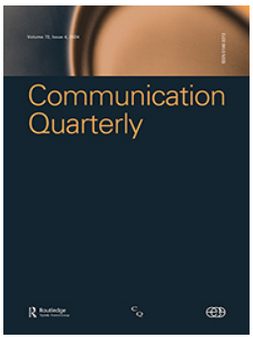

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Understanding the influence of student expectations of instructor immediate behaviors on AI-based education: the moderating role of social presence of AI instructors

Jihyun Kim, Stephanie Kelly, and Kun Xu

ABSTRACT
Amidst the rapid evolution and integration of AI within higher education, there is an urgent need to explore students' perceptions of AI-based learning. Despite the growing scholarly discussion, little attention has been given to whether students' expectations of their instructors influence their views on AI-driven education. To fill this void, this study gathered data from undergraduate students in the U.S. A key finding reveals the crucial role of perceived social presence in AI instructors. Specifically, students with high expectations for instructor nonverbal immediate behaviors demonstrate more positive perceptions of AI-based education when they experience stronger social presence in their AI instructor. These results underscore the importance of social presence and provide initial insights into how student expectations of instructors shape their evaluation of AI-led educational approaches.

KEYWORDS
AI-based education; social presence; expectations of instructors; immediate behaviors; machine teachers

Broadly, *machine teachers* refer to "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" (Kim et al., 2020, p. 1904). One specific form of machine teachers is an artificial intelligence (AI) instructor that can deliver, or supplement the delivery of, classroom content (Kim et al., 2021). The earliest example of a machine teacher is Jill Watson, an AI teaching assistant who instantaneously addressed students' questions on a discussion board at Georgia Tech in 2016 (Georgia Tech, 2017). Given the amount of time and money these entities can save higher education institutions by meeting the needs of students and instructors without increasing staffing, adoption rates of AI instructors are expected to increase (A. Edwards & C. Edwards, 2017; Kim, 2021). However, while AI instructors can be useful to students with their anytime, anywhere availability, little is known about how to optimize their design beyond their ability to convey accurate and relevant information (Kim, 2021).

The term "machine teachers" appeared in the education literature, long before AI instructors were created, to refer to teaching on autopilot, without passion, and striving only for students to memorize rather than understand

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content (Pooley, 1961). In recent days, machine teachers are being designed with a variety of communicative tools as designers work to optimize their utility and customize their assistance to learners, including text-only correspondence, vocal correspondence, and haptic response as is the case of robot machine teachers utilized in labs (c.f., Benedito, 2018; Goel & Polepeddi, 2018; Karapetsas & Stamatis, 2009). As AI instructors become more popular in the classroom as lecturers with an audible voice, juxtaposed against students learning experiences with human instructors, scholars call for research to ensure that literal machine teachers are perceived to be more useful than Pooley's (1961) metaphorical machine teachers (c.f., C. Edwards et al., 2018; Kim, 2021). Thus, this present study takes a step toward addressing the scholarly calls to better understand students' perceptions of AI instructors and ultimately AI-based education.

Instructors' social and relational characters (e.g., self-disclosure) can help foster positive learning experiences (Song et al., 2016, 2019), and for this reason students may have some expectations about their instructors' immediate behaviors. However, when it comes to AI-based education, the nature of the learning environment changes as AI can take a role in communicating with students and providing educational materials as an instructor (c.f., Kim et al., 2020). Then, the question is whether students' preexisting expectations of instructor immediate behaviors would have any impact on the way they perceive AI-based education. In this regard, the present study explores this unknown.

