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Embracing AI-Based Education: Perceived Social Presence of Human Teachers and Expectations About Machine Teachers in Online Education

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Abstract

Technological advancements in education have turned the idea of machines as teachers into a reality. To better understand this phenomenon, the present study explores how college students develop expectations (or anticipations) about a machine teacher, particularly an AI teaching assistant. Specifically, the study examines whether students' previous experiences with online courses taught by a human teacher would influence their expectations about AI teaching assistants in future online courses. An online survey was conducted to collect data from college students in the United States. Findings indicate that positively experienced social presence of a human teacher helps develop positive expectations about an AI teaching assistant. The study provides meaningful implications and contributions to our understanding of a machine agent in education.

Keywords: artificial intelligence; AI instructor; machine teacher; online education; social presence

While the past decades benefitted from the use of technology as a tool that allows for the creation of an online learning environment and enhances learning outcomes in a traditional classroom (e.g., Al Ghamdi et al., 2016; Kaufmann et al., 2016; Limperos et al., 2015),

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educators have recently started to use technology as an agent in the classroom. For example, Jill Watson, the world's first artificial intelligence (AI) teaching assistant, which was built based on IBM's Watson platform, was introduced to help students in an online learning environment. This AI teaching assistant helps students by answering questions in a course management website. The advent of Jill Watson signals that this new era of education is starting to incorporate machine teachers in education. The current status of technology-based education is already in the process of transforming to a new level (J. Kim, 2021).

Acknowledging the importance of technology in education, research has explored the idea of machine teachers in higher education. For example, A. Edwards and Edwards (2017) highlighted the importance of machines, such as robots, in effective learning. Further, J. Kim et al. (2020, 2021) examined college students' perceptions about an AI teaching assistant and AI instructor in online education. These studies provide preliminary but foundational understanding about the new era of education. However, there exists much more to explore in this realm.

Given the current trend of technology use in education, it is possible that universities may implement AI-based education at various levels in the coming future. One of the key differences between traditional online education and AI-based online education is the nature of the teacher, human versus machine. Then, the question is whether students' previous experiences with a human teacher in an online learning environment would translate into students' expectations (or anticipations) about a machine teacher, which could eventually affect their perceptions and adoption of an AI-based online education.

To address the above-mentioned question, we focus on one particular aspect, social presence. Social presence was selected because of its importance in creating positive online learning experiences (e.g., J. Kim et al., 2016; Song, Kim, & Park, 2019). Students can feel socially connected to their teacher (J. Kim et al., 2016; Song, Kim, & Park, 2019), and this highlights that students develop social perceptions of their teacher based on available cues regardless of whether they meet with the instructor in a physical classroom or not. In this regard, the study examines whether previously experienced social presence of a human teacher helps students develop certain expectations about a machine teacher, who students would not meet in a face-to-face context but would serve in a similar role as a human teacher. Specifically, the study focuses on an AI teaching assistant, which typically assists a primary instructor, such as answering questions from students about the course and the assignments on the course management website. The following section begins with a review of literature, followed by a method, results, and a discussion of the findings, implications, and contributions of the study.

Social Presence in Online Education

Given that social presence is an important experience in a mediated environment (Biocca et al., 2003), the notion has been understood and described from various perspectives and approaches (e.g., Biocca et al., 2003; Lee, 2004; Lombard & Ditton, 1997). Of them, Lee (2004) conceptualizes *social presence* as "a psychological state in which virtual social actors are experienced as actual social actors in either sensory or non-sensory ways" (p. 37). In other words, social presence is concerned with one's experiences with other humans or artificial social actors that manifest humanness connected by technology (Lee, 2004).

