Chapter 3
Do 3D Pedagogical Agents Help Students Learn Science?
A Systematic Review

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EXECUTIVE SUMMARY

This systematic review investigates the effects of 3D pedagogical agents on learning scientific materials. A comprehensive search of the literature produced 576 research abstracts. After applying pre-determined inclusion criteria, fifteen studies compared the use of 3D pedagogical agents with a non-agent control condition to offer instruction to participants. The results revealed that 3D pedagogical agents provided more benefits to students learning science than other instructional approaches, such as reading a text. The results are discussed, and suggestions for future research are delineated.

INTRODUCTION

Over the past decade, researchers have explored the motivational and cognitive benefits of working with pedagogical agents. However, reviews of the field have either been limited by small sample sizes in different studies with pedagogical agents (Clarebout, Elen, Johnson, & Shaw, 2002; Kim & Ryu, 2003; Mayer, 2005)

or found inconsistent results throughout the literature, with some studies yielding positive effects, some yielding mixed effects, and a considerable number of studies not showing any learning differences in agent versus non-agent environments (Heidig & Clarebout, 2011). Moreover, none of the reviews specifically investigated pedagogical agents, which facilitated the learning of scientific materials; rather they investigated pedagogical agents regardless of subject domain. Researchers have observed that pedagogical agents may embody the ability to demonstrate and model tasks (Clarebout, et al., 2002; Moreno, 2005), which may facilitate scientific learning more than other knowledge domains due to the abstract nature of science.

Although pedagogical agents are described somewhat differently by many researchers, for the purposes of this study, a pedagogical agent is an on-screen character designed to facilitate learning in a multimedia environment (Adcock & Van Eck, 2005; Choi & Clark, 2006; Craig, Gholson, & Driscoll, 2002; Gulz, 2004; Johnson, Rickel, & Lester, 2000; Moreno, 2005; Veletsianos & Miller, 2008). Researchers have noted that little is known in the literature concerning the features of pedagogical agents that facilitate or inhibit learning. For example, research is inconclusive on whether the learning benefits afforded by pedagogical agents stem from the pedagogy they can facilitate (e.g. internal properties) or their appearance or voice (Moreno, 2005). Moreno, Reislein, and Ozogul (2010) examined the use of pedagogical agents for signaling the learner's attention, and found that the pedagogical agent group outperformed both an animated arrow and control group. Additionally, the pedagogical agent group rated the system as less difficult than the animated arrow or control group (Moreno, Reislein, & Ozogul, 2010). Moreno et al.'s (2010) study thus finds support for the agent being able to provide effective pedagogy. Investigating the role of pedagogical agent's appearance and voice, Domagk (2010) suggests that "an appealing image of a pedagogical agent, as well as an appealing voice, facilitated transfer performance compared to unappealing ones…. The presentation of a pedagogical agent dislikeable in appearance and voice (two unappealing social cues) even hindered learning" (p. 93). Moreover, Veletsianos (2007) suggests, "evidence from social psychology and human computer interactions suggest that deliberate attempts to improve the aesthetic properties of pedagogical agents may influence learning perceptions and learning outcomes" (p. 375). Thus, we can see the literature does not specify whether the agent's internal or external properties lead to any cognitive benefits (Moreno, 2005).

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