resultant from this activity were unrealistic, requiring significant modification to the media, thus violating the constraint, or incorporating the media in non-consequential ways (e.g., for entertainment purposes).

While visiting the dome (Figure 2), they began identifying affordances for using the dome to teach: making particular features salient, interactive, and three-dimensional, and showing time lapse in three dimensions. While some of their ideas still violated the constraint, their suggestions were no longer non-consequential. This aligns to findings that highlight the importance of having understanding of the materials greatly improves design plans, (Anning, 1994), allowing designers to shift from hypotheticals to practical (Koehler et al., 2004; Svihla, 2009, 2010).

Figure 2. One of the teachers learning to navigate with a WiiMote and pressure-sensor platform in the dome. The WiiMote allows users to turn and to interact with the environment-- an asteroid field—while using the platform to navigate. The red sad face indicates he has crashed into too many asteroids and the ships is losing oxygen.

Next Steps

On-going analysis will follow the teachers designs' into their classrooms, with a focus on understanding how their designs did (not) support learning, and how to better support teachers to incorporate immersive technologies in consequential ways. Specific attention will be paid to the development of design skills, such as incorporating customer needs, optimizing across constraints, and designing practical, usable projects.

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