The extant body of research documents that social presence can be understood through various dimensions, such as psychological involvement and copresence (e.g., Biocca et al., 2003; Kelly & Westerman, 2016). *Psychological involvement* refers to a feeling of "psychologically" sensing another entity, and it is originated from the initial social presence research by Short et al. (1976). This aspect of social presence is about the connection with another agent in a mediated environment and/or the mutual awareness of another agent. *Copresence* refers to the perception of being "physically" with another entity in the same place (Biocca et al., 2003). In this regard, technology users may forget they are in a mediated context and feel as if their mediated experience was in a shared, physical space. In other words, people feel like they are with another social entity in the same space although they are physically apart from each other.

These two aspects are both conceptually related but distinct (J. Kim et al., 2016; Westerman et al., 2018). To clarify, although feeling physically present might be assumed as part of being psychologically present, it does not mean they always occur simultaneously. A person may experience a strong psychological sense of social richness, but it does not guarantee or indicate that they feel the sense of physically being together in the same space. However, when people feel each other's social nature, although they are aware of the physical distance from each other, they may experience the feeling of being together, although this feeling may only be momentary.

In an online learning environment, social presence plays a critical role in fostering positive learning experiences. A significant body of research documents that social presence positively influences student learning experiences, such as class participation and motivation to learn (Mazzolini & Maddison, 2007), course and instructor satisfaction (Akyol & Garrison, 2008; Strong et al., 2012), and learning outcomes (Hostetter, 2013; Joksimović et al., 2015; Kang & Im, 2013; J. Kim et al., 2016). Overall, these findings are well demonstrated in a meta-analysis that social presence is positively related to students' satisfaction with online learning experiences and perceived learning outcomes (Richardson et al., 2017).

In all, the fact that students experience social presence of their teachers in online courses, even though their teachers are not physically present, implies that students still develop perceptions about their teachers based on available cues online. During this experience, students may realize that they can still engage in meaningful learning in an online environment without a face-to-face interaction. In this regard, the present study questions whether this positively experienced social presence of a human teacher would translate into developing certain expectations or anticipations about a teacher that is a machine who serves a similar role as a human teacher.

Developing Expectations About Machine Teachers

Machine Teacher

The extant research indicates that a *machine teacher* is "a technology that plays a meaningful role during an interaction with humans in helping them engage in affective, cognitive, and behavioral learning through various ways" (J. Kim et al., 2020, p. 1904). Machine teachers can appear in diverse forms (J. Kim et al., 2020). For example, social robots (e.g., Pepper, NAO) and telepresence robots can be effectively used in a face-to-face pedagogical context.

Virtual agents (e.g., chatbots, software agents) can engage in interactions through text or voice in an online learning environment.

Although the idea of machine teachers is relatively new, scholars note a significant potential of machine teachers in an online learning environment for higher education. J. Kim et al. (2020) explored how undergraduate students perceive an AI teaching assistant in online education. They found that perceived usefulness of and perceived ease of communicating with an AI teaching assistant predict positive attitudes toward an AI teaching assistant. Then, the positive attitudes eventually predict intentions to take an AI teaching assistant-based online course. J. Kim et al. (2021) further examined the role of communication styles of an AI instructor in online education and found that undergraduate students experience more positive perceptions (e.g., attitudes) about a relational AI instructor than a functional, task-oriented AI instructor. Importantly, J. Kim et al. (2021) highlight the important role of social presence. That is, a relational AI instructor fosters stronger social presence of the AI instructor than a functional AI instructor; then, heightened social presence of the AI instructor facilitates positive perceptions about the AI instructor. Students' intentions to take an AI-based education depends on the availability of such courses, which should be first adopted by universities. Considering the potential of such availability in the future, J. Kim et al.'s (2020, 2021) findings suggest that developing positive perceptions about a machine agent is a key for the successful adoption of an AI-based education.