Expectations of instructor immediate behaviors

One of the most frequently studied instructional communication variables is instructor immediate behaviors (Allen et al., 2006; Liu, 2021). Instructor immediate behaviors are any behavior displayed by an instructor that makes students feel physically or psychologically closer to them (Kelly & Westerman, 2016; McCroskey et al., 1995). Immediate behaviors are assessed as frequencies of these behaviors displayed by an instructor (Kelly & Fall, 2011; McCroskey et al., 1995; Violanti et al., 2018). However, instructor immediate behaviors do not directly prompt student reactions (Kelly & Westerman, 2016; Kelly et al., 2015). Rather, students respond to their perceptions of those behaviors, assessed as perceived immediacy, the actual perceptions of physical or psychological closeness that may be influenced by immediate behaviors (Croucher et al., 2021; Kelly & Westerman, 2016; Vareberg & Westerman, 2020; Weidlich et al., 2024).

Instructor nonverbal immediate behaviors typically include smiling, using vocal variety, making eye contact with students, and having a relaxed posture (McCroskey et al., 1995). Instructor verbal immediate behaviors usually involve addressing students by name, using humor, praising students for

their contributions, and inviting out-of-class communication (Gorham, 1988; Violanti et al., 2018). Instructor computer-mediated immediate behaviors entail text-based communicative behaviors such as responding promptly to messages, using friendly language in written messages, addressing students by name in e-mail or other written electronic messages (Gaytan et al., 2023; Kelly & Fall, 2011), and using emojis (Vareberg & Westerman, 2020, 2023). Each of these types of behaviors is highly likely to be perceived as immediate by students, but there is not a guaranteed match between what an instructor intends to be an immediate behavior and a student's perception of that behavior. For an example, an instructor who guarantees that each student has a response to their e-mails within 24 hours may feel that they are displaying immediate behaviors by responding timely, but depending on how urgent a student feels a particular message is, they may feel that having to wait several hours is not timely, meaning that the intended immediate behavior would not be perceived as such by the student. This is why instructor immediate behaviors are assessed as mediated influences of student learning experiences (Kelly & Westerman, 2016; Kelly et al., 2015).

Instructor behaviors have positive effects on student learning. In both online and face-to-face learning experiences, when instructors display more immediate behaviors, students are likely to have less anxiety toward course tasks (Gaytan et al., 2023; Kelly & Gaytan, 2020; Kelly et al., 2015), more motivated to learn (Allen et al., 2006; Kelly & Fall, 2011; Liu, 2021; Vareberg et al., 2020), and experience more affective learning (Johnson et al., 2023; Kelly & Gaytan, 2020; Kelly et al., 2015; Vareberg et al., 2020; Violanti et al., 2018). In distance learning courses, students also have higher self-efficacy for using course technologies (Johnson et al., 2023) and perceive that their instructor is more caring (Vareberg & Westerman, 2020; Vareberg et al., 2023) when instructors use immediate behaviors. These findings imply that students must have some expectations for instructor immediate behaviors whether they communicate with their instructor online or face-to-face.

What is not yet known is how these expectations may transfer to the standards they hold for AI-based education facilitated or supplemented by an AI instructor. It is possible that students who expect copious immediate behaviors from their instructors may negatively evaluate AI-based education because they may perceive that AI instructors have limited capability for producing immediate behaviors (e.g., limited communicative cues). Else, it is possible that AI instructors are held to a completely different standard than human instructors, making students' expectations of instructor immediate behaviors irrelevant in assessments of AI-based education.

When considering the potential adoption of a new technology, an individual's perceived usefulness and attitudes toward the technology play pivotal roles in determining their intention to engage with it (Davis, 1989). Perceived usefulness describes the degree to which an individual believes a technology

offers substantial enhancing capabilities, and attitudes reflect an individual's overall stance or disposition toward the technology. The significance of these perceptions within the realm of AI in education is well-documented (e.g., Kelly, 2021; 2022; Kim et al., 2020). For instance, Kim et al. (2020) investigated how college students might perceive AI-based online education and found that perceived usefulness and attitudes significantly influence students' intentions to enroll in AI-based courses. As such, to further explore this area, the present study raises the following research questions with the focus of the perceived usefulness and attitudes.

