

# The Role of Gender and Ethnicity in Pedagogical Agent Perception

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**Abstract:** To investigate the role of pedagogical agent gender and ethnicity, 139 students were randomly assigned to one of four conditions, where agents differed by ethnicity (African-American, Caucasian) and gender (male, female). Results indicated a main effect for agent gender, in which male agents were perceived as more extraverted and agreeable than the female agents. Further, with respect to learning and motivation, students working with the male agents were more satisfied with their performance and reported that the agents better facilitated self-regulation. An interaction effect between student ethnicity and agent ethnicity revealed that students working with agents of the same ethnicity perceived the agents to be significantly more engaging and affable. Another significant interaction of student gender and agent ethnicity revealed that female students perceived the African-American agents to be more open to new things than the Caucasian agents, whereas the opposite was the case for the female students.

## Introduction

Pedagogical agents are animated life-like characters designed to facilitate learning in computer-mediated learning environments (Johnson, Rickel, & Lester, 2000). Researchers have designed human-like interfaces to promote social interaction between human and computer (Koda & Maes, 1996). They found that the users perceived computing as more engaging and interactive with a human face as part of the interface. Pedagogical agents facilitate learning through social interaction between the learner and agent because an individual's intellectual and cognitive development is molded in the social and cultural contexts (Lave & Wenger, 2001). Yet, while gender and cultural differences have manifested in various aspects of academic activities, the role of these factors with interactive learning technologies such as pedagogical agents has not been sufficiently examined.

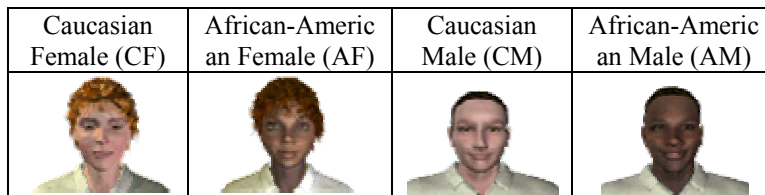
Pedagogical agents have the potential to address gender and cultural differences. In human social modeling research, attribute similarity, such as age, gender, and ethnicity, is a critical factor for students' learning and self-efficacy beliefs (Bandura, 1997). When learners worked with everyday associates (as role models) who shared similar attributes, the learners attained higher self-efficacy beliefs. Similarly, a pedagogical agent can be designed to be an effective social model by rendering it the same attributes as the learner. Learners with a pedagogical agent who share the same gender or ethnicity may better engage in interaction with the agent and enhance learning and motivation, accordingly. This study aimed at investigating the role of the gender and ethnicity of pedagogical agents to ascertain their impact across diverse learners.

The purpose of the study was to examine the relationship between students' and pedagogical agents' gender and ethnicity on student perceptions of pedagogical agents, facilitation of learning, and motivation. First, four pedagogical agents were created with identical voice, animation, and scripts, differing only by image in terms of ethnicity (African-American, Caucasian) and gender (male, female). Second, the agents were validated as representing the intended population in terms of gender and ethnicity. Third, an experiment was conducted to examine the impact of agents' gender and ethnicity while considering the students' gender and ethnicity.

## Agent Development

### Design

Four agent images were designed by a graphic artist based on the same basic face, but differing by gender and ethnicity. The animated agents were then developed using a 3D character design tool, Poser 5, and Microsoft Agent Character Builder. Next, the agents were incorporated into the web-based research application, MIMIC (Multiple Intelligent Mentors Instructing Collaboratively) (Baylor, 2002). To control confounding effects, we used consistent parameters and matrices to delineate facial expression, mouth movement, and overall silhouettes across the agents. Also, except for image, the agents were consistent with script, voice, animation, and emotion. For voice, we used computer-generated male and female voices. For animation, blinking and mouth movements were included. Emotion was expressed using the scripts together with facial expression, such as smiling. Figure 1 presents the images of the four agents used in the study.



**Figure 1:** Images of four agents

### Validation

We initially validated that each agent was effectively representing the intended gender and ethnicity with 83 undergraduates in a between-subjects design. The results indicated successful instantiations of the four agents which simulated each intended population respectively. Female agents ( $M=3.0$ ,  $SD=1.1$ ) were perceived as significantly more feminine than male agents ( $M=1.71$ ,  $SD=.71$ ). Male agents ( $M=4.02$ ,  $SD=0.82$ ) were perceived as significantly more masculine than female agents ( $M=1.57$ ,  $SD=1.64$ ). Caucasian agents ( $M=3.1$ ,  $SD=1.1$ ) were perceived as significantly more Caucasian than African-American agents ( $M=1.84$ ,  $SD=1.81$ ). African-American agents ( $M=4.12$ ,  $SD=1.16$ ) were perceived as significantly more African-American than Caucasian agents ( $M=2.451$ ,  $SD=1.19$ ).

