

# Chapter 75

## Pedagogical Agents for Learning

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### ABSTRACT

*Throughout the past two decades, researchers have seen rapid innovations in the field of learning technologies. Virtual reality, video games, and online learning are becoming quite common in educational contexts. Pedagogical agents are often present in a variety of these virtual environments. Pedagogical agents are virtual characters with an on-screen presence that are designed to facilitate learning in multimedia environments. In this chapter the author examines the theoretical rationale for incorporating a pedagogical agent into a learning environment, critically examines their effectiveness for learning, and discusses how they have been implemented in research studies to date. Suggestions for future research in virtual reality environments are highlighted.*

### INTRODUCTION

Researchers in the field of educational technology have made massive strides in the past few decades. Each year new technologies become available, the cost of many technologies steadily decreases, and new graphic user interfaces make technically challenging programs more user-friendly. As advanced technologies have become more accessible in regard to both the cost and the technical ability needed to utilize them, the research literature has seen a plethora of studies using a variety of digital environments. For instance, virtual reality (e.g., Merchant, Goetz, Cifuentes, Keeney-Kennicutt, & Davis, 2014), mixed reality (e.g., Johnson-Glenberg, Birchfield, Tolentino, & Koziupa, 2014), augmented reality (e.g., Enyedy, Danish, Delacruz, & Kumar, 2012), and other multimedia interfaces such as smartphones (e.g., Huang, Wu, & Chen, 2012) and tablets (e.g., Alegría, Boscardin, Poncet, Mayfield, & Wamsley, 2014; Alvarez, Brown, & Nussbaum, 2011) are increasingly common in the research literature. In educational contexts, virtual characters often appear within these environments.

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There are many types of virtual character. For instance, researchers have investigated the use of avatars (Okita, Turkay, Kim, & Murai, 2013), pedagogical agents (Johnson, Ozogul, Moreno, & Reisslein, 2013; Lane et al., 2013), motivational agents (Baylor, 2011; Baylor & Kim, 2005), and conversational agents (Graesser, 2011). The wide variety of virtual characters has led to their implementation in a number of disciplines. For instance, virtual characters have appeared in content areas such as physics (VanLehn et al., 2007), communications skills (Adcock, Duggan, Nelson, & Nickel, 2006), microbiology (Sabourin & Lester, 2014), and informal science education (Lane et al., 2013).

Virtual characters are not always designed to accomplish the same tasks in the learning environment. For example, conversational agents are equipped with artificial intelligence that allows them to facilitate a conversation by holding a dialogue with the learner (Tegos, Demetriadis, & Tsiatsos, 2014), while motivational agents are designed to facilitate the learner's motivation (Baylor, 2011). In order to accomplish these tasks, virtual characters' features may vary widely depending upon their purpose. For instance, their level of artificial intelligence, their ability to communicate with the learner, how they communicate with the learner, their physical appearance, their ability to move around a virtual space, or even their teaching role in the learning environment (i.e., teacher or peer) can be manipulated in order to achieve different types of human-computer interactions.

Pedagogical agents are virtual characters designed to facilitate learning in multimedia-based environments (Johnson, Ozogul, & Reisslein, 2014). Research surrounding the efficacy of pedagogical agents for learning has yielded mixed results (Heidig & Clarebout, 2011), however a recent meta-analysis found an overall small, positive effect (Schroeder, Adesope, & Barouch Gilbert, 2013). Regardless of their past effectiveness, researchers strive to discover the salient features of agent design and implementation in order to facilitate learning. While the virtual environments used in many studies of pedagogical agents are not likely considered virtual reality environments, it is critical to understand the foundations of pedagogical agent research as instructional designers begin implementing them in novel environments and frameworks, such as virtual reality.

The purpose of this chapter is to review the many uses of pedagogical agents in desktop-based learning environments. The chapter begins with an examination of the theoretical perspectives that have guided pedagogical agent implementation. Second is a brief discussion situating theoretical contributions into practice. Third, the varied findings around pedagogical agents' influence on learning outcomes are discussed. Fourth, a discussion of the different roles a pedagogical agent can play in the learning environment is presented. Finally, the chapter concludes with an examination of the implementation of pedagogical agents in specific knowledge domains and a discussion of the use of pedagogical agents in virtual reality environments. While a wide variety of studies will be reviewed in this chapter, all of those discussed measured learning outcomes when examining the use of a pedagogical agent compared to a non-agent condition

## **THEORETICAL BACKGROUND**

Those in the field of pedagogical agent research have used a number of theories to guide their experimental designs. For the purposes of this chapter, three prominent theories in the literature surrounding how people learn with pedagogical agents are discussed. Specifically, we will examine how pedagogical agent research has been guided by the hypotheses of cognitive load theory (Sweller, 2010), the cognitive theory of multimedia learning (Mayer, 2014a), and social agency theory (Mayer, Sabko, & Mautone, 2003).

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