HMC in the Educational Context

Chad Edwards[1] and Matthew Craig[2]
[1]COMBOT Labs, School of Communication, Western Michigan University, Kalamazoo MI, USA
[2]COMBOT Labs, College of Communication & Information, Kent State University, Kent, OH, USA

Techonlogies in HMC can interrupt a lot of our pedagogical techniques and has the opportunity to change what education looks like for many. Using robots in the classroom is not a new endeavor. From social robots as stand-ins for math tutoring, working with students identified with Autism Spectrum Disorder (ASD), to telepresence robots—there are various uses for robots and they don't need to be overly sophisticated either. AI can be used in the classroom as tools to facilitate individualized learning, however, in its adoption we must understand who is involved in its development and adoption and how these systems can and do harm those most often marginalized. HMC scholars need to be interdisciplinary and holistic in their research about AI in educational contexts. VR and AR systems also have great use in the classroom, especially regarding public speaking. These technologies have a great opportunity for enhancing instructor content by providing immersive experiences for students (and instructors too). Regarding HMC and instructional communication research, variables such as immediacy, credibility, and teacher clarity are important for encouraging positive interactions with machine actors in the classroom settings. This chapter provides a bird's eye view of the use of HMC technology in the classroom and important avenues of work regarding HMC in instructional communication research.

Keywords: human-machine communication, artificial intelligence, human-robot interaction, virtual reality, augmented reality, telepresence robots, immediacy, credibility, clarity

Introduction

Human-machine communication (HMC) can interrupt many of our pedagogical techniques and change how education operates (A. Edwards & Edwards, 2017; C. Edwards et al., 2018). It is crucial to bring the scholarship of instructional communication researchers to the study of machines in the educational experience to help with the design, implementations, assessment, and evaluation. Technology has been an essential and necessary part of the educational experience. From a historical perspective, the idea of a machine actor (e.g., AI, social robots) in the educational process goes back to the early 20th Century; however, it was not until recently that the actors in the educational context could be changed from a person to a machine. The addition of machine actors in education is a seismic land shift. Machine actors (e.g., AI, social robots) and systems for virtual/augmented reality are being utilized as teachers, tutors, and peer mentors (Vasagar, 2017). Bodkin (2017) argues that within the next ten years, we will see a "revolution in one-to-one learning" from social machines (para 1). Machine actors have been increasingly acting as tutors both in the classroom and in homes (Han et al., 2005). The COVID-19 pandemic beginning in 2020 is expected to increase this revolution in the classroom. To a great extent, "students and instructors are not only talking *through* machines, but also *to* them, and *within* them" (A. Edwards & Edwards, 2018), p. 185. With well-tested pedagogical practices for social machines, teachers might be able to spend more time with students in support and mentoring roles and letting the machines take on more basic educational tasks. We divided this chapter into two sections to explore HMC in the academic environment. The first section is dedicated to discussing various contexts of using machine partners for educational purposes. We then in a second section discuss HMC in instructional communication research before offering our concluding thoughts.

Chad Edwards Matthew J. A. Craig
Correspondence concerning this article should be addressed to Chad Edwards, School of Communication, Western Michigan University, 1903 Western Michigan Ave, Kalamazoo, MI 49008-5200. E-mail: chad.edwards@wmich.edu.

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HMC Technologies of Education

Social Robots in Education

The use of robots in education is not new (Hrastinski et al., 2019; Mubin et al., 2013). In a review of the use of robots in education, Mubin et al. (2013) identified several cases study examples in which robots were used in language, science, and technologies as tutors, peers, and as tools. Social robots have even been shown to be good stand-ins for math tutoring (Brown et al., 2013), and giving students feedback in the college classroom (Park et al., 2011). To provide some specific examples of evaluating their usefulness, A. Edwards et al. (2016) demonstrated that a social robot delivering an identical teaching performance as a human using a telepresence robot can be perceived as having credibility and that students had positive affective and behavioral learning scores. Li et al. (2016) showed that social robots were useful at instructing in terms of students' knowledge recall of information presented. Furthermore, social robots have been used to teach second languages and have been observed as being more effective than other traditional methods (Hur and Han, 2009).

