Schroeder, N. L., & Adesope, O. O. (2015). Impacts of Pedagogical Agent Gender in an Accessible Learning Environment. *Educational Technology & Society, 18* (4), 401–411.

# Impacts of Pedagogical Agent Gender in an Accessible Learning Environment

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(Submitted August 25, 2014; Revised March 19, 2015; Accepted April 7, 2015)

**ABSTRACT**

Advances in information technologies have resulted in the use of pedagogical agents to facilitate learning. Although several studies have been conducted to examine the effects of pedagogical agents on learning, little is known about gender stereotypes of agents and how those stereotypes influence student learning and attitudes. This study investigates if the pedagogical agent's gender influences cognitive and affective outcomes in learner-attenuated system-paced environments. The findings reveal that the gender of the agent did not produce any statistically significant effects. This indicates that the effects of learning with pedagogical agents may be independent of the agents' gender. The implications for theory and practice are discussed, along with future research directions.

**Keywords**

Multimedia learning, Pedagogical agent, Gender, Pacing

## Introduction

Learning technologies are changing not only the way we learn, but also how we engage and communicate with one another (Archembault & Crippen, 2009). Without a doubt, the digital media produced by such technologies have significant impacts on modern life (Warschauer & Matuchniak, 2010). While digital media produce new challenges in teaching and learning, technology allows for innovation in the classroom (Shapley, Sheehan, Maloney, & Caranikas-Walker, 2011). For example, innovative technologies have given us pedagogical agents, which are virtual characters visually present in multimedia environments for the purpose of facilitating learning (Moreno, 2005).

While some studies have shown that pedagogical agents hold potential for facilitating learning (Clarebout, Elen, Johnson, & Shaw, 2002; Schroeder, Adesope, & Barouch Gilbert, 2013), their design and implementation must be thoughtfully guided. For instance, Veletsianos, Miller, and Doering (2009) suggested that pedagogical agent implementation should focus on improving "the social, pedagogical, and technological opportunities provided to learners" (p. 179). If these considerations remain absent yet an agent is implemented in a learning system, it is possible that a split-attention effect could occur (Moreno, 2005). In other words, a pedagogical agent's presence could be distracting to the learner (Moreno, 2005; van Mulken, André, & Müller, 1998), thereby inhibiting learning. Hence, it appears that implementing a pedagogical agent effectively is not only a matter of obtaining the appropriate software, but also appropriately designing the agent to enhance learning.

While the theoretical implementations of pedagogical agents are appealing, one may wonder what practical use they offer. Researchers have claimed that pedagogical agents can model or demonstrate tasks or skills, help coach students, or even provide scaffolding for learning (Clarebout, Elen, Johnson, & Shaw, 2002). Clearly, when articulated and implemented appropriately pedagogical agents provide a versatility rivaled by few technology tools. Further, as demonstrated by previous research, pedagogical agents can be used in a wide range of instructional domains, including the humanities, mathematics, and science (e.g., Atkinson, 2002; Domagk, 2010; Dunsworth & Atkinson, 2007; Johnson, Ozogul, Moreno, & Reisslein, 2013; Kizilkaya & Askar, 2008; Moreno, Mayer, Spires, & Lester, 2001; Ozogul, Johnson, Atkinson, & Reisslein, 2013). Yet, these experiments represent just the tip of the iceberg. The potential uses of pedagogical agents are what provide the most exciting insights. For instance, as technology evolves, pedagogical agents could help learners participate in virtual science experiments in biology or chemistry classrooms, explore virtual environments or museums in history or government classes, or even demonstrate the customs of different cultures for those learning a second language or planning to travel abroad. It is plausible that as one technological innovation leads to the next, the role the pedagogical agent plays will be limited only by the software's abilities and by the designer's imagination.