RQ1a-b: How are students' expectations of instructor (a) *verbal* and (b) *nonverbal* immediate behaviors related to students' perceptions about the usefulness of AI-based education?

RQ2a-b: How are students' expectations of instructor (a) *verbal* and (b) *nonverbal* immediate behaviors related to students' attitudes toward AI-based education?

Social presence

Students would have some level of expectations about their instructor's immediate behaviors given the critical influence of students' classroom experience; however, this does not mean that students respond directly to instructor immediate behaviors (Kelly et al., 2015). Instead, students respond to the perceptual change in social or psychological closeness to their instructors (Kelly & Westerman, 2016; Kelly et al., 2015; Vareberg & Westerman, 2020; Weidlich et al., 2024). In this regard, the notion of social presence becomes important in an online learning environment where AI instructors exist.

Although there is no consensus on the definition of social presence, most of the literature conceptualizes it as social perceptions of feeling connected or being together with another entity in a mediated environment without noticing, or temporarily not acknowledging, the existence of the medium (Biocca et al., 2003, Lee, 2004; Short et al., 1976). Given the nature of mediated environments, a considerable body of literature has documented the importance of social presence in an online learning environment (e.g., Kim et al., 2016; Yang et al., 2022). In particular, research has documented that social presence plays an important role in the relationship between instructors' immediate behaviors and students' responses to those behaviors in the online classroom (Kelly & Westerman, 2016; Song et al., 2016, 2019).

In the present study's context, we raise a question whether perceived social presence of an AI instructor would interact with students' preexisting expectations of instructor immediate behaviors in the assessment of AI-based

education. Research finds that students respond to the social or psychological closeness to their instructors' immediate behaviors (Kelly et al., 2015). This implies that students' social responses may influence how students perceive instructor immediate behavior and its impact on learning experiences. Applying this reasoning to the present study's context, the study examines the moderating role of perceived social presence of an AI instructor. That is, it is possible that students who have higher expectations of instructor immediate behaviors would demonstrate negative perceptions of AI-based education, given the assumption that learning process is facilitated or supported by a machine that would not have human characteristics, such as immediate behaviors. However, this may change depending on social perceptions they experience in AI-based education. What if these students experience a strong sense of social presence of an AI instructor? Would the negative perceptions about AI-based education be reduced or negated? While this question touches on an important area, there is no evidence that could address this inquiry. Thus, the study proposes the following research questions:

RQ3a-b: How does the perceived social presence of an AI instructor moderate the way students' expectations of instructor (a) *verbal* and (b) *nonverbal* immediate behaviors affect students' perceptions about the usefulness of AI-based education?

RQ4a-b: How does the perceived social presence of an AI instructor moderate the way students' expectations of instructor (a) *verbal* and (b) *nonverbal* immediate behaviors affect students' attitudes toward AI-based education?

Methods

Sample

A total of 120 students completed the study with the average age of 22.03 years ($SD = 4.24$). The majority of the sample consisted of females ($n = 81$; 67.5%). Participants identified as White/Caucasian ($n = 48$; 40%), Latino/a/x or Hispanic ($n = 33$; 27.5%), Black/African American ($n = 26$; 21.7%), and other racial/ethnic ($n = 13$; 10.9%).

Materials

To help participants understand the scope and context of AI-based education that was being assessed in the present study, a short voice-based lecture clip, without any visual cues, was developed as an example of AI-based education. The topic of the lecture was interpersonal communication

conflict – a course content typically taught in introductory social science courses at the undergraduate level. First, a lecture script was created. Then, it was converted to an audio clip using text-to-speech (TTS) software on OSX system. This software provides a wide range of synthetic voices that vary by diverse features such as sex, age, and accent. It also provides flexibility to adjust the rate of speech. Thus, the present study chose this software to create an optimal voice that is natural but distinct from a human voice but still creates an acceptable accent. After evaluating several mechanical voices, one female voice was selected as an AI instructor's voice. In fact, this particular AI's voice was also adopted in another study (e.g., Kim et al., 2021), which demonstrated that this voice was perceived to be natural but still machinelike, which implies that this voice provides cues that it is an AI, not a human instructor. The lecture clip was approximately 1 minute and 30 seconds long.