Human Responses to Machines

There is a growing interest in the understanding of how humans respond to various forms of technology. Currently, there are a few perspectives that suggest humans treat technology in a similar way as they treat a human. In particular, the computers are social actors (CASA) paradigm states that people mindlessly apply social scripts to interactions with computers, and it is due to people focusing on social cues and failing to focus on asocial characteristics (Nass & Moon, 2000). In doing so, these individuals interact with computers in a similar manner to how they interact with other people. Over the years, the CASA paradigm has been examined in diverse technologies, such as robots (Fischer, 2011), chatbots (C. Edwards et al., 2014), exergames (J. Kim & Timmerman, 2018), and AI (C. Edwards et al., 2019). Generally, findings indicate that humans are mindlessly responding to technologies as they would in their interpersonal interactions with other humans. As newer and more technologies develop, Gambino et al. (2020) proposed an extension of the CASA paradigm. The extension of the CASA paradigm suggests that humans may develop and apply human-media social scripts when interacting with machines, rather than mindlessly applying human-human social scripts.

In another line of research, Spence et al. (2014) suggested the idea of "human-to-human interaction script" (p. 277). The core of the human-to-human interaction script is concerned with differences in humans' expectations when interacting with another human or a machine, with a preference for a human. Supporting the aforementioned argument, a series of empirical studies (e.g., C. Edwards et al., 2016; Spence et al., 2014) documents that people experience less uncertainty and stronger social presence when they anticipate interacting with another human compared to when anticipating an interaction with a robot. Noticeably, after an actual interaction with a robot, people experience less uncertainty and

greater social presence about the robot, compared to an initial expectation that was formed prior to the actual interaction (A. Edwards et al., 2019).

Overall, CASA (Reeves & Nass, 1996), an extension of CASA (Gambino et al., 2020), and the human-to-human interaction script (Spence et al., 2014) help us understand how humans perceive machine agents. Although not explicitly discussed, these perspectives may be a foundation for the idea that previous experiences with a human may contribute to developing certain expectations about a machine or interactions with a machine in a situation where both the human and the machine serve the same or similar roles in the same or similar context. However, there is lack of evidence in the extant literature that supports this conjecture.

Thus, this study investigates the above-mentioned inquiry in the context of machine teachers in online education. Of multiple roles that machine teachers can serve (e.g., primary instructor, teaching assistant), we focus on an AI teaching assistant. Specifically, we examine whether positively experienced social presence of a human teacher contribute to developing positive attitudes toward an AI teaching assistant. Then, we further examine whether the positive attitudes toward an AI teaching assistant would eventually influence intentions to take an AI teaching assistant-based online course when it becomes available.

> **H1a–b:** Social presence, particularly (a) social presence as psychological involvement and (b) social presence as copresence, of human teachers experienced in online courses influences the way students develop attitudes toward an AI teaching assistant in online courses.

> **H2:** Attitudes toward an AI teaching assistant predict intentions to take an AI teaching assistant-based online course.

Methods

Participants

For this study, undergraduate students from communication classes at a large public university in the US were recruited. In order to identify eligible participants and to ensure the quality of the data, a few steps were taken. First, we removed responses recorded from any attempt beyond one's first-time participation. Second, we removed responses from participants who failed an attention check, which occurred in the middle of the survey.

After completing the screening steps, the final sample consisted of 294 undergraduate students who have online course experiences. The sample included more females (n = 188: 63.9%) than males (n = 106: 36.1%). The average age of participants was 21.55 years (SD = 4.29). The sample consisted of White/Caucasian (n = 153: 52%), Latino/a/x or Hispanic (n = 67: 22.8%), Black/African American (n = 49: 16.7%), and other ethnic groups (n = 25: 8.5%).

Procedure

Data were collected using an online survey tool. Upon the university's IRB approval, a recruitment message was distributed to potential participants. Upon clicking on the survey

link, participants were asked to read the informed consent. Then they proceeded to the main page of the survey.

The survey consisted of three major sections. The first section included participants' preexisting attitudes toward new technologies and previous experiences with online courses. Specifically, participants were asked to identify one online course they most recently completed and provide the name of the course. This was necessary to help them think about their recent online experience. Then they were asked to answer questions based on their experiences of the particular course that they indicated.