Yet, one aspect of pedagogical agent implementation that deserves thorough investigation is the effect of the agent's physical appearance (Domagk, 2010; Veletsianos, 2010). Researchers have found that learners stereotype pedagogical agents by their physical appearance and non-verbal cues (Moreno et al., 2002; Veletsianos, 2010). This study investigates one particular facet of this interaction: gender stereotypes and their impact on learning and perceptions. Gender stereotypes are unconscious thought processes that guide expectations of how each gender should look, speak, and behave (Llorente & Morales, 2012; Erdin, 2009). Accordingly, it is easy to see how gender stereotypes could influence an interaction between the agent and the learner. For the purpose of this study, we are interested in how students project stereotypes onto their instructor, or in this case, how gender stereotypes come into play due to the gender of the pedagogical agent.

Another important aspect of pedagogical agent design is the environment itself. More specifically, the pacing of the environment deserves to be more closely examined. Many pedagogical agent studies have utilized learner-paced environments, where the learner can move forward or backward through pre-determined segments of instruction (e.g., Dunsworth & Atkinson, 2007). Alternatively, very few studies have examined system-paced environments, where the learner had no control over the speed or presentation of the information. In other words, the learner is shown a video clip and cannot pause or rewind it.

Anecdotal reflection in the classroom reveals that not all learning systems can be split into this clean dichotomy of system- or learner-paced. For example, consider a non-segmented video that allows learners to pause, fast-forward, and rewind, such as an individual video clip from the Khan Academy (https://www.khanacademy.org/) or a recorded lecture (e.g., Pierce & Fox, 2012). These types of videos are becoming increasingly common in the classroom as faculty members harness the power and accessibility of the Internet. For instance, the notion of a "flipped classroom" is becoming more popular (Tucker, 2012) and faculty members are recording their presentations or lectures and uploading the videos onto the Internet for students to access outside of class (e.g., Crampton, Vanniasinkam, & Ragusa, 2012; Pierce & Fox, 2012; Zappe, Leicht, Messner, Litzinger, & Lee, 2009).

Instructional videos such as those described by Pierce and Fox (2012) and Zappe et al. (2009) do not fall within the theoretical boundaries of learner-pacing as reflected within pedagogical agent research because they are not segmented as in other studies. In other words, while units of instruction may be separate videos, each instructional unit is one contiguous presentation that the student could pause, rewind, or fast-forward. Since the learners had limited control over the presentation, the video also does not fall within the bounds of system-pacing. After consulting the pedagogical agent literature, the authors realized that instructional videos such as the one described have not been characterized as a particular type of pacing. Since evidence suggests there may be some interaction between the pacing of the learning environment and certain instructional design principles (e.g., the modality effect; see Ginns, 2005) the authors feel it is important to clearly delineate the pacing of instructional videos. As such, we feel a video as described could be more properly considered learner-attenuated system-paced (LASP) instruction. Specifically, in LASP instruction the learner has some aspect of control, yet they are still shown a contiguous video clip. To date, we are aware of only one other published pedagogical agent study that utilized this type of pacing (Schroeder & Adesope, 2013). Due to the inherent differences between LASP, learner, and system-paced environments, it is plausible that there may be effects on learner's cognitive and affective outcomes.

This study investigated the following research questions to explore how a pedagogical agent's gender might affect cognitive and affective outcomes in pre-service teachers learning with a pedagogical agent in a LASP learning environment.

- How does learning with a male pedagogical agent affect the learner's free recall, multiple choice, and transfer scores compared to learning with a female agent?
- How does learning with a male pedagogical agent affect the learner's perception of the agent compared to a female agent?

## Literature review

Pedagogical agent research has been grounded in theories from a broad range of disciplines. Below, we discuss the most prominent theories that guided this study.

## Social agency theory

Social agency theory denotes how social cues from a multimedia learning environment can activate the same communication rules as conversing with another human (Mayer, Sobko, & Mautone, 2003; Veletsianos, Miller, & Doering, 2009). In other words, the learner tries "harder to make sense of what the computer is saying by engaging in deep cognitive processing" (Mayer, et al., 2003, p. 419). Social agency theory has been well supported throughout the literature. For instance, eye-tracking research found that agents were seen as conversational partners (Louwerse, Graesser, McNamara, & Lu, 2008), researchers found that pedagogical agents were seen as social models (Kim, Baylor, & Shen, 2007), and Moreno, Mayer, Spires, and Lester (2001) found that "students learn a computer-based lesson more deeply when it is presented in a social agency environment than when it is presented as a text and graphics source" (p. 209).