Procedure

Participants were recruited from undergraduate communication courses at a large, southeastern university in the U.S. Upon IRB's approval, a recruitment message was distributed to potential participants. After acknowledging the informed consent, participants answered a series of questions regarding their expectations of instructor immediate behaviors. Then, participants were told that they would listen to a lecture created by an AI instructor and share their perceptions about the AI instructor and AI-based education. Participation was voluntary, and all participants received extra credit for the study completion.

Measures

Three variables were measured prior to listening to the AI instructor's lecture: attitudes toward new technology, expectations of instructor verbal immediate behaviors, and expectations of instructor nonverbal immediate behaviors. *Attitudes toward new technology* ($\omega = .82$), which was used as a control variable, 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 reports, novelists)?), adopted from Nass et al. (1995). Responses were obtained on a 6-point scale (1 = *Uncomfortable*, 6 = *Very comfortable*).

Expectations of instructor verbal immediate behaviors ($\omega = .79$) were evaluated with 7 items (e.g., "I expect instructors to address me by name"), adopted from Gorham (1988). Although the Gorham measure has received criticism (c.f., Robinson & Richmond, 1995), Violanti et al. (2018) assert that a subset of strong items exists within the measure, obscured by weaker items. Thus, items for the present study were

Table 1. Fit statistics of the study variables.

	GFI	CFI	RMSEA	SRMR
Verbal	.92	.90	.11	.06
Nonverbal	.98	.98	.12	.03
Social Presence	.93	.98	.09	.03
Usefulness	.93	.97	.28	.02
Attitudes	.95	.99	.14	.01

Note. Verbal: Expectations of instructor verbal immediate behaviors, Nonverbal: Expectations of instructor nonverbal immediate behaviors, Social Presence: Social presence of an AI instructor Usefulness: Perceived Usefulness of AI-based education, Attitudes, Attitudes toward AI-based education.
GFI = Goodness-of-Fit Indicators, CFI = Comparative Fit Index, RMSEA = Root Mean Square Error of Approximation, SRMR = Standardized Root Mean Square Residual

adopted from the strong items identified by Violanti et al. that did not require reverse coding. Responses were obtained on a 5-point Likert scale (1 = *Strongly Disagree*, 5 = *Strongly Agree*).

Expectations of instructor nonverbal immediate behaviors ($\omega = .80$) were assessed with 4 items (e.g., "I expect instructors to use a variety of vocal expressions when talking to the class," "I expect instructors to use gestures when talking to the class."). Items were adopted from Richmond et al. (1987). Responses were obtained on a 5-point Likert scale (1 = *Strongly Disagree*, 5 = *Strongly Agree*).

Three variables were measured after listening to the AI instructor's lecture: social presence of an AI instructor, perceived usefulness of AI-based education, and attitudes toward AI-based education. *Social presence of an AI instructor*($\omega = .94$) was measured with 8 items (e.g., While listening to the AI's lecture, I felt like the AI was "remote – immediate," "impersonal – personal"). Items were adopted from Short et al. (1976) and Lombard et al. (2009). Reponses were obtained on a 7-point semantic differential scale.

Perceived usefulness of AI-based education ($\omega = .96$) was measured with 4 items (e.g., "Using an AI would be useful for learning," "Using an AI would increase my academic performance"). Items were adopted from Davis (1989). Responses were obtained on a 7-point Likert scale (1 = *Strongly Disagree*, 7 = *Strongly Agree*).

Attitudes toward AI-based education ($\omega = .97$) were evaluated with 5 items (e.g., I think the use of an AI in online education would be "negative – positive," "harmful – beneficial"). Items were adopted from Davis (1993). Reponses were obtained on a 7-point semantic differential scale.