The next section included the study material. In this section, participants were asked to read a short story about an AI teaching assistant. The article primarily explained the tasks that the AI teaching assistant performed in an online learning management site, such as responding to students' questions about the course and assignments. The article was written in a way that does not lead readers to create certain perceptions or expectations about an AI teaching assistant (see Appendix A). To ensure that participants read the article before proceeding to the next page, a timer was set to prevent them from skipping the task.

The last section focused on assessing participants' responses about the article they read. In particular, this section assessed how students perceived the AI teaching assistant. At the end of the survey, demographic questions were asked. All participants received extra credit and confidentiality was guaranteed.

Measures

At the start of the survey, participants' perceptions about social presence of a teacher and preexisting attitudes toward new technologies were assessed. *Social presence as psychological involvement* (α = .92) was evaluated with eight items (e.g., When I was taking the online class, I felt like my teacher was . . . "remote—immediate," "unsociable—sociable," and "impersonal—personal"). Items were adopted from the extant literature (Lombard et al., 2009; Short et al., 1976) and slightly modified for the study context. Specifically, the phrase, "when I was taking the online class, I felt like my teacher was . . ." was added to provide participants with the study's context for their responses. Responses were obtained on a 7-point semantic differential scale.

Social presence as copresence (α = .95) was assessed with four items (e.g., When I was taking that online class . . . "I felt like my teacher was with me" and "I felt like my teacher was interacting with me in the same space"). Items were adopted from Lee et al. (2006) and slightly modified for the study context. The original items were focused on an interaction with a social robot, AIBO. To make the items fit in the study context, interaction with AIBO-related phrases were replaced with taking an online class/perceptions about a teacher. Responses were recorded on a 7-point scale (1 = *Strongly Disagree*, 7 = *Strongly Agree*).

Preexisting attitudes toward new technologies (α = .89) were evaluated with three items (e.g., "How comfortable would you be with new technologies—e.g., robots, AI—taking interpretive roles (e.g., editorial writers, newspaper reporters, novelists)" and " . . . taking personal roles (e.g., colleagues, bosses)"). Items were adopted from Nass and colleagues (1995). Responses were obtained on a 6-point scale (1 = *Very uncomfortable*, 6 = *Very comfortable*).

After learning about an AI teaching assistant described in the study material (see Appendix A), participants' responses were evaluated. *Attitudes toward an AI teaching assistant* (α = .95) was assessed with adjectives on a 7-point semantic differential scale. The measure was adopted from Davis (1993). *Intentions to take an AI teaching assistant-based course* (α = .95) was assessed with three items (e.g., "If an AI teaching assistant-based online class is available, I intend to take the class," " . . . I would consider taking the class"). The measure was slightly modified from the extant research, which focused on the adoption of autonomous vehicles (Choi & Ji, 2015) to fit with the present study's context, the adoption of an AI teaching assistant-based course. Responses were recorded on a 7-point Likert-type scale (1 = *Strongly Disagree*, 7 = *Strongly Agree*).

Results

First, correlations between all tested study variables were assessed (see Table 1). Then, we conducted a path analysis, which is a particular type of structural equation modeling, to test the proposed hypotheses. A path analysis was used because it has the advantages of evaluating and presenting the comparative strengths of different relationships in the model[1] (Lleras, 2005). Mplus 7 was used to test the model (Muthén & Muthén, 2015). Maximum likelihood estimation was used when the analyses were conducted. According to Hu and Bentler (1999), a model has good fit when the Chi-square test is non-significant, *CFI* > .95, *RMSEA* < .06, and *SRMR* < .08. Based on the guidelines of Kline (2005) and Schreiber et al. (2006), after controlling for participants' age, sex, and preexisting attitudes toward new technologies, the result indicated that the model has a reasonable goodness of fit for the data, *AIC* = 1819.93, *BIC* = 1867.77, X^2 (2, *N* = 293) = 6.92, *p* = .03, *CFI* = .98, *TLI* = .91,