Accordingly, it is plausible that the communication between a computer and a learner can be manipulated to foster either instructor-student or student-student interactions. Researchers have found that the visual appearance of pedagogical agents can invoke stereotypes in the learner (Moreno et al., 2002; Veletsianos, 2007). As such, it is also plausible that one could create a specific social interaction by mindfully changing the agent's features to enhance the agent's contextual-relevance. These features include the agent's appearance, behavior, and speech. In the past, Veletsianos (2007) argued that an agent's relevance could be critical "because it may influence learners' attention and perceptions and degree of agent relevance, seriousness, and authenticity" (p. 374). This study investigates the effect of learners' gender stereotypes on their cognitive and affective outcomes by using contextually-relevant agents that varied only by their gender-specific appearance and voice.

## Gender stereotypes

Gender stereotypes can create problems in educational contexts (Potvin, Hazari, Tai, & Sadler, 2009) because they influence people's rationality and how they behave due to certain expectations (Llorente & Morales, 2012). For instance, females are often stereotyped as obedient, shy, submissive, or dependent, while males may be seen as competent, assertive, or aggressive (Llorente & Morales, 2012; Erdin, 2009). Without a doubt, these stereotypes in educational contexts could cause damage to students' self-esteem or motivation to learn (Erdin, 2009). Accordingly, the first question we must consider is how these stereotypes play out in the classroom.

Classroom interactions can be influenced by gender stereotypes not only from the teacher's perspective, but also the student's (Madrid & Hughes, 2010). For instance, teachers may provide male or female students with differing levels of instruction due to their own lack of awareness, expectations, or gender (Davis & Nicaise, 2011). Alternatively, the student may also act on gender stereotypes they project on their teacher. For example, one study found that students felt female teachers provided more student support, while male teachers use an authoritarian teaching style (Madrid & Hughes, 2010). Yet, the literature has not provided consistent, conclusive findings that female or male teachers are thought to be better teachers in regards to learning. Could this be due to students' perceptions and stereotypes changing as they age? This question is outside the scope of this study, but it is certainly worthy of future research.

Few researchers have examined how gender stereotypes affect learning and perceptions with pedagogical agents. Moreno et al.'s study (2002) showed that the agents were stereotyped by the learners and that male agents were more effective at fostering learning outcomes than female agents. Further work by Kim, Baylor, and Shen (2007) found that a male pedagogical agent was rated higher by learners on affective measures. Yet, not all research in the area has produced consistent results. For instance, Baylor and Kim (2004) found that female agents were able to increase a learner's self-efficacy more than male agents, and the learning outcome results from a number of experiments has not provided clear conclusions as to one gender being significantly better for learning than the other (Baylor & Kim, 2004; Kim, Baylor, & Shen, 2007). In sum, the limited research surrounding pedagogical agents and gender stereotypes shows that while affective measures seem to be influenced by gender stereotypes, cognitive measures do not. This study sought to expand the literature surrounding pedagogical agent gender by investigating whether contextually-relevant female or male pedagogical agents provide any affective or cognitive advantage in a LASP learning environment.

## Methods

### Participants and design

The participants in this study were 77 pre-service teachers at a large, public university in the Pacific Northwestern United States. Participants were randomly assigned to work with either a female agent (Figure 1) or male agent (Figure 2) and participated for course credit. Forty participants were in the male agent group, and 37 participants were in the female agent group.

