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A Case for the use of Pedagogical Agents in Online Learning Environments

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Framework

Progressive multimedia learning tools have been extensively researched over the past twenty years. Two of these tools include intelligent tutoring systems (Graesser et al., 2004; Ma, Adesope, & Nesbit, 2011; VanLehn, 2011) and pedagogical agents (Mayer & DaPra, 2012; Moreno, Mayer, Spires, & Lester, 2001). In this paper we discuss pedagogical agents, which are visible characters in multimedia learning environments designed to facilitate learning (Moreno, 2005; Schroeder, Adesope, & Barouch Gilbert, 2012). Some researchers have expressed reservations that pedagogical agents may not be cost-effective (Choi & Clark, 2006; Clark & Choi, 2005; 2007). However, while it previously may have taken a considerable amount of time and resources to design and implement a pedagogical agent within a learning environment, recent advances in technology make pedagogical agent-based systems more accessible and affordable to educators.

Pedagogical agent research is typically grounded in social agency theory. Social agency theory is based on previous research which indicates that people treat computers as fellow humans (Reeves & Nass, 1996), and posits that "social cues in a multimedia message can prime the social conversation schema in learners" (Mayer, Sabko, & Mautone, 2003, p. 419). Thus, Mayer et al. (2003) suggest that learners may perceive computer interaction as a social exchange of information. In sum, it is hypothesized that if the learner perceives the computer interaction as social communication, it may cause increased performance on transfer tests due to the student engaging in the "sense-making process" (Mayer et al., 2003, p. 420). This process describes active learning, which is delineated into three stages: selecting information, organizing it, and integrating it with prior knowledge (Mayer et al., 2003; Mayer, 2005). Alternatively, Mayer et al. (2003) posit that a lack of social cues in a multimedia message will not cause a social response in the learner, and thus foster rote learning, or memorization. As such, it is the process of deeper understanding (Atkinson, Mayer, & Merrill, 2005) that pedagogical agent researchers hope to foster to promote meaningful learning (Mayer et al., 2003) in pedagogical agent-based learning environments.

Are pedagogical agents useful in multimedia environments?

Research suggests that pedagogical agents have the ability to play many roles in the multimedia learning environment, such as demonstrating, scaffolding, coaching, modeling and testing (Clarebout, Elen, Johnson, & Shaw, 2002). However, throughout research, pedagogical agents often take the role of an instructor or a coach (Clarebout et al., 2002). Recent research has started to investigate the use of peer-agents (e.g., Holmes, 2007), however this area is under-represented compared to studies which utilized the agent as an instructor.

Pedagogical agents are not necessarily artificially intelligent, although in the past researchers have paired them with intelligent tutoring systems (e.g., Moreno, Mayer, Spires, &

Lester, 2001). To some this may seem a major limitation. However, an alternative viewpoint suggests that constructing artificially intelligent agents generally requires computing and programming knowledge that many educators may lack. Thus, the ability to incorporate a non-intelligent agent into a multimedia learning environment with relative ease may increase the effectiveness of the environment for minimal cost. Cost-effectiveness should be an important consideration for educational researchers, as it is well known that budget cuts continue to affect many higher education programs (Potter, 2003).

Empirical Results

Clarebout et al.'s (2002) seminal review concluded that "pedagogical agents do have possibilities for supporting learners when working with complex tasks…The potential of these pedagogical agents offer opportunities that should be grasped" (p. 281). These claims were reiterated by Kim and Ryu's (2003) meta-analysis, which indicated that pedagogical agents presence in multimedia learning environments increased both learners' retention (d=.30, p<.05) and transfer (d=.64, p<.05) scores.

Mayer's (2005b) review revealed a median effect size of d=.22 for studies in which an agent was present. Similarly, Moreno's review (2005) investigated pedagogical agent research in relation to Mayer's (2005) cognitive theory of multimedia learning. Moreno found support for the redundancy principle, in that learners were able to learn more when the learning material did not provide redundant text and narration. Additionally, Moreno found support for the modality principle, in that learners were able to perform better on post-tests if the pedagogical agent provided narration as the modality of communication rather than text. Moreover, Moreno's review did not find support for the deleterious effects of the split-attention principle (Ayers & Sweller, 2005). In other words, while learner's split their attention between the agent and the learning material, it did not produce negative learning effects. Finally, and perhaps most importantly, Moreno found that pedagogical agents can foster the active learning process.