TABLE 1 Zero-Order Correlations Among Study Variables

	1	2	3	4	5	6
1. Age	–					
2. Attitudes toward new technologies	–.12*	–				
3. Social presence as psychological involvement	.10	–.07	–			
4. Social presence as copresence	.08	.10	.65**	–		
5. Attitudes toward an AI teaching assistant	–.13*	.27**	.18**	.09	–	
6. Intentions to take an AI teaching assistant-based course	–.09	.26**	.15*	.16**	.77**	–
M	21.55	3.01	4.97	4.08	4.42	4.24
SD	4.29	1.38	1.20	1.63	1.43	1.50

*$p < .05$, **$p < .01$

1. Measurement models were not used in this study because the scales used in this study were already established and reliable in the previous studies. Thus, variables were treated as manifest variables in the model.

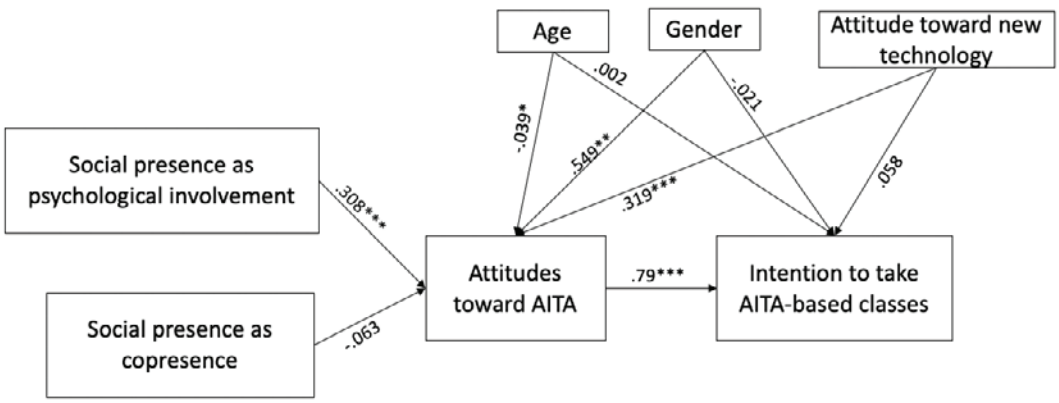
RMSEA = .09, *SRMR* = .01. Although the Chi-square test was significant and RMSEA was larger than .06, the model fit can still be considered acceptable for the following reasons: (a) the Chi-square test is sensitive to the sample size, (b) the value of RMSEA that is smaller than .10 can still be considered as a mediocre fit (Hooper et al., 2008; MacCallum et al., 1996), and (c) a set of fit indices determine the goodness of fit as a whole (Kline, 2005).

H1a–b predicted that social presence of a human teacher experienced in an online course, particularly social presence as psychological involvement (H1a) and social presence as copresence (H1b), would influence the way that students develop attitudes toward an AI teaching assistant in an online course. Regarding H1a, social presence as psychological involvement significantly and positively predicted attitudes toward an AI teaching assistant, $B = .31$, $SE = .04$, $p < .001$. With regard to H1b, social presence as copresence did not significantly predict attitudes toward an AI teaching assistant, $B = -.06$, $SE = .06$, $p = .32$. H1a was supported, but H1b was not.

Next, H2 proposed that attitudes toward an AI teaching assistant would predict intentions to take an AI teaching assistant-based online course. As predicted, there was a statistically significant and positive association between the two variables, $B = .79$, $SE = .04$, $p < .001$. H2 was supported. See Figure 1.

After the primary hypotheses testing, we conducted an additional analysis to understand which type of social presence students felt more strongly in their online learning experiences. Results from a paired *t*-test indicated that students reported stronger psychological involvement ($M = 4.97$, $SD = 1.20$) than copresence ($M = 4.08$, $SD = 1.63$). The difference was statistically significant, $t(293) = 12.25$, $p < .001$.