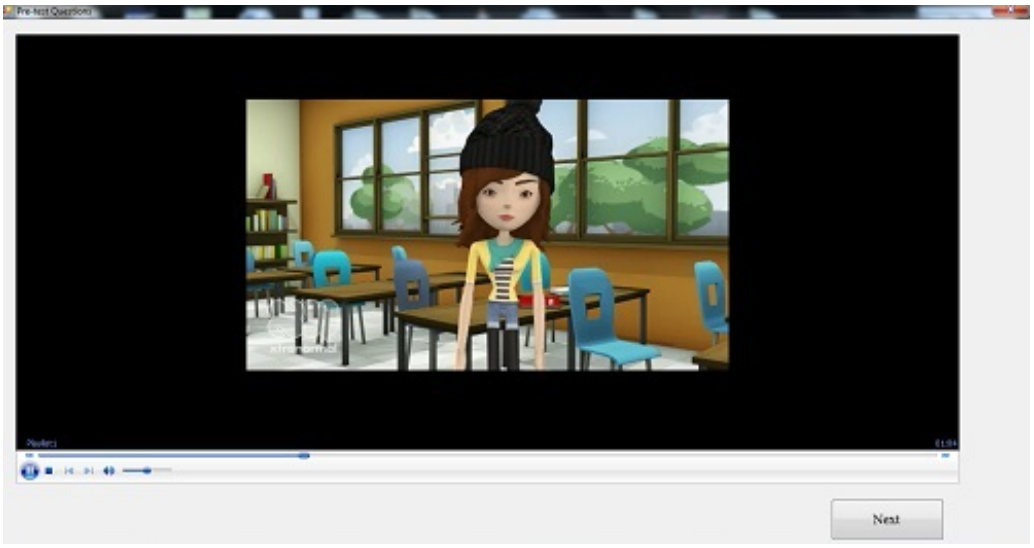


*Figure 1.* Screenshot of the female agent condition

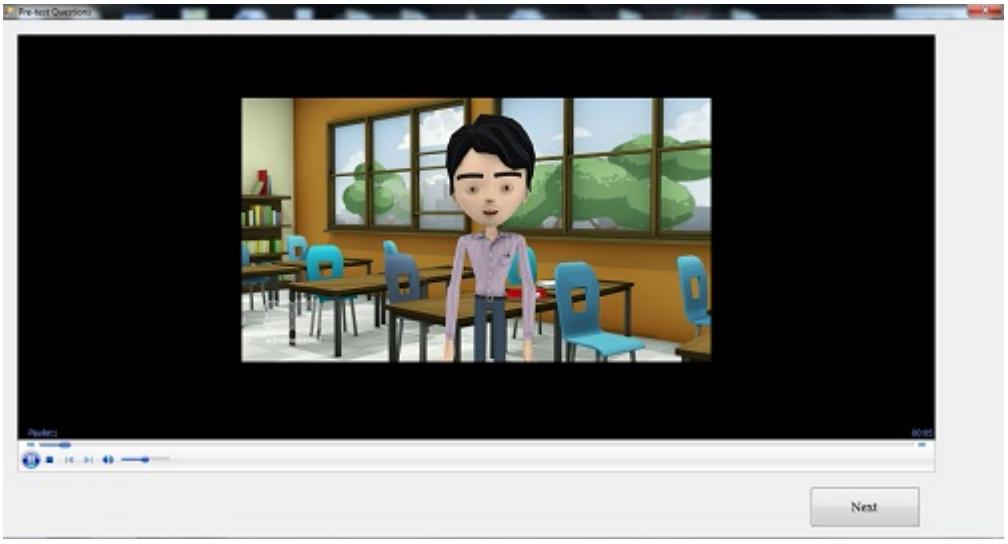


Figure 2. Screenshot of the male pedagogical agent condition

The participants' average age was 20.75 (*SD* = 1.60) years old. On average the participants had completed 2.5 years of post-secondary education, and 74 percent of the participants were female. About 86 percent of the sample was Caucasian, 8 percent reported multiple ethnicities, and 4 percent was Hispanic while two percent of the participants chose not to report their ethnicity.

While the participants sometimes use multimedia in their own teaching (*M* = 3.35, *SD* = .96, where 1 is "never" and 5 is "almost always"), 71% of the participants had never received formal instruction about multimedia learning theory. The pre-test reiterated this point as the average pre-test score was 4% (*M* = .55, *SD* = .82, points possible =

14). Taken together, the participants' self-reported experience with formal multimedia learning theory instruction and their pre-test scores showed that they had very little knowledge of multimedia learning theory before the intervention. This was done to ensure that we do not have a ceiling effect relative to the materials used.