Some of the measures were slightly modified in wording to fit within the present study's context. To ensure validity, a confirmatory factor analysis (CFA) was conducted on all primary variables. As noted in Table 1, the results provided evidence of maintained content validity of each measure.

Results

Prior to the primary testing, a control variable was considered. A body of literature has documented that individuals' attitudes toward new technology play a role in the assessment of new technology and its use and implications (c. f., Kim et al., 2023; Kim, Xu, et al., 2022; Merrill Jr. et al., 2022). To avoid any potential effect, the study included preexisting attitudes toward new technology in all the analyses as a control variable.

To test the proposed RQs, a series of regression analyses were performed. For each test, attitudes toward new technology (control variable), expectations of verbal immediate behaviors, and expectations of nonverbal immediate behaviors were entered in the first block (model 1). Next, perceived social presence of an AI instructor was entered in the second block (model 2). Then, the products of social presence and (a) verbal and (b) nonverbal immediate behaviors (social presence x verbal; social presence x nonverbal), respectively, were entered in the third block (model 3).

RQ1a-b asked how expectations of instructor verbal and nonverbal immediate behaviors are related to students' perceptions about the usefulness of AI-based education. Then, RQ3a-b examined whether perceived social presence of an AI instructor moderates the associations examined in RQ1a-b. First, regarding RQ1a-b, results from model 1 revealed a statistically significant variance [$R^2 = .19$, $F(3, 116) = 8.85$, $p = .000$]. In the model, there was no significant association between expectations of instructor verbal immediate behaviors and the perceived usefulness of AI-based education ($\beta = .14$, $p > .05$). However, expectations of instructor nonverbal behaviors were negatively associated with the perceived usefulness of AI-based education at a statistically significant level ($\beta = -.29$, $p = .002$).

Next, to address the potential moderation effect of social presence (RQ3a-b), results from model 3 were examined. Although the significance level was slightly greater than the conventionally acceptable cutoff (p-value at .05), results from model 3 revealed noteworthy additional variance [$\Delta R^2 = .47$, $\Delta F(2, 113) = 2.85$, $p = .062$]. In model 3, there was no significant moderation effect of social presence with verbal immediate behaviors ($\beta = .26$, $p > .05$). However, an interesting pattern was observed regarding the moderating role of social presence with regard to expectations of nonverbal immediate behaviors ($\beta = .70$, $p = .073$). As the positive sign of the beta indicates, the result implies a possibility that when strong social presence of an AI instructor was experienced, students with higher expectations of instructor nonverbal immediate behaviors perceived AI-based education to be more useful. As mentioned, the p-value was slightly greater than .05, but considering the relatively small sample size, this finding is worthy of being recognized.

RQ2a-b asked whether expectations of instructor verbal and nonverbal immediate behaviors are related to students' attitudes toward AI-

based education; then, RQ3a-b examined whether this association would be moderated by perceived social presence of an AI instructor. With regard to RQ2a-b, results from model 1 revealed a statistically significant variance [$R^2 = .19$, $F(3, 116) = 9.32$, $p = .000$]. Upon examining variables in the model, there was no statistically significant association between expectations of instructor verbal immediate behaviors and attitudes toward AI-based education ($\beta = .09$, $p > .05$). However, expectations of instructor nonverbal behaviors were negatively related to attitudes toward AI-based education at a statistically significant level ($\beta = -.20$, $p = .035$).

Next, to examine the potential moderation effect of perceived social presence (RQ4a-b), results from model 3 were assessed. Findings from model 3 revealed significant additional variance [$\Delta R^2 = .03$, $\Delta F(3, 113) = 3.37$, $p = .038$]. In the model, there was no significant moderation effect of social presence with verbal immediate behaviors ($\beta = -.27$, $p > .05$). However, the finding indicated a significant moderating role of social presence with regard to expectations of nonverbal immediate behaviors ($\beta = .93$, $p = .014$). As the sign of the beta indicates, when perceiving strong social presence of an AI instructor, students with high expectations of instructor nonverbal immediate behaviors indicated favorable attitudes toward AI-based education. See Table 2 for the entire results from regression tests.

