Digital Dome Versus Desktop Display in an Educational Game: Gates of Horus

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ABSTRACT

A visually immersive display can make an educational game more effective, if concepts are embodied in an information-rich space and the interaction/perception design exploits the egocentric view that the display affords. For example, ancient Egyptian temples juxtapose language and symbol in an architecture meant to be understood from the inside. In this study, students, ages 11 through 14, played an educational game based on a virtual temple. In an unstructured test in which students produced their own guided tours of the temple, those who played the game in a digital dome showed better factual recall ($P < 0.05$) than those who used a standard desktop.

Keywords: Cultural Heritage, Digital Dome, Educational Games, Immersion, Museum, Spatial, Virtual Reality

INTRODUCTION

We live in a time of rapid advances in the use of communication technologies for education. (Dede, 2009; Mihalca, 2007). This includes virtual reality (VR), computer-based media which employ a three-dimensional virtual world. Students can interact with this imaginary space and things in it, psychologically “inhabiting” that world, as themselves or as some other personas (Winn, 2003; Slater, 2009). Researchers are working to develop curricula and learning environments that take advantage of the opportunities provided by these new media (Takacs, 2008). One key strategy is to cast the learning activity in the form of a game (Dondlinger, 2007; Squire, 2008; Anderson, 2010; Dede, 2009). Nevertheless, there is still controversy over whether the choice of media makes any fundamental difference in learning (Clark, 2010; Russell, 2000). If not, the educator’s choice of media should be an economic one. Either way, research is needed to determine what works and how to use it.

The purpose of this case study is to contribute data to the debate by showing one way that visually immersive display can support learning in game-like educational virtual reality. Visually immersive displays provide the user with the ability to look in most directions and see the virtual environment. The most straightforward example is the all-digital projection dome which can display a virtual landscape in a panoramic view up to 180 degrees wide (Lantz, 2007).
CAVE and similar devices also surround the user with a panoramic view, but they are much smaller, generally square, and usually focused on an individual user, providing that user with sophisticated interaction devices (Cruz-Neira, 1993). Another approach is the Head Mounted Display (HMD), a pair of glasses in which each lens is a video screen showing the virtual environment. The computer employs a tracking device on the user’s head so that it can show a stable view of the virtual environment in any direction the user looks.

In our study, we employed the Earth Theater at the Carnegie Museum of Natural History. Its main screen is a section of a sphere, providing a view 210 degrees horizontal by 30 degrees vertical. Specifically, middle school students played Gates of Horus, an educational game based on our Virtual Egyptian Temple (Troche, 2010). In Jacobson (2009), we describe in detail Gates of Horus and our experimental findings, which indicate that students learned from the game and found it enjoyable and engaging (P < 0.05). In this article, we describe our case study, in which individual students who played Gates of Horus in the Earth Theater had better factual recall (P < 0.05) regarding the temple than those who played the game on a standard desktop computer.

In this article, we will situate our study in the literature, describe Gates of Horus, describe our experiments, and discuss our findings. We believe that we have found a case in which visual immersion does make a positive difference, although more research is needed to find the mechanisms at work.

**Does Media Matter?**

Clark (1988) challenges the idea that learning outcomes can be affected by communication media used in the learning process. He likens the media to a delivery vehicle and the information to be learned as the payload. To him (Clark, 1994), the only important difference among media is their cost, and therefore the most appropriate and efficient one should be chosen for the task at hand. Russell (2000) cites a very large number of studies that attempted but failed to find any significant differences in learning when comparing two or more media employed in the same or very similar curricula. Today, Clark (2010) continues to cite a lack of hard evidence of media-related differences in learning and a lack of good experimental studies. Instead, he focuses on theories and methods for good instructional design.

However, Russell himself states that the lack of significant media-related differences in learning is more likely due to inappropriate or incomplete use of the media (Russell, 2000, pp. xii-xvi) or weak means of measuring difference. In refuting Clark’s claim, Kozma (1994) begins by stating that media and method (instructional design) are inseparable. Good design takes advantage of the affordances offered by the media, and the media exists to serve the design – one cannot simply substitute one communication media for another and hold all else equal. Mayer (2001) says much the same thing.

Kozma (1994) goes on to argue that learning is not a process of simply accepting delivery of information, but an active process of exploration. Central to that exploration is a reciprocal relationship between the learner’s cognitive resources and the external environment. Winn (2003) describes learning as an act of mutual adaptation between the student and the environment. Constructivist learning theory (Jonassen, 2000) describes learning as the individual or social process of building knowledge (Vygotsky, 1978) which requires a supportive environment.

Today, most educational research focuses on learning environments (Mihalca, 2007) that support the learning process in increasingly intelligent and flexible ways. It is interesting that Clark, Kozma, and other central players in new media for education (Barab, 2009) all state that (apart from individual learner differences) it is the quality of the design of the learning experience that matters. Perhaps the main difference between Clark and the others is a difference of opinion on the extent to which media creates meaningful opportunities for better design.
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