Examining the use of social robotics specifically in the field of special education, findings by Papakostas et al. (2021) suggest positive effects of incorporating social robots in the special education classroom, especially concerning specific social robots intended for specific intended for children with differing abilities. For example, the NAO robot is "preferred" for students identified with Autism Spectrum Disorder (ASD), or robots with five fingers teaching sign language such as Robovie (Papakostas et al., 2021, p. 29). In these roles, various researchers have shown increased learning and teamwork (Eguchi, 2012). For example, students with ASD working with social robots have benefited from the behaviors modeled and practiced by social robots (Kim et al., 2013). Social robotics gives greater means for educators to engage content with students—a resource for teachers to use in the classroom. Additionally, the use of robotics in the classroom does not need to be enormously sophisticated to have a practical use. For example, in special education, a keep-on robot can help show students on the autism spectrum how to properly touch (Kozima et al., 2009). Robot pets (Joy for All Companion Pets, https://joyforall.com/products/companion-pet-pup) have been used to aid in social-emotional learning (K. Heljakka and Ihamäki, 2019; K. I. Heljakka et al., 2020) or used in a library for stress reduction (A. Edwards et al., 2022)

Artificial Intelligence in Education

Artificial Intelligence (AI) in the classroom can disrupt much of the educational enterprise and become salient when this change can impact the student-teacher dynamic (Schiff, 2021). Most AI systems in education are utilized for tutoring systems (Roll and Wylie, 2016; VanLehn, 2011). These systems can lessen teachers' burdens in the classroom for more routinized teaching materials (Hrastinski et al., 2019). AI in the educational environment can help implement individualized learning, enhance student collaboration, and be effective for tutoring (VanLehn, 2011). Digital assistants can help students by providing interaction through speech, virtual characters, and text messages (Tegos et al., 2015), facilitate learning (Schroeder and Gotch, 2015), serve as mentors (Haake and Gulz, 2009), learn a second language (Ayedoun et al., 2015), and can help increase the number of information cues during an interaction (Johnson et al., 2000).

While AI has strong potential in the education domain, we must always guard against the potentially significant risks associated with these technologies in the classroom (McStay, 2020). Berendt et al. (2020) argue that when AI is used in education (and more generally), there need to be strong regulations for the use and privacy protections. McStay (2020) maintains that there is a great concern when AI is being used to quantify both emotional and social learning. AI systems can be built and trained on insufficient data (Custer et al., 2018). And because many of these problems are often unseen or unintended, severe damage can occur in the classroom (Pringle et al., 2016). It is important to have a firm understanding of who is involved in an AI systems' development and adoption (Gebru, 2020). Too often AI and machine learning systems are considered objective vessels of research and development–absolved of racism, sexism, homophobia, and more. It is the abstraction of science where companies (and yes, scholars too), fail to recognize the importance of including those most marginalized and how their lives and voices remain affected by this technology (Gebru, 2020). Scholars need to "learn about the ways in which their technology is being used, question the direction institutions are moving in, and engage with other disciplines to learn their approaches" (Gebru, 2020, p. 268). HMC scholars can and should engage critical lenses for examining many of these aspects in and out of the classroom and avoid the adoption of systems that were developed without a diverse set of voices.

Virtual/Augmented Realities in Education

Virtual/augmented realities systems are being used to educate in a variety of contexts. Virtual reality is a computer-generated world that can appear to be 3D with sound and sometimes tactile simulations. Augmented reality (AR) refers to "a situation in which a real-world context is dynamically overlaid with coherent location or context sensitive virtual information" (Klopfer and Sheldon, 2010, p. 205). Previous research has demonstrated that VR and AR can enhance learning in the classroom (Ke et al., 2016; Lau and Lee, 2015; Omale et al., 2009; Wu et al., 2013).

Virtual audiences have helped students learn to speak in public by creating a positive and safe audience environment (Chollet et al., 2015). VR has helped student teachers learn positive pedagogical techniques with virtual students (Ke et al., 2016). Frisby et al. (2020) and Vallade et al. (2021) found that the use of VR headsets utilizing 360 videos of the speaking environment as good student practice and can increase knowledge retention and student engagement (Harrington et al., 2018; Sultan et al., 2019; Rupp et al., 2019). Walshe and Driver (2019) argued that 360° videos could be used as tools for reflecting on the student teaching experience. Applied in the classroom, VR/AR systems provide students an immersive experience in instructional content.