## Procedure

The study was conducted in a computer laboratory that has 30 identical Dell computers. Each participant used a set of headphones that were attached to the computer before they arrived. The screen resolution was set to the university's default setting of 1280x1024. When the participants arrived, they were given a piece of paper that contained their user ID. The computer program we developed used the user ID to route each participant into the appropriate experimental condition. The participants were introduced to the experiment and given an opportunity to opt-out if they chose to. Participants then completed the experiment using their assigned computer station.

## Materials

### *Pedagogical agent and learning environment design*

When examining a multimedia learning environment, one easily overlooked design feature is the background, or in this case, the virtual environment in which the agent is situated. In many studies, the background environment is a blank screen (e.g. Atkinson, 2002; Domagk, 2010). Yet, Veletsianos (2007) made a compelling argument for the contextual-relevance of the agent. Following this logic, we have expanded previous research by utilizing a background that appears to be a virtual classroom. In order to minimize potential confounding variables, the virtual classroom did not contain any other agents except the peer agent who was providing instruction. However, the classroom background contained desks, chairs, and windows (Figure 1). The background environment was identical between the two conditions.

The learning environment was created using Xtranormal. Xtranormal was an Internet-based program that allowed for the incorporation of pedagogical agents into virtual learning environments. The program was designed to be extremely user-friendly, as there was no required coding or special software. Rather, one utilized mostly drag and drop methods to create their instructional materials. Videos created with Xtranormal afford learners some aspect of control, similar to videos on other popular educational websites (e.g., Khan Academy, https://www.khanacademy.org/), thus placing them within the context of LASP instruction. Since the time of this study Xtranormal has closed, and the software is now under new ownership (http://www.nawmal.com).

Finally, as has been common practice in pedagogical agent research, the agent in this study provided the instructional material to the learner. Since this study introduced a new type of pacing to pedagogical agent research, as well as expanded the research around peer agents (discussed in the next section) and added a contextually-relevant background scene we did not deviate from the traditional role of the agent as the primary source of information. While delivering instruction, the agent made five gestures. While the gestures did not reference any on-screen learning materials, they were added in the hope of aiding understanding (Hostetter, 2011). Furthermore, the gestures were designed to aid in the agent's deictic believability, or its ability to move in relation to objects in the virtual space (Lester, Voerman, Towns, & Callaway, 1999), which presumably may facilitate its ability to be perceived as human-like.

### *Peer agents*

Researchers have primarily used instructor-type agents rather than peer agents in pedagogical agent studies (Clarebout et al., 2002). However, it is hard to argue with the compelling evidence for peer interaction within classroom environments (Kim & Baylor, 2006, p. 569). Kim and Baylor (2006) argued that peer agents "may serve as a social model for enhanced motivation and learning in computer-based environments" (p. 580), and be able to foster a learner's efficacy beliefs. These notions suggest that peer agents may foster both cognitive and affective outcomes more effectively than instructor agents. As such, we question if peer agents may foster an increased sense of social agency than an instructor agent. While researchers have recently utilized peer agents to foster learners'

attraction to an unpopular knowledge domain (Kim & Wei, 2011), peer agents are still not often utilized throughout the literature. Accordingly, this study adds to the growing literature surrounding pedagogical agents by utilizing contextually-relevant, peer agents.

*Demographic questionnaire*

Demographic information was obtained with a questionnaire consisting of eight questions that addressed the student's age, gender, ethnicity, and previous experiences with multimedia and multimedia learning theory.

*Pre-test*

The pre-test consisted of three free response questions. One question addressed cognitive load theory, another addressed the modality principle, and the final question addressed the split-attention principle. The pre-test was worth a maximum of 14 points, with one point given for each correct answer. The participants earned one point for correctly identifying or describing each of the following ideas in their response to the first question: working memory, long-term memory, schema, germane cognitive load, intrinsic cognitive load, and extraneous cognitive load. Thus, the first question had 12 possible points. Participants earned one point for correctly describing the split-attention principle in the second question, and one point for correctly describing the modality principle in the third question. The goal of the pre-test was to examine the learner's prior knowledge while minimizing any error due to guessing.