FIGURE 1 Final Model



Note 1. $X^2(2) = 6.915$; $p = .03$; CFI = .984; RMSEA = .092; SRMR = .014
Note 2. * $p < .05$, ** $p < .01$, *** $p < .001$
Note 3. AITA refers to AI teaching assistant

Discussion

We examined whether positively experienced social presence of a human teacher in an online course would influence the way that students develop certain expectations about a machine teacher, specifically an AI teaching assistant. Overall, findings indicate that social presence of a human teacher plays an important role in developing positive attitudes toward an AI teaching assistant, which consequently leads to intentions to adopt an AI teaching assistant-based online education when it becomes available. The following sections discuss implications and contributions of the study's key findings and future research directions based on limitations identified in this investigation.

Primary Findings, Implications, and Contributions

First, we found that positively experienced social presence, particularly social presence as psychological involvement, of a human teacher influence developing positive attitudes toward an AI teaching assistant. From a broad perspective, this finding confirms the extant research that documents an important role of social presence in fostering positive experiences in an online learning context (e.g., J. Kim et al., 2016; Sellnow & Kaufmann, 2018; Song, Kim, & Park, 2019). However, to the best of our knowledge, no research has shown that positively experienced social presence of a human teacher could influence developing positive attitudes about a machine teacher, an encounter that may occur in the future. In this regard, this finding makes a notable contribution to the existing literature.

Although social presence as psychological involvement is found to be significant, we did not find a significant role of social presence as copresence. This suggests that dimensions of social presence may work differently or may serve different roles. In fact, this argument is supported by the research indicating that social presence as psychological involvement and as copresence are related but distinct (J. Kim et al., 2016; Westerman et al., 2018). Another possible explanation is that students may not feel copresence as strongly as they feel psychological involvement in an online class environment, which may have consequently influenced the way copresence could predict attitudes toward an AI teaching assistant. In fact, this tendency appeared in the present study, as students reported stronger social presence as psychological involvement than social presence as copresence.

Although social presence as copresence did not produce a significant role, it is still important to consider it along with psychological involvement. In fact, the existing literature highlights that when diverse dimensions of social presence are considered together, it increases the predictability of learning outcomes in online education (J. Kim et al., 2016). Thus, the pattern found in the study that copresence is weaker compared to psychological involvement signals a need to find ways to facilitate a feeling of shared space. The extant literature reports that perceived similarity of the interaction partner fosters a strong sense of copresence (Song, Kim, & Choi, 2019) and extroverted individuals tend to feel strong copresence (J. Kim et al., 2018). These findings suggest that teachers are encouraged to find a way to create an environment where students perceive some similarity with teachers.

The finding that positively experienced social presence of a human teacher helps develop positive attitudes toward an AI teaching assistant signals a need to find ways to foster social presence of human teachers as the new era of an AI-based online education has started (J. Kim, 2021). Lessons can be drawn from the extant literature. A good deal

of research documents various factors that facilitate social presence of others in an online environment, such as self-disclosure (J. Kim & Song, 2016; J. Kim & Yang, 2019; Song, Kim, & Park, 2019), perceived similarity (Song, Kim, & Choi, 2019), and supportive feedback (J. Kim & Timmerman, 2018). More germane to the study's context, an instructor's self-disclosure is an important way to foster social presence (Song, Kim, & Park, 2019). In preparation for the new era of an AI-based online education, it is important to further investigate how to foster social presence of a human teacher in an online learning environment.

