

Chapter 2.17

Lessons Learned about Designing Augmented Realities

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ABSTRACT

While utilizing GPS-enabled handheld computing units, we have developed and studied augmented reality (AR) curricula to help middle school students learn literacy and math. In AR, students move around an outdoor physical environment, interacting with virtual characters and artifacts on their handheld computer. These invisible objects and characters provide clues to help solve a mystery, guiding the students through a process of inquiry and evidence building. The first AR curriculum we developed, *Alien Contact!* is based on a scenario where aliens have crash landed near the students' middle school. Students, working in teams, learn math and literacy skills in the course

of determining why the aliens have come to earth. This study describes the design heuristics used during the initial development and deployment of *Alien Contact!*, the results of two formative evaluations of this curriculum, and the impact these findings have had on revising our design heuristics for a subsequent AR curriculum about beached whales, called *Gray Anatomy*.

INTRODUCTION

Researchers are starting to study how AR modalities for learning aid students' engagement and understanding (Dunleavy, Dede, & Mitchell, in press; Klopfer & Squire, 2008; Klopfer, Yoon, & Perry, 2005; Klopfer, Yoon, & Rivas, 2004). This article explores the background of AR, describes

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the Handheld Augmented Reality Project (HARP) at Harvard University, explains the results from formative evaluations of the first AR curriculum created through HARP, and delineates how the lessons learned from this evaluation impacted the development of a subsequent AR curriculum.

THEORETICAL FRAMEWORK

The theory that learning occurs most effectively in authentic setting is not new. Hendricks (2001) stated that complex social interactions are at the heart of learning. Brown, Collins, and Duguid (1989) more precisely defined this thinking through their belief that individuals' interactions with their social teams lead to their adoption of learned behaviors. This phenomenon, which Hendricks called situated cognition, is different from practices in traditional educational settings. There is ample research to substantiate that social interactions are important for accomplishing challenging learning tasks. Bandura (1977), Vygotsky (1978), and Scaife and Bruner (1975) found that observation of and assistance from others at times precedes and always interacts with human cognitive development. Bandura (p. 12) highlights the importance of "symbolic, vicarious, and self-regulatory" processes in social learning. As compared to a psychological view where learning is a matter of an individual "performing responses and experiencing their effects." Bandura elaborates on his theory that learning is a social process, explaining that we learn everything vicariously before we learn it directly because it is the only way we can "acquire large, integrated patterns of behavior without having to form them tediously by trial and error. The harder the task to be learned, the more we must learn it through observation first.

Hendricks (2001) found evidence to support the idea that practices based on situated cognitive theory can have significant impacts on immediate learning. Klopfer et al. (2004) focused on the use of

technology to facilitate situated learning environments—particularly through the use of handheld and wearable computing devices. Through the use of *participatory simulations* they found that students were more motivated, engaged, and excited by the process of participatory learning than they are by more traditional means of learning.

Motivation concerns the selective direction, energizing, and regulating of behavior patterns (Ford, 1992). It is central to persistence in learning and to producing positive outcomes (Ryan & Deci, 2000). Vygotsky (1978) found that, even before behavior sets in, through motivation we decide where we direct attention. There are different types of motivation, and they have different impacts on learning and sustaining learning (Ryan & Deci). Extrinsic motivation ranges from, at one end, a sense that our behavior is controlled by others who do things to regulate our behavior, to the other end, where we have a sense that we are in control of our own actions and get support from outside actors but little direct regulation of our behavior (Ryan & Deci). Most of the incentives to succeed academically in postsecondary education are designed to stimulate various forms of extrinsic motivation. For example, in a competitive classroom, some students' suboptimal performance, made explicit through student rankings and bell curves, serve as extrinsic motivators for other students to achieve.

There is strong evidence that cooperative learning is better for stimulating intrinsic motivation than competitive learning (Gehlbach, 2007). Classrooms that focus on cooperative learning make students responsible for one another's outcomes (Gehlbach). Social learning approaches may be more likely to foster intrinsic motivation, the form of motivation most likely to positively influence persistence, because it is the most self-directed form of behavior regulation and taps into our innate desire and capacity to seek out challenge and explore (Ryan & Deci, 2000). Later research by Klopfer et al. (2005) substantiated these earlier findings as to the impacts of simulations. More

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