*Post-test*

The cognitive aspects of the post-test consisted of three different types of questions. First, the participants answered a free recall question that asked them to write down everything they could remember from the instructional video. There were a maximum of 18 points awarded for the free recall question. Points were allotted for correctly identifying (1 point) and describing (1 point) the following ideas: germane cognitive load, schema, extraneous cognitive load, intrinsic cognitive load, cognitive load theory, long-term memory, working memory, the modality principle, and the split-attention principle.

The participants then answered 30 multiple-choice questions in which each correct answer was worth one point. The questions in this section required the participants to recall specific information as well as apply their knowledge to a hypothetical situation. The scale's internal consistency reliability was found to be $\alpha = .70$.

The final question was a free response transfer question. The participants were asked to design a lesson plan utilizing cognitive load theory, the split-attention principle, and the modality principle. The free response transfer question had a maximum score of 18, with points given for each correct reference to theory when describing their lesson plan. The grading for this question was identical to that of the free recall question.

To measure the participants' perceptions of the agent, they completed the Agent Persona Instrument (Ryu & Baylor, 2005). The instrument consisted of 10 items which addressed how well the agent facilitated learning ($\alpha = .94$), five items which addressed how credible the agent was ($\alpha = .92$), five items which addressed how human-like the agent was ($\alpha = .87$), and five items which addressed how engaging the agent was ($\alpha = .86$) (Ryu & Baylor, 2005). The participants responded using a 5-point Likert scale, where 1 is "Strongly Disagree" and 5 is "Strongly Agree". For this study, the scale's internal consistency reliability was found to be $\alpha = .94$ for facilitated learning, $\alpha = .87$ for credibility, $\alpha = .88$ for human-like, and $\alpha = .89$ for engaging.

## Results and discussion

The purpose of this study was to investigate if changing a contextually-relevant, peer pedagogical agent's gender in a LASP learning environment would influence either cognitive or affective outcomes. This section describes the findings of the study in relation to previous research.

**Research question one: How does learning with a male pedagogical agent affect the learner's free recall, multiple choice, and transfer scores compared to learning with a female agent?**

The data (Table 1) were first examined graphically in order to check for normality (Tabachnick & Fidell, 2013). Multivariate analysis of variance (MANOVA) was conducted using the cognitive tests as the dependent variables and the agent's gender as the independent variable. Further analyses indicated that the assumption of homogeneous covariance matrices was met (Box's $M = 3.67$, $p > .05$), as was the assumption of the equality of error variance for each cognitive measure (Levene's tests $p > .05$). The assumptions of MANOVA having been met, the analysis revealed no significant differences between groups on cognitive outcomes (Wilks' $\lambda = .94$, $F(3, 73) = 1.60$, $p > .05$).

*Table 1*. Cognitive outcome results

| | Male ($n$ = 40) | | Female ($n$ = 37) | |
|---|---|---|---|---|
| | Mean | *SD* | Mean | *SD* |
| Pre-test | 0.63 | 0.93 | 0.46 | 0.69 |
| Free recall | 6.68 | 4.02 | 4.89 | 3.55 |
| Multiple choice | 17.08 | 4.42 | 16.03 | 4.40 |
| Transfer | 3.20 | 2.99 | 3.32 | 2.68 |

*Note*. Maximum possible scores: Pre-test: 14; Free Recall: 18; Multiple Choice: 30; Transfer: 18.

These findings support some of the literature around pedagogical agent gender. For instance, Baylor and Kim (2004) found no significant differences in learning outcomes between those who worked with female or male pedagogical agents, as did one experiment in Kim, Baylor, and Shen's (2007) work. Yet, other experiments have found that male pedagogical agents were more effective for learning (Kim, Baylor, & Shen, 2007; Moreno et al., 2002). Accordingly, it is plausible that in some situations learners may show gender stereotypes with pedagogical agents. However, more work is needed to determine the reasons why these stereotypes may occur.