Further, attitudes toward an AI teaching assistant significantly predict one's intentions to take an AI teaching assistant-based course when it becomes available. In fact, the relationship between attitudes of a new technology and intentions to adopt that technology is well supported in various adoption models, such as the Technology Acceptance Model (TAM; Davis, 1989), the Theory of Planned Behavior (TSP; Ajzen, 1991), and the Value-based Adoption Model (VAM; H.-W. Kim et al., 2007). Also, empirical research findings support the relationship between attitudes and intentions (e.g., J. Kim et al., 2020; Sohn & Kwon, 2020). Sohn and Kwan found that attitudes related to AI-based intelligence products significantly predict one's intentions to adopt that AI-based intelligence product. More germane to the current investigation, J. Kim et al. (2020) found that attitudes toward AI teaching assistants predict intentions to adopt an AI teaching assistant-based online education. Thus, the present study's finding reemphasizes the important link between attitudes and intentions when considering the adoption of a new technology.

Overall, the study's findings contribute to new knowledge concerning how humans perceive and develop expectations about machines. The CASA paradigm suggests that humans treat machines in a similar manner to how they treat other humans, and this is often noted as an automatic process where humans assign social conventions to machines (Reeves & Nass, 1996). While CASA's perspective provides foundational understanding of how humans treat machines, it does not directly or explicitly state that experiences with humans can influence developing expectations or perceptions about a machine. In this regard, the study's finding that past experiences with humans can affect expectations about machines in similar roles (e.g., teacher-teacher) is a significant addition to the extant knowledge and suggests venues for future research.

More broadly, the study's finding has meaningful implications for human-machine communication (HMC). Guzman (2018) conceptualizes HMC as the creation of meanings between humans and machines. Research on HMC encompasses the scholarship of human-computer interaction, human-robot interaction, and human-agent interaction. It also investigates the sociocultural and critical aspects of these emerging technologies (Guzman, 2018). One advantage of incorporating machine agents into education is that machines are efficient at presenting pre-scripted messages to learners. Humans can carefully craft and edit educational scripts and utilize machine agents to deliver the messages. Although the idea of machine teachers is new to many educators and educational institutions, the use of machine agents in education has the potential to grow and make meaningful contributions to the study of HMC.

It is not clear yet when a machine teacher or AI-based education will be readily available in higher education. However, in preparation for the coming future, it is important to consider educating and training human teachers for effective use of a machine teacher or teaching assistant in an AI-based education. One should consider training for teachers

or teacher certification programs that teach instructors how to use AI effectively and help them realize the value AI teaching assistants can bring to the teaching and learning experience (C. Edwards et al., 2018).

Limitations and Future Research Directions

Although we report meaningful findings in this investigation, we acknowledge limitations that should be further examined in future research. First, the scope of the study is limited to assessing the intentions to take an AI teaching assistant-based online course, rather than the actual behavior. Although extant theoretical perspectives, such as the TAM (Davis, 1989), indicate a strong relationship between intentions and actual adoption, there may exist a gap between the two variables. When an AI-based education becomes readily available, it is necessary to examine how students' attitudes translate to adoption.

Second, participants in this study learned about AI teaching assistants by reading an article rather than directly interacting with it. It is likely that a direct interaction with an AI teaching assistant could elicit different responses among the participants. When the use of AI teaching assistants become readily available in the education system, future research should investigate whether students would respond differently to an AI teaching assistant after a direct interaction.

Lastly, we did not specify the nature or type of courses (e.g., topic, structure) when assessing students' intentions to take an AI teaching assistant-based online course. A seminar-based versus a lecture-based course may require AI teaching assistants to demonstrate different skills in assisting students in understanding course materials, completing worksheets or activities, or engaging in discussions. Teaching a social science versus a hard science course may also involve different means of course organizations that differ in terms of AI teaching assistants' responsibilities. Therefore, future research could examine whether the current findings can be generalized to all subject areas with various responsibilities of AI teaching assistants in online courses.

Conclusion

The present study examined whether previously experienced social presence of a human teacher in online courses would influence developing certain expectations about a machine teacher. Primary findings indicate that social presence as psychological involvement of a human teacher positively predicts attitudes toward an AI teaching assistant. Then, the attitudes predict intentions to take an AI teaching-based online course when it becomes available. This research is one of the first that demonstrates that prior experiences with a human can potentially influence one's expectations about a machine that performs similarly to the aforementioned human.