Recently, Heidig and Clarebout (2011) reviewed pedagogical agent research; however their results were not promising. They summarize that "the majority of studies (9 out of 15) yielded no difference on learning" (Heidig & Clarebout, 2011, p. 51). However, Schroeder, Adesope, and Barouch Gilbert's (2012) recent meta-analysis indicates that pedagogical agents produce a small, positive effect on learning.

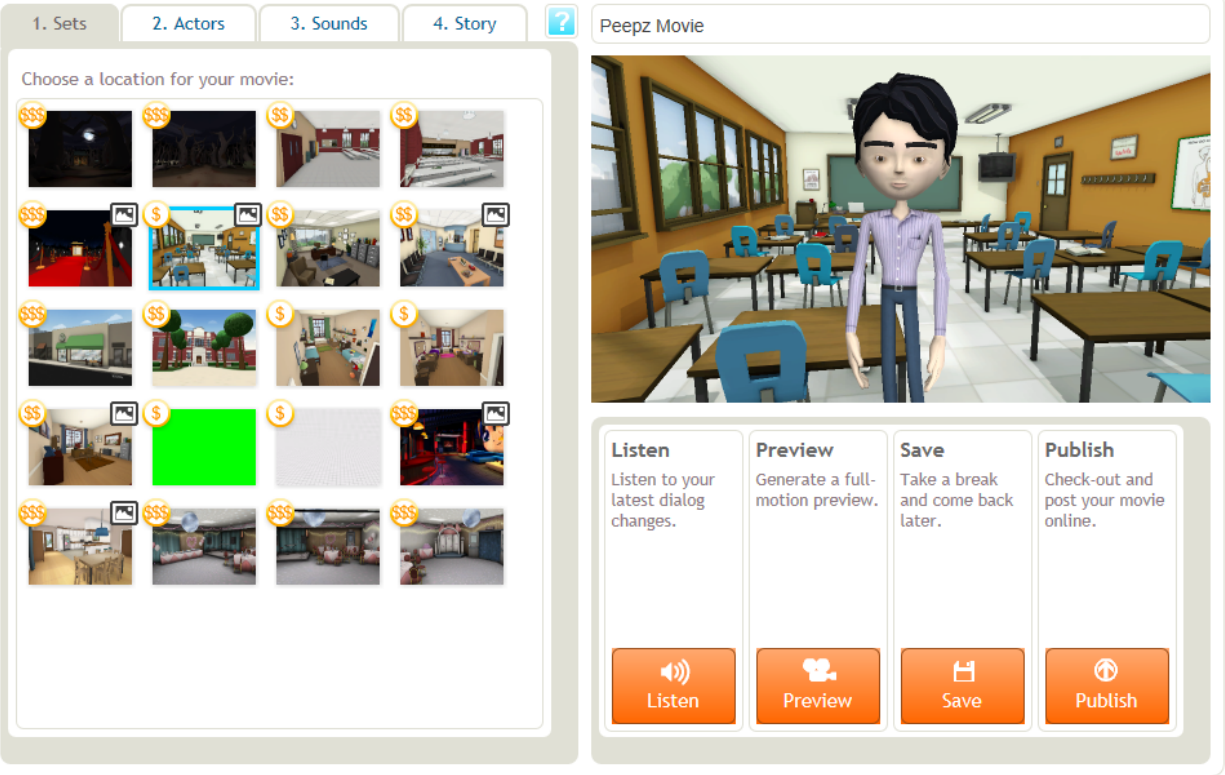
Making it Work

As mentioned, researchers have suggested that pedagogical agents may not be cost-effective (Choi & Clark, 2006; Clark & Choi, 2005; 2007). In the past, pedagogical agent learning environments needed to either be created from scratch, or through the use of complex computer programs. Recently, inexpensive and easy to operate software options are becoming available to educators who want to include an agent in their instruction. For example, Xtranormal (2012) can be used to create presentations which include pedagogical agents (see Figure 1).

Xtranormal (2012) allows the user to create videos using animated characters in virtual environments. The characters range from cartoons characters and stick figures to fully anthropomorphized humanoids dressed in business attire. The program is very simple to operate: you choose whether you want one or two agents, select the setting in which they will appear, select which the characters you will like to use, choose background sounds and type in the text which the text-to-speech engine will generate as narration. Alternatively, one could record

human voices and upload the recording to provide the narration. The program also allows the user to customize the agents' gestures and movements to make them more realistic.

Figure 1. A screenshot which shows the user-interface of Xtranormal. From Xtranormal (2012).