## Method

### Dependent Measure and Analysis

The six dependent variables included agent persona, agent personality, affability, satisfaction, self-regulation, and learning. Agent persona was measured by Agent Persona Instrument (Baylor & Ryu, 2003), which includes 4 sub-measures: Facilitating learning (10 items), Credible (5 items), Human-like (5 items), and Engaging (5 items). Agent personality were measured according to the Big Five Personality Traits (McCrae & John, 1992), including Open to new things, Conscientious, Extraverted, Agreeable, and Neurotic. Agent affability was measured by three items (nice, attractive, and personally warm). Satisfaction was measured by a question asking how much the students were satisfied with their performance. For self-regulation, the students rated their reflective and self-monitoring behaviors on two items. The scale of the measures and sub-measures ranged on a Likert scale from 1 (Not at all) to 5 (Highly agree). Learning was measured by open-ended recall and transfer posttests.

The study used a four-factorial design: 2 (student gender)  $\times$  2 (student ethnicity)  $\times$  2 (agent gender)  $\times$  2 (agent ethnicity) to examine the effects on agent persona, agent personality, affability, satisfaction, and self-regulation. ANOVA was conducted to analyze each sub-measure of agent persona and agent personality, affability, satisfaction, and self-regulation, respectively. For learning, a 2 (agent gender)  $\times$  2 (agent ethnicity) factorial design was used. Recall and transfer data were analyzed by MANOVA. Alpha was set as .05.

### Participants

Participants included 139 pre-service teachers enrolled in an introductory educational technology class in two large southeast universities in the United States. 27.3% of the participants were male and 72.7% were female; 59.7% of the participants were Caucasian and 40.3% were African-American. The average age of the participants was 20.43 ( $SD=2.95$ ).

## Procedure

The experiment was conducted during a regular session of an introductory educational technology course. The participants were randomly assigned to one of the four agent conditions (CF, AF, CM, and AM). They logged onto the MIMIC (Multiple Intelligent Mentors Instructing Collaboratively) web-based application, which was designed to help the students develop instructional plans. The participants were given as much time as they needed to finish each phase of the tasks. The entire session took about an hour with individual variations.

## Result

### Agent Persona

There was a marginally significant interaction effect for student ethnicity and student gender on Facilitating learning,  $F [1, 123] = 3.04, p = .08$ . Among the Caucasian students, the female students ( $M = 3.35, SD = .73$ ) perceived the agents as significantly more Facilitating their learning than the male students ( $M = 2.89, SD = 1.03$ ). Among the African-American students, the male students ( $M = 3.41, SD = .92$ ) perceived the agents as more Facilitating learning than the female students ( $M = 3.30, SD = .78$ ).

There was a similar, marginally significant interaction effect for student ethnicity and student gender on agent Credibility,  $F [1, 123] = 3.24, p = .07$ . Among the Caucasian students, the female students ( $M = 3.71, SD = .73$ ) perceived the agents as more Credible than the male students ( $M = 3.2, SD = 1.08$ ), whereas among the African-American students, the male students ( $M = 3.8, SD = .68$ ) perceived the agents as more Credible than the female students ( $M = 3.48, SD = .95$ ). Also there was a marginally significant interaction effect for student gender and agent ethnicity on Credible,  $F [1, 123] = 2.79, p = .09$ . The male students perceived the Caucasian agents ( $M = 3.73, SD = .63$ ) as more Credible than the African-American agents ( $M = 3.12, SD = 1.18$ ). The females students perceived the African-American agents ( $M = 3.82, SD = .82$ ) as more Credible than the Caucasian agents ( $M = 3.55, SD = .67$ ).

There was a significant interaction effect for student ethnicity and agent ethnicity on Engaging,  $F [1, 123] = 3.79, p < .05$ . The Caucasian students perceived the Caucasian agents ( $M = 3.25, SD = .70$ ) as more Engaging than the African-American agents ( $M = 2.98, SD = .89$ ), whereas the African-American students perceived the African-American agents ( $M = 3.8, SD = .68$ ) as more Engaging than the Caucasian agents ( $M = 3.48, SD = .95$ ).