These findings provide meaningful implications for social agency theory. While social agency theory predicts that social cues in multimedia messages can engage the social conversation schema, and thus improve learning (Louwerse, Graesser, Lu, & Mitchell, 2005; Mayer, Sobko, & Mautone, 2003; Moreno et al., 2001), this study has shown that both male and female peer agents can provide statistically equivalent social cues in a LASP learning environment. As such, it appears as though gender stereotypes did not influence the way the social cues were interpreted by the learners. However, since this study was examining only the gender-specific appearance and voice of the agent, both conditions utilized the same gestures and movements throughout the instructional video to improve the internal validity of the study. Future research should investigate if gender-specific movements or gestures impact students' learning.

While we found that there were not significant differences in learning outcomes between those who worked with the male or female agents, these results have important practical implications. Earlier, we argued that pedagogical agent design must be carefully guided to suite their purpose. Findings from this study show that if the purpose is to facilitate learning in a LASP environment, the gender of the contextually-relevant, peer pedagogical agent may have no significant difference on learning outcomes. However, we caution that this finding may not be replicated in other knowledge domains or for agents that do not appear as peers. For instance, Schroeder et al. (2013) found that pedagogical agents were more effective at facilitating learning in scientific knowledge domains than within the humanities, and Veletsianos (2010) found that agents were stereotyped differently depending upon if they were providing instruction on music or science. Accordingly, future research should explore if an agent's gender influences learning or affective outcomes in other knowledge domains.

**Research question two: How does learning with a male pedagogical agent affect the learner's perception of the agent compared to a female agent?**

We began investigating this research question by first examining the data distribution for each affective scale to examine normality (Tabachnick & Fidell, 2013). The data (Table 2) were found to be normally distributed, so we proceeded with the MANOVA using the agent's gender as the independent variable and the affective measures as the dependent variables.

*Table 2*. Affective outcome results

| | Male ($n$ = 40) | | Female ($n$ = 37) | |
|---|---|---|---|---|
| | Mean | *SD* | Mean | *SD* |
| Facilitated learning | 26.18 | 8.38 | 26.62 | 9.61 |
| Credible | 16.28 | 3.97 | 15.73 | 4.79 |
| Human-like | 10.43 | 4.19 | 10.57 | 4.57 |
| Engaging | 11.15 | 4.46 | 11.03 | 4.37 |

*Note*. Maximum possible scores: Facilitated Learning: 50; Credible: 25; Human-Like: 25; Engaging: 25.

Initial analyses indicated that all assumptions for MANOVA were met (Box's $M$ = 15.58, $p > .05$; Levene's tests $p > .05$). The analysis revealed no significant differences between groups (Wilks' $\lambda = .98$, $F(4, 72) = .34$, $p > .05$). In other words, the gender of the pedagogical agent did not have a significant impact on how it was perceived by the learners.

The results do not align with the literature surrounding how students' stereotype those providing instruction. For example, since men may be stereotyped as being authoritative teachers (Madrid & Hughes, 2010), then it is plausible that male agents would receive higher ratings of credibility. Further, since women may be seen as being more supportive teachers (Madrid & Hughes, 2010), one may expect them to receive higher ratings on the facilitated learning scale. Kim, Baylor, and Shen (2007) found that male pedagogical agents were found to be more interesting than female agents, and they were also perceived more positively. Yet, our findings show no significant differences between how agents of different genders were perceived in a LASP environment. Could this be due to the fact that the agents appeared as peers rather than instructors?

As mentioned previously, Veletsianos (2010) found that agents were stereotyped differently depending upon the domain of the learning materials. In this case, humanities materials in relation to learning theory were used. We question if stereotypes would have been reflected in the outcome measures if the materials fell within the domains of science or mathematics. Future research can explore this question.

Our findings also have implications for social agency theory. Based on the literature around gender stereotypes, some may posit that agent gender may influence students' perception of social cues. Yet, in a LASP environment with contextually-relevant peer pedagogical agents this was not the case. In other words, either gender of pedagogical agent was able to provide the same level of social cues in their multimedia message to the learner in this study.