Future Implications

It is plausible that creating a short presentation in Xtranormal (2012) may take slightly longer than a comparable slideshow or other multimedia presentation. However, the novelty of the presentation may facilitate student learning and motivation. While pedagogical agents are not the panacea of multimedia learning, in certain situations where something different is needed to grasp students attention, the use of pedagogical agents may be beneficial.

References

Atkinson, R.K., Mayer, R.E., & Merrill, M.M. (2005). Fostering social agency in multimedia learning: Examining the impact of an animated agent's voice. *Contemporary Educational Psychology, 30,* 117-139.

Ayers, P., & Sweller, J. (2005). The split-attention principle in multimedia learning. In R. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (pp.19-30). New York, NY: Cambridge University Press.

Choi, S., & Clark, R.E. (2006). Cognitive and affective benefits of an animated pedagogical

agent for learning English as a second language. *Journal of Educational Computing Research, 34*(4), 441-466.

Clarebout, G., Elen, J., Johnson, W.L., & Shaw, E. (2002). Animated pedagogical agents: An opportunity to be grasped? *Journal of Educational Multimedia and Hypermedia*, *11*(3), 267-286.

Clark, R.E., & Choi, S. (2005). Five design principles for experiments on the effects of animated pedagogical agents. *Journal of Educational Computing Research, 32*(3), 209-225.

Clark, R.E., & Choi, S. (2007). The questionable benefits of pedagogical agents: Response to Veletsianos. *Journal of Educational Computing Research, 36*(4), 379-381.

Graesser, A.C., Lu, S., Jackson, G.T., Mitchell, H.H., Ventura, M., Olney, A., & Louwerse, M.M. (2004). AutoTutor: A tutor with dialogue in natural language. *Behavioral Research Methods, Instruments and Computers, 36,* 180-193.

Heidig, S., & Clarebout, G. (2011). Do pedagogical agents make a difference to student motivation and learning? Educational Research Review, 6, 27-54.

Holmes, J. (2007). Designing agents to support learning by explaining. *Computer & Education*, *48*, 523–547.

Kim, M,. & Ryu, J. (2003). Meta-analysis of the effectiveness of pedagogical agent. In D. Lassner & C. McNaught (Eds.), *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications 2003* (pp. 479-486). Chesapeake, VA: AACE.

Ma, W., Adesope, O.O., & Nesbit, J.C. (2011). *Intelligent tutoring systems: A meta-analysis.* American Educational Research Association Meeting, New Orleans, LA.

Mayer, R.E., (2005). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (pp.19-30). New York, NY: Cambridge University Press.

Mayer, R.E., (2005b). Principles of multimedia learning based on social cues: Personalization, voice, and image principles. In R. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (pp.201-212). New York, NY: Cambridge University Press.

Mayer, R.E., & DaPra, S.C. (2012). An embodiment effect in computer-based learning with animated pedagogical agents. *Journal of Experimental Psychology: Applied, 3,* 239-252.

Mayer, R.E., Sabko, K., & Mautone, P. (2003). Social cues in multimedia learning: Role of speaker's voice. *Journal of Educational Psychology, 95*(2), 419-425.

Moreno, R. (2005). Multimedia learning with animated pedagogical agents. In R. Mayer (Ed.), *The Cambridge Handbook of Multimedia Learning* (pp. 507-523). New York, NY: Cambridge University Press.

Moreno, R., Mayer, R.E., Spires, H.A., & Lester, J.C. (2001) The case for social agency in computer-based teaching: Do students learn more deeply when they interact with animated pedagogical agents? *Cognition & Instruction, 19*(2), 177-213.

Potter, W. (2003, August 8). State lawmakers again cut higher-education spending. *The Chronicle of Higher Education*, p. A22.

Reeves, B., & Nass, C. (1996). *The Media Equation: How People Treat Computers, Television, and New Media like Real People and Places.* Stanford, CA: CSLI Publications.

Schroeder, N. L., Adesope, O. O., & Barouch Gilbert, R. (2012). *A meta-analysis of the effects of pedagogical agents on learning*. Paper presented at the American Educational Research Association Annual Meeting. Vancouver, British Columbia.

VanLehn, K. (2011). The relative effectiveness of human tutoring, intelligent tutoring systems, and other tutoring systems. *Educational Psychologist, 46(4),* 197-221.

Xtranormal. (2012). *Xtranormal* [computer software]. http://www.xtranormal.com