### Agent Personality

There was a significant main effect for student gender on Open to new things,  $F [1, 123] = 7.24, p < .01$ . The female students ( $M = 2.83, SD = .92$ ) significantly perceived the agents as more Open to new things than the male students ( $M = 2.37, SD = 1.10$ ). There was also a significant main effect for agent ethnicity,  $F [1, 123] = 4.96, p < .05$ . The Caucasian agents ( $M = 2.75, SD = .84$ ) were significantly perceived as more Open to new things than the African-American agents ( $M = 2.66, SD = 1.12$ ). There was a significant interaction effect for student gender and agent ethnicity,  $F [1, 123] = 6.90, p < .01$ . The male students perceived the Caucasian agents ( $M = 2.74, SD = .99$ ) as more Open to new things than the African-American agents ( $M = 2.00, SD = 1.11$ ), whereas the female students perceived the African-American agents ( $M = 2.90, SD = 1.03$ ) as more Open to new things than the Caucasian agents ( $M = 2.75, SD = .79$ ).

There was a significant main effect for agent gender on Extraverted,  $F [1, 123] = 6.90, p < .01$ . The students perceived the male agents ( $M = 3.22, SD = .88$ ) as more Extraverted than the female agents ( $M = 2.86, SD = 1.09$ ).

There was a marginally significant main effect for agent gender on Agreeable,  $F [1, 123] = 2.81, p = .09$ . The students perceived the male agents ( $M = 3.38, SD = .81$ ) as more Agreeable than the female agents ( $M = 3.11, SD = 1.0$ ).

There was a significant interaction effect for student ethnicity and agent gender on Neurotic,  $F [1, 123] = 4.41, p < .05$ . The Caucasian students perceived the female agents ( $M = 2.13, SD = .97$ ) as more Neurotic than the male agents ( $M = 1.84, SD = .89$ ), whereas the African-American students perceived the male agents ( $M = 2.32, SD = 1.15$ ) as more Neurotic than the female agents ( $M = 1.87, SD = .86$ ).

### Affability

There was a marginally significant main effect for student ethnicity,  $F [1, 123] = 3.17, p = .07$ . The African-American students ( $M = 2.98, SD = .71$ ) perceived the agents as more affable than the Caucasian students ( $M = 2.76, SD = .78$ ). Also, there was a significant interaction effect for student ethnicity and agent ethnicity,  $F [1, 123] = 5.94, p < .05$ . The Caucasian students significantly perceived the Caucasian agents ( $M = 2.77, SD = .61$ ) as more affable than the African-American agents ( $M = 2.74, SD = .90$ ), whereas the African-American students significantly perceived the African-American agents ( $M = 3.15, SD = .75$ ) as more affable than the Caucasian agents ( $M = 2.84,$

SD=.67).

### **Satisfaction**

There was a significant main effect for agent gender,  $F [1, 123] = 3.84, p < .05$ . The students working with the male agents ( $M=3.72, SD=0.96$ ) were significantly more satisfied with their performance than the students working with the female agents ( $M=3.37, SD=0.98$ ).

### **Self-regulation**

There was a significant main effect for agent gender,  $F [1, 123] = 4.88, p < .05$ . The students working with the male agents ( $M=3.83, SD=0.82$ ) reported engaging in more self-regulation than the students with the female agents ( $M=3.53, SD=0.85$ ).

### **Learning**

There were no significant main and interaction effects for agent gender and ethnicity on learning.

## **Discussion**

Results indicated interesting interrelationships between students' and agents' ethnicity and gender. Students working with agents of the same ethnicity perceived the agents to be significantly more engaging and affable. The male agents' personalities were perceived as more extraverted and agreeable than the female agents, suggesting that students applied human stereotypes to the pedagogical agents. Perhaps the most significant findings in terms of learning and motivation were that male agents impacted learner satisfaction and self regulation more positively than the female agents. These latter results suggest that male agents may lead to more favorable learning-related results for learning, although further research is necessary to substantiate this conclusion.

The significant interactions with respect to personality-related factors also revealed the importance of both the students' and agents' gender and ethnicity. Male students perceived the Caucasian agents to be more open to new things than the African-American agents, whereas the opposite was the case for the female students. A similar trend (marginally significant) was found with respect to agent credibility. The interaction of student ethnicity and agent gender showed that African-American students found the male agents to be more neurotic than the female agents, whereas the opposite was the case for the Caucasian students.

Although marginally significant, it is of interest that Caucasian females and African-American males tended to respond more positively to the agents in general (e.g., Facilitating learning and Credible). Overall, the results show that the design of pedagogical agents' gender and ethnicity influences learner perception of agent personality, motivational qualities, and perceived influence on the learning process. Further research is necessary to replicate these findings with different agent images.

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