Table 2. Immediate behaviors and perceptions about AI-based education.

			Outcome variables	
Predictor variables			Usefulness	Attitudes
Model 1		R^2	.19	.19
		F	8.85***	9.32***
	(Control)	β	.34***	.41***
	Verbal	β	.14	.09
	Nonverbal	β	−.29**	−.20*
Model 2		ΔR^2	.26	.28
		ΔF	53.94***	60.74***
	(Control)	β	.20**	.25***
	Verbal	β	.12	.07
	Nonverbal	β	−.14	−.04
	Social presence	β	.55***	.57***
Model 3		ΔR^2	.03	.03
		ΔF	2.85$^+$	3.37*
	(Control)	β	.17*	.24**
	Verbal	β	.04	.13
	Nonverbal	β	−.43**	−.40*
	Social presence	β	−.39	−.09
	Verbal x Social presence	β	.26	−.27
	Nonverbal x Social presence	β	.70$^+$	.93*

Note. Control: Pre-existing attitudes toward new technology (control variable), Verbal: Expectations of instructor verbal immediate behaviors, Nonverbal: Expectations of instructor nonverbal immediate behaviors, Social Presence: Social presence of an AI instructor Usefulness: Perceived Usefulness of AI-based education, Attitudes, Attitudes toward AI-based education

$^+p \le .08$ $^*p \le .05$, $^{**}p \le .01$, $^{***}p \le .001$

Discussion

The present study explored how undergraduate students' expectations of instructor immediate behaviors influence their perceptions of AI-based education. Overall, the study finds the important role of social presence of an AI instructor in AI-based education. The following sections highlight the key findings, implications, and contributions of the study. Then, the study ends with limitations and future research directions.

Primary findings, implications, and contributions

The key finding of the present study is the role of perceived social presence of an AI instructor in AI-based education. In particular, the study finds that when examining a bivariate relationship only, students' expectations of instructor nonverbal immediate behaviors are negatively related to how they view AI-based education (perceived usefulness and attitudes). That is, students who expect their instructors to be more nonverbally immediate tend to evaluate AI-based education more negatively. However, when perceived social presence of an AI instructor is considered, the direction of the pattern changes to the positive. That is, when students experience strong social presence of an AI instructor while listening to the AI's lecture, the associations between expectations of instructor nonverbal immediate behaviors and perceptions about AI-based education become positive. Although the *p*-value of the finding regarding the usefulness of AI-based education is slightly greater than the conventionally acceptable cutoff (as reported in the result section), it is still noteworthy considering the small sample size and the exploratory nature of the study.

A possible explanation of the finding is that when merely thinking about AI, students may automatically assume that an AI instructor would not provide effective communicative features or interactions because it is a machine, not a human. Partially, this assumption may have been unconsciously caused by machine heuristics, mental shortcuts wherein people attribute machine characteristics when making judgments about outcomes of an interaction (Sundar, 2008). This tendency may have prompted students, especially with higher expectations of immediate behaviors which are typically considered to be human characteristics, to think that AI-based education would not be helpful. However, once students perceive strong social presence of an AI instructor, which may not have been expected from a machine, these students may realize the potential of positive learning opportunities in AI-based education. In fact, the literature supports the positive role of perceived social presence of an AI instructor (e.g., Kim, Merrill Jr., et al., 2022; Kim, Merrill Jr., et al., 2022).

To further unpack the study's findings, it is worth discussing why students desire or expect immediate behaviors from their instructors and how it may play a role in the expectations for the immediacy from their AI instructors.