HMC and Instructional Communication Research

When examining how HMC will impact the educational context, it is vital to consider how impressions of the source affect the machine actor's student-teacher relationship, learning outcomes, and general characteristics and capabilities. Because communication is often a scripted task (Kellermann, 1992), machine actors can have the ability to guide the educational experience in some contexts. As such, general interpersonal impressions of the machine actor will matter in the educational context. Physical behaviors combined with messages can help convey meaning in the interaction (Ali and Williams, 2020; Craig and Edwards, 2021; Rosenthal-von der Pütten et al., 2018).

Human-to-human interaction scripts work well when trying to understand the educational environment. Previous research has demonstrated that people anticipate lower liking and social presence when first interacting with a machine actor. Additionally, they will have more significant uncertainty (C. Edwards et al., 2016; Spence et al., 2014; A. Edwards et al., 2016). Developing academic scripts for machine actors would allow researchers to critically analyze the material communicated to students for issues of racism, classism, or sexism. Additionally, people have an anthropocentric expectancy bias when interacting with others (Spence et al., 2014; A. Edwards et al., 2019). We assume that the teachers will be human. Students may face extreme uncertainty when interacting with machine agents in the classroom. After a time, this uncertainty will decrease, but initial interaction is vital for setting expectations for the educational domain. We will end this chapter by examining three important instructional communication variables and how they can be utilized in HMC to establish positive interactions in the classroom. (see C. Edwards et al., 2018 and A. Edwards and Edwards, 2017 for further information).

Immediacy

Psychological closeness, or immediacy, has been a long-standing variable of interest in instructional communication (Andersen, 1979; Gorham, 1988). Immediacy refers to perceptions of closeness between individuals (Mehrabian et al., 1971). In the classroom, immediacy is based on closeness perceptions between students and teachers (Frymier, 1993). Immediacy has been correlated with teacher credibility and learning (Schrodt and Witt, 2006; Violanti et al., 2018). Because perceptions of immediacy tend to be driven by closeness inducing behaviors, HMC scholars would be wise to examine immediacy. Machine actors in large measures can reproduce these behaviors with scripts. Kennedy et al. (2017) demonstrated that children could recall more information about a story when the robot is perceived as more immediate. Exploring how perceptions of psychological closeness can occur between student and machine actor is important research ground.

Credibility

In instructional communication, the issue of teacher credibility has been well researched (McCroskey and Teven, 1999) and is built on the ideas of competence, caring, and character. Credibility has been related to a host of positive behaviors in the educational context. Perceptions of credibility will matter for machine actors. In an experiment, C. Edwards et al. (2016) show that students could perceive a social robot as credible in teaching performances/scripts. In related fields to HMC, such as HRI, machine trust is similar to instructor credibility. Sanders et al. (2011) argue that machine trust is an important factor to consider when examining robots' use. Salem et al. (2015) suggest that even if a machine agent makes some mistakes, these mistakes will not be enough to reduce this trust or credibility significantly. Examining the perceptions of credibility (machine trust) and how machines can build trust would help researchers understand the efficacy of using technologies in education.

Teacher Clarity

Teacher clarity has been another significant variable to consider in instructional communication that HMC scholars should pay attention to for their research. Powell and Harville (1990) argue that teacher clarity is concerned with the constancy of an instructional message and can have positive instructional outcomes. For HMC research, vocal cues can be a strong part of being perceived as being clear in the classroom. Research in HRI has found that higher-pitched robots have been perceived as more attractive (Niculescu et al., 2013). Goble and Edwards, 2018 argued that things like pitch, speech rate, vocal fillers, and even voices could be altered/scripted in HMC research with machine actors. Sandry (2015) points out that when a robot provides information, the message's clarity is essential for communication efficiency. There still is a lot of work to be done in this area, examining how clarity can be changed (more clear to less clear) with machine agents such as chatbots or social robots.

Conclusion

Human-Machine Communication (HMC) has a lot to offer for instructional communication in the coming years. As we have encountered in the COVID-19 pandemic of starting in 2020, our limited ability to meet physically (i.e., close contact face-2-face) ignites a more extensive discussion on how we foster connection and create meaning with each other. Communication with machines allows communication scholars to revisit theoretical considerations for our human communication practices. Specifically, as these machines advance—how we assemble and assign meaning is essential to HMC in education contexts whether a pet robot in the classroom, a virtual reality scenario exhibiting an audience, or an AI chatbot to answer syllabus questions (Landau and Broz, 2020), these systems and machines show great potential in their ability to foster connection and practice in the classroom.

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