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The Effect of Augmented and Virtual Reality Interfaces in the Creative Design Process

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ABSTRACT

The aim of the article is to investigate how virtual reality (VR) and augmented reality (AR) interfaces affect the creative design process in design education. The article focuses on how technology traits affect the creative design process. 10 subjects were selected and their design process was analyzed using protocol analysis. The results of the study indicate that epistemic action reduces cognitive load, thereby reducing fixation in the design process and enhancing the creative design process.

KEYWORDS

Augmented Reality, Creativity, Linkography, Virtual Reality

1. INTRODUCTION

The problem-solving process has been discussed extensively in a number of studies (Ackoff, 1974; Broadbent, 1973; Lawson, 1983). Design problem solving has been analyzed and explained using methods such as insight problem solving (Chandrasekera, Vo, & D'Souza, 2013), trial and error problem solving (Youmans, 2011), and formal and logical processes (Dorst, 2011). The effect of prototyping (which is essentially a trial and error method of problem solving) is discussed in a number of studies with regard to design problem solving (Kershaw et al., 2011; Youmans, 2011; Viswanathan, & Linsey, 2009). In most studies in which prototyping in the design process is discussed, one recurring theme is its effect on fixation (Chandrasekera, 2014; Viswanathan & Linsey, 2009; Youmans, 2011).

Gestalt psychologists have extensively studied mental blocks as a phenomenon interchangeable with fixation found in design studies (Murty & Purcell, 2003). While a mental block is defined as "a barrier in our minds preventing us from producing desired information" (Kozak, Sternglanz, Viswanathan, & Wegner, 2008, p. 1123) design fixation is described as the inability of the designer to move away from an idea in order to resolve a problem (Jansson & Smith, 1991). Fixation is often identified as a process that interferes with creative reasoning and leads one to become fixated on a small number of unvaried solutions (Agogue & Cassotti, 2013). Fixation can become a hindrance in the creative design problem solving process. Potential solutions to mitigate fixation effects in the design process have been explored in previous studies, including encouraging group work (Youmans, 2011) and introducing analogical inspiration sources (Casakin & Goldschmidt, 1999). Even though in some instances prototyping has been identified as a method of reducing fixation (Dow et al., 2010; Youmans, 2011), in other studies physical prototyping increased fixation (Christensen & Schunn, 2007). Researchers have explained the fixation caused through physical prototyping as a result of sunk-cost effect: the time designers spend making the physical prototype of their initial ideas is when

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they tend to fixate more (Viswanathan & Linsey, 2013). Digital prototyping can be considered an approach to alleviate fixation effects caused by physical prototyping because digital prototyping is a way of bypassing the sunk-cost effect.

AR is an interface that offers tangible interaction (Ishii, 2007) and is often referred to as a tangible user interface (TUI). Kim and Maher (2008) suggested that digital prototyping using TUIs such as AR allowed users to make additional inferences from visio-spatial features, freeing designers from fixation effects. Kim and Maher stated that tangibility in these types of interfaces allows more opportunities for trial and error type of problem solving through epistemic actions in prototyping.

Kirsh and Maglio (1994) introduced the concepts of epistemic action and pragmatic action. They discussed how expert players of the popular video game Tetris conserve their cognitive resources by trying different positions of the Tetris cubes rather than trying to figure it out in their minds. These experimental moves, which they termed epistemic actions, allow the players to use their cognitive resources for something else. Fitzmaurice (1996) used the same terms in discussing tangibility in user interfaces. She introduced the concept of graspable user interface (similar to TUI) and suggested that the tangibility in interfaces such as AR interfaces allows more epistemic action, thereby reducing the cognitive load and conserving mental effort.

Others (Kershaw et al, 2011; Moreno et al., 2014; Youmans, 2007) suggested that when cognitive load is reduced the fixation effects in design are reduced as well because epistemic actions allow a designer to manipulate the design freely. At the same time this reduction in cognitive load allows the designer to avoid fixation. This does not imply that fixation can be eliminated by allowing epistemic action alone, but merely that epistemic action reduces fixation effects. However, studies have shown that fixation adversely affects the creative process (Kohn & Smith, 2009; Smith & Blankenship, 1989, 1991), so it is important to investigate whether epistemic actions could reduce cognitive load and thereby reduce the chances of fixation and positively affect the creative design process (see Figure 1).

Understanding how AR and VR provide opportunities for epistemic actions and how these epistemic actions affect the creative design process is the primary focus of this study. From a practical standpoint, the findings of this study contribute to helping designers and design educators use interfaces such as AR and VR in the design process. The results suggest that by reducing the cognitive load the creative design process can be enhanced. In terms of teaching, this not only suggests that AR interfaces offer less cognitive load, it also confirms that decisions about using any instructional medium should be made carefully and should consider the cognitive load of the chosen instructional interface. Fixation is considered to be a negative aspect in design, in most cases hindering the creative design process. Therefore, the findings of this study are invaluable in justifying the development of such an AR CAD system to be used effectively in the creative design process.

Figure 1. Effect of epistemic action and cognitive load on the creative design process