Students who have experienced the indirect learning benefits of immediate behaviors (c.f., Kim et al., 2016; Song et al., 2016, 2019) should crave replication of their positive experiences, and as such may expect immediate behaviors from their instructors In a face-to-face classroom, without a direct or intentional interaction, students can be naturally exposed to a variety of nonverbal immediate behaviors, such as instructors moving around the classroom, sitting or standing closer to students, smiling, or showing warm hand gestures. Thanks to a video conferencing system, the amount of nonverbal immediate behaviors can be greater, if not the same, in an online learning environment, as instructors replicate many of their nonverbal immediate behaviors from the face-to-face classroom (e.g., vocal variety, gestures), simulate other nonverbal immediate behaviors such as eye contact by using the technology skillfully (Kelly, 2021; Kelly & Westerman, 2016), and incorporate new artifacts such as personalized virtual lecture backgrounds with their personal photos (e.g., Kelly et al., 2023). This is different than verbal and computer-mediated immediate behaviors, many of which require individualized (e.g., addressing students by name) or two-way communication (e.g., response time) to be delivered. As such, students who have experienced the benefits of instructor immediate behaviors may come to expect instructors to utilize those behaviors which can be used in mass through one-way communication (i.e., nonverbal immediate behaviors) regardless of their teaching platform.

With the rise of AI in education, this tendency could play a role in the way students respond to or expect immediate behaviors from machine teachers. According to the CASA paradigm (Reeves & Nass, 1996), humans respond to machines in the same way they do to other humans and apply the same social rules to both humans and machines. As such, students may also expect a similar, if not the same, level of possible immediate behaviors from their AI instructors. Although expectations were not assessed in the present study, the extant literature documents that students positively respond to an AI instructor when the AI uses a more immediate behavior, such as relational communication styles (Kim et al., 2021). Because of the nature of an AI instructor that mostly appears as a disembodied agent or software, some aspects of nonverbal immediate behaviors may be limited (e.g., body movement, gesture, facial expressions) and rely on mostly vocal cues. In this sense, it is possible students may be disappointed at first with the limited range of nonverbal immediate behaviors of an AI instructor. However, as long as students perceive strong social presence of an AI instructor, they will still have positive experiences, as found in this research. There is much to further unpack in this realm. To deepen our understanding of how students' expectations of instructors (both human and machines) influence what they expect from AI instructors, the study calls for follow up research.

Although statistically significant findings are usually of primary interest, it is also important to address non-significant results. The present study

does not find significant associations between expectations of instructor verbal immediate behaviors and perceptions about AI-based education. One possible reason might be related to the AI instructor's communication style embedded in the lecture clip. To simulate a typical classroom atmosphere, the AI instructor in this study began the lecture by sharing a warm greeting and small talk. In synchronous online learning, students respond positively to instructors providing a warm greeting and beginning class with small talk regardless of whether students feel any impetus to respond to that communication (Chui et al., 2021). In that sense, an AI instructor's communication style might have met students' expectations of instructor verbal immediate behaviors, and this may have contributed to the non-significant associations. To test this conjecture, the present study calls for follow-up studies.

Collectively, the study's findings suggest valuable implications for research and practice. First, the study highlights the need to find ways to foster social presence of machine teachers in AI-based education. Theory-driven research documents that technology-related features (Lombard & Ditton, 1997) and social factors (Lee & Nass, 2005) can foster social presence, and these factors can be incorporated when creating a machine teacher and/or AI-based education. Although limited, some research highlights ways to foster social presence of AI instructors, such as incorporating relational communication styles into an AI instructor's lecture styles (Kim et al., 2021) and employing human-like voice features into AI instructor's voice (Kim, Merrill Jr, et al., 2022). Also, considering that humans mindlessly apply the same social heuristics for interactions with both humans and machines (Reeves & Nass, 1996), lessons can be also learned from causal factors for social presence of human instructors, such as instructor self-disclosure (e.g., Song et al., 2019) when designing an AI instructor. As such, instructors who wish to adopt some level of AI-based education may consider incorporating various causal factors for social presence when creating AI-based lecture content and/or AI-based lecture delivery to help students experience social presence of their machine teacher to maximize their learning experiences.