**Limitations**

As with any research study, this one is not without its own set of limitations. The most prominent limitation of the study was the voice that provided the narration in both conditions. The voice was created using a text-to-speech generator provided by the Xtranormal program. Unfortunately, the voice was computer-generated, and we could not control the speed of the voice or its inflection. In fact, a few participants stated that the voice was distracting, even though they were not prompted to provide their opinion on the subject. We question if the results of this study would have been the same if recorded, human voices of standard accent had been used rather than using the text-to-speech feature. Future research may explore this.

Veletsianos (2010) noted that a pedagogical agent's appearance could influence how the agent is perceived. As such, another limitation of this study was the pedagogical agents' appearance. The agents that were chosen wore gender-specific clothing. However, the male agent was dressed more formally than the female agent. Could these differences in the formality of clothing have caused stereotypes to occur, or rather, not to occur? The results of our study reify Veletsianos's (2010) call for research surrounding the appearance of pedagogical agents and its effect on cognitive and affective outcomes.

In this study we were not interested in how male and female students stereotyped agents of the same or opposite gender specifically. While the similarity-attraction hypothesis suggests this may be a relevant factor to consider (Moreno & Flowerday, 2006), Moreno and Flowerday's (2006) results did not support this claim. Future research can investigate if an individual's gender influences their perception of the agent. In addition, our measurement techniques

were similar to those of other pedagogical agent researchers who investigated gender stereotypes (Kim, Baylor, & Shen, 2007; Veletsianos, 2010). However, the instruments did not directly measure stereotypic views, but rather tried to infer them from perceptive and learning measures. While we chose our methodology to be consistent with literature in the area, future research should utilize stereotype specific measurement techniques using instruments with validity evidence to support their use.

## Conclusion

The results show that male and female peer pedagogical agents were not perceived differently by the learners, and that neither was able to more effectively facilitate learning outcomes. One must then question why, if agents are engaged as conversational partners (Louwerse et al., 2008), did gender stereotypes not affect learning or perceptions in a LASP learning environment? We hypothesize that the nature of the LASP system itself may be the cause. Learner-paced systems have built in pauses where the learner must hit a button to continue, while LASP environments do not have these features. Could these mandatory pauses in the learning material allow the learners time to apply these stereotypes in learner-paced environments? In other words, it is plausible that in a LASP environment an engaged learner will utilize the full extent of their working memory to learn the information being presented throughout the duration of the instructional time. This is due to the information being presented as one contiguous flow of information, unless paused by the learner. Alternatively, learner-paced environments force the learner to pause at pre-determined intervals. During these intervals, it is likely that the learner may reflect upon the information that was just presented, thereby allowing additional working memory capacity to shift towards unconscious thought processes such as gender stereotypes. However, at this point there is no empirical evidence to support this notion. Future research can explore if the pacing of the environment and the application of gender stereotypes are related. In addition, future research should examine what learners actually do when presented with a LASP environment. Do they pause the video? Do they rewind the video? If they do pause the video, how long are the pauses, how do the frequency and duration of the pauses correlate to learning outcomes, and how do they impact working memory capacity and stereotype activation?

Another plausible explanation of why we did not see a stereotype effect comes from examining the data for the affective results (Table 2). Examination of the data indicates that the average rating for the learner's engagement with the agent was less than 50% of the possible score. Could this lack of engagement with the agent have caused the lack of gender stereotypes? To what extent did the agent's voice effect the learner's engagement? Replication of this study using recorded human-voices would be beneficial to examine this limitation.

In sum, this study has shown that pedagogical agent research is still in its infancy with many relevant questions to be addressed. The cognitive and affective responses to the pacing of the system, the agent's appearance, the role of the agent in the learning environment, and the agent's ability to interact with the learner are just a few areas of research which are yet to be thoroughly explored. We encourage researchers to continue to explore the varied uses of pedagogical agents in an effort to better understand the best practices and implementations of pedagogical agents. However, we echo Clark and Choi's (2005) call for research that examines the cost-effectiveness of the technology, and encourage researchers to pursue agent technologies that are easily accessible to many instructors.

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