Because the adoption of machine teachers is arguably still in its infancy, pervasive use of them in mainstream online education may take years. However, technology-enhanced instruction is only growing and using machine teachers as assistants and perhaps also as primary instructors is likely to be as well. Thus, based on the present study's exploratory findings, future researchers are encouraged to further investigate this important area of research.

Author Biographies

Jihyun Kim is an Associate Professor in the Nicholson School of Communication and Media at the University of Central Florida. Broadly, her research is focused on the effects and implications of new media/communication technologies for meaningful outcomes (e.g., education, health). Her research examines the role of technology not only as a tool but also as a digital agent, which is centered on human-machine communication. She is particularly interested in people's perceptions about AI and social and psychological impacts of AI from communication perspectives. Additionally, her research is primarily driven by the theoretical notion of presence, especially social presence.

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Appendix A

Innovations

What happened when a professor built a chatbot to be his teaching assistant

By Matt McFarland
May 11, 2016

Here's a sample interaction between the chatbot and a student. (Courtesy Ashok Goel)

To help with his class this spring, a Georgia Tech professor hired Jill Watson, a teaching assistant unlike any other in the world. Throughout the semester, she answered questions online for students, relieving the professor's overworked teaching staff.

But, in fact, Jill Watson was an artificial intelligence bot.

Ashok Goel, a computer science professor, did not reveal Watson's true identity to students until after they'd turned in their final exams.

Students were amazed. "I feel like I am part of history because of Jill and this class!" wrote one in the class's online forum. "Just when I wanted to nominate Jill Watson as an outstanding TA in the CIOS survey!" said another.

Now Goel is forming a business to bring the chatbot to the wider world of education. While he doesn't foresee the chatbot replacing teaching assistants or professors, he expects the chatbot's question-answering abilities to be an invaluable asset for massive online open courses, where students often drop out and generally don't receive the chance to engage with a human instructor. With more human-like interaction, Goel expects online learning could become more appealing to students and lead to better educational outcomes.

"To me this is a grand challenge," Goel said. "Education is such a huge priority for the entire human race."

At the start of this semester Goel provided his students with a list of nine teaching assistants, including Jill, the automated question and answering service Goel developed with the help of some of his students and IBM. Goel and his teaching assistants receive more than 10,000 questions a semester from students on the course's online forum. Sometimes the same questions are asked again and again. Last spring he began to wonder if he could automate the burden of answering so many repetitive questions.

As Goel looked for a technology that could help, he settled on IBM Watson, which he had used for several other projects. Watson, an artificial intelligence system, was designed to answer questions, so it seemed like a strong fit.

To train the system to answer questions correctly, Goel fed it forum posts from the class's previous semesters. This gave Jill an extensive background in common questions and how they should be answered.

Goel tested the system privately for months, having his teaching assistants examine whether Jill's answers were correct. Initially the system struggled with similar questions such as "Where can I find assignment two?" and "When is assignment two due?" Goel tweaked the software, adding more layers of decision-making to it. Eventually Jill reached the point where its answers were good enough.

"I cannot create chaos in my classroom. Jill had to be almost perfect as a human TA or I am," Goel said.

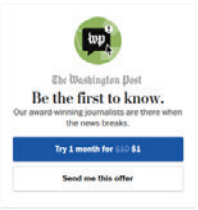
The system is only allowed to answer questions if it calculates that it is 97 percent or more confident in its answer. Goel found that was the threshold at which he could guarantee the system was accurate.

There are many questions Jill can't handle. Those questions were reserved for human teaching assistants.

Goel plans to use Jill again in a class this fall, but will likely change its name so students have the challenge of guessing which teaching assistant isn't human.

"A really fun thing in this class has been once students knew about Jill they were so motivated, so engaged. I've never seen this kind of motivation and engagement," Goel said. "What a beautiful way of teaching artificial intelligence."

27 Comments



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