Also, related to the above, the study's findings suggest that when designing and incorporating AI-based education, it is important to include immediate cues. Based on a theoretical argument (Reeves & Nass, 1996), students would expect some degree of immediate behaviors from their machine teachers, whether verbal or nonverbals. Also, like students benefit from human instructor immediate behaviors (Gaytan et al., 2023; Kelly & Fall, 2011; Kelly & Gaytan, 2020; Kelly et al., 2015; Vareberg et al., 2020), a similar, or the same, benefit may be experienced from machine teachers' immediate behaviors. As such, it is one of the ultimate instructional strategies for human instructors to find ways to incorporate immediate cues when employing AI-based education.

Collectively, the present study provides an opportunity to extend our understanding of instructor immediate behaviors. Higher instructor immediacy cues typically lead to greater social presence of human instructors (Song et al., 2016, 2019). Yet, it is not clear whether it will be the same when an instructor is a machine. It is possible that some students may consider different behavioral cues to be immediate when the sender is a machine. In this regard, the study suggests a need to investigate expected or anticipated immediate behaviors of machine instructors from student perspectives.

Limitations and future research directions

Although the present study reveals interesting findings, the study also acknowledges potential limitations that should be addressed in future research for more complete understanding of the phenomenon. First, the study encourages future researchers to utilize a repeated exposure or longitudinal study design. Instructor immediate behaviors are important factors in fostering positive relationships with students and their learning experiences, especially in online classes (e.g., Song et al., 2016), but this would not occur during one time exposure of the interaction with an instructor. In this regard, it is important to understand how students develop social perceptions toward an AI instructor in an online learning environment over time, and how this would affect students' perceptions about the AI instructor as well as AI-based education in general.

Second, the study encourages researchers to examine how students' preferences for instructor communication styles influence the way they perceive an AI instructor and AI-based education. For instance, some students may prefer their instructors to be more relational and social with students beyond the classroom setting, while other students may appreciate an instructor being more task-oriented. Given the unique nature of AI, students may develop certain assumptions regarding what the interactions with an AI instructor would be like, and their perceptions about the AI instructor could change depending on their preferences for an instructor style. To unpack this unknown, the study calls for more research in this realm.

Lastly, it will be worth investigating the role expectations of instructor computer-mediated immediate behaviors when assessing students' responses to AI instructors, who essentially communicate with students in a technology/computer-mediated platform. The general expectations of instructor immediate behaviors still provide meaningful fundings, as reported in the present investigation, but it is not clear whether platform specific expectations have any impacts on the way students perceive AI instructor and AI-based education. As Rocker et al. (2021) point out, scholars are limited in their ability to study computer-mediated immediate behaviors when our data collection instruments only capture text-based

behaviors. To address this inquiry, the study calls for follow-up research and echoes Rocker et al. (2021) call for additional measurement development work.

Conclusion

The present study investigated whether students' expectations of instructor immediate behaviors are related to their assessment of AI-based education. Findings indicate that students who have higher expectations of instructor nonverbal immediate behaviors show more negative perceptions about AI-based education. However, this pattern changes depending on perceived social presence of an AI instructor. When students perceive strong social presence of an AI instructor while listening to the AI's lecture, expectations of instructor nonverbal immediate behaviors become positively related to favorable perceptions about AI-based education. Although exploratory in nature, these findings provide preliminary understanding of how student characteristics may influence the way they evaluate AI-based education and highlight the importance of social presence of AI instructors. Acknowledging that AI technology will continue to develop and stay here with us, it seems crucial to find ways to maximize the benefits of AI technology in fostering student learning rather than merely focusing on the harmful effects of the technology. Therefore, the present study calls for more research in this realm.

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No potential conflict of interest was reported by the author(s).

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