Artificially Intelligently (AI) Tutors in the Classroom:

A Need Assessment Study of Designing Chatbots to Support Student Learning

Research-in-Progress

Sambhav Gupta
San Jose State University
sambhav.gupta@sjsu.edu

Krithika Jagannath
UC Irvine
kjaganna@uci.edu

Nitin Aggarwal
San Jose State University
nitin.aggarwal@sjsu.edu

Ramamurti Sridar
San Jose State University
ramamurti.sridar@sjsu.edu

Shawn Wilde
San Jose State University
shawn.wilde@sjsu.edu

Yu Chen
San Jose State University
yu.chen@sjsu.edu

Abstract

Supporting student academic success has been one of the major goals for higher education. However, low teacher-to-student ratio makes it difficult for students to receive sufficient support and guidance that they might want to. The advancement of AI and conversational agents, such as chatbots, has provided opportunities for assisting student learning. This research in progress aims at investigating the opportunities and requirements of chatbots as intelligent tutors to support student learning. We developed a chatbot as an experimental platform to investigate the design opportunities of using chatbots as an intelligent tutor. Through a chatbot-led user study with 215 undergraduate students, we found chatbot could serve as an intelligent tutor by answering student questions, creating an environment for advanced learning, and support student life and wellbeing in an accessible, interactive, and privacy-enhanced way. We then pointed out future work.

Keywords: chatbot, learning, IS education, artificial intelligent, natural language processing

Introduction

Education research has shown that positive social interaction between student and teachers enhance student learning. In the current classroom setting, however, low teacher-to-student ratio makes it difficult for every student to receive sufficient one-on-one interaction and guidance from teachers that they might want to. Besides interactivity, in the current era of information technology, students are also becoming more interested in self-paced learning (Allaire 2018). Online learning offerings and programs, such as Coursera, edx, Udacity, and becoming increasingly widely adopted to enable self-paced learning. Nowadays, researchers and educators have started to investigate how to offer blended learning experience with both social interactions with teachers and independent learning on students' own pace by leveraging information technology.

The advancement of artificial intelligent and conversational agents (Luger and Sellen 2016), such as chatbots (Schlesinger et al. 2018), has provided promising opportunities for assisting student life in higher education (Goel and Polepeddi 2016; Kerlyl et al. 2007; Kerry et al. 2009). The term "chatbot", coined from "chatting robot", refers to intelligent machines that are able to conduct text-based conversations with users. Chatbots were initially studied in the early 1980s, but did not receive much attention until the past decade with the development of natural language processing and deep learning. Starting from chatbots that are integrated in messaging applications (e.g., Facebook and Slack) and used for customer services, researchers have also leveraged chatbot in answering basic

questions, providing information, and offering interactive support in various domains (Avula et al. 2018; Jain et al. 2018; Tallyn et al. 2018; Winkler and Soellner 2018). In particular, researchers have started to discuss the scenarios in teaching and learning where chatbots might be adopted, as shown in a recent workshop (Gonda et al. 2018). However, to the best of our knowledge, there lacks an empirical study to investigate the above topic. This research study aims at investigating the opportunities and requirements of chatbots as intelligent tutors to support student learning. In particular, we aim to answer the following research questions (RQs):

- RQ1: What are the opportunities of designing a chatbot as an intelligent tutor?
- RQ2: What are the strengths of chatbots as an intelligent tutor?
- RQ3: What are the potential challenges of chatbots as an intelligent tutor?

To answer these questions, we developed a chatbot called "Sammy" as an experimental platform to investigate the design opportunities of using chatbots as an intelligent tutor (see Figure 1). We conducted a user study with 215 undergraduate students at a large public university in the United States who completed an "interview" (i.e., a chat) with Sammy. In particular, the chatbot aims at investigating the main barriers for students to receive help, advice, and coaching from course instructors, the opportunities that a chatbot might help, and benefits and concerns of using chatbots in supporting student learning. We found that chatbots have the potential to answer basic questions regarding courses and content, provide supplementary materials or questions for advanced learning, and chat about life and wellbeing issues. Such opportunities were mainly supported by three qualities of chatbots: accessibility at anytime and anyplace, interactivity with students, and the possibility to keep conversations confidential. Our participants also expected the enhanced ability for chatbots to understand conversation flow and social-emotional cues. We conclude by proposing our design for an intelligent tutor and design implications.

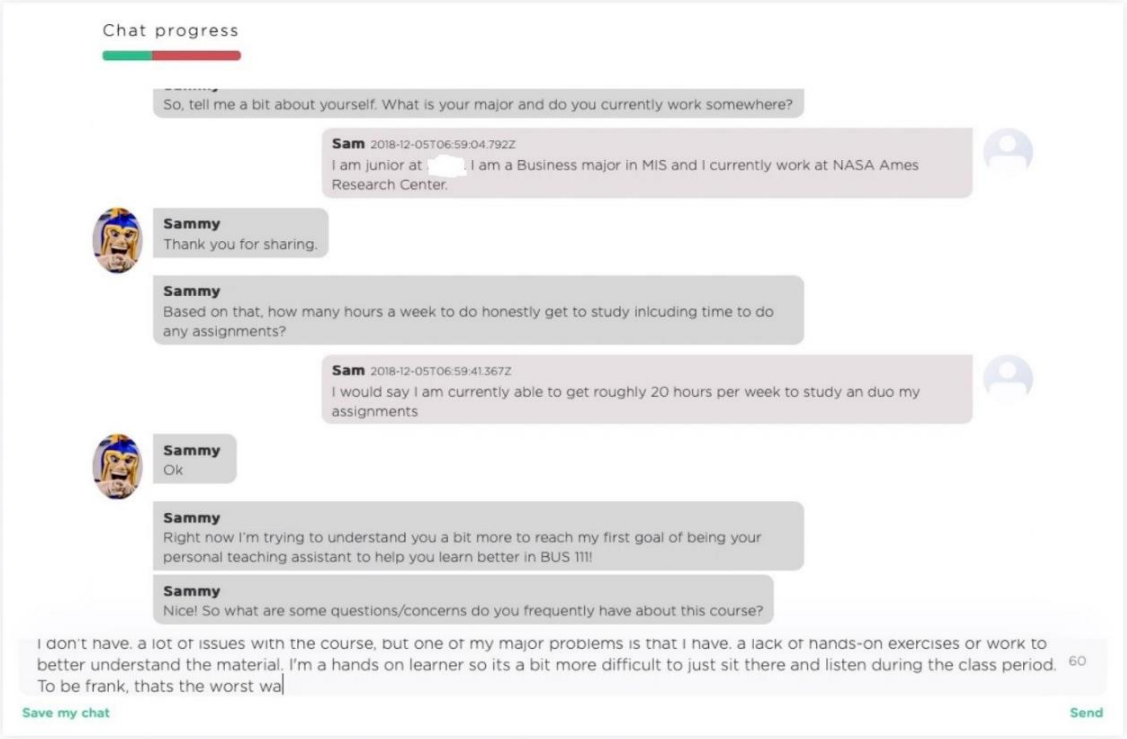

Figure 1. Screenshot of the interface of the chatbot used in the need assessment study

Related Work

Artificial Intelligence continues to grow in popularity on various industrial platforms, including chatbot technology. Chatbot has primarily been used for commercial purposes such as customer support (Johannsen and Florian 2018; Xu et al. 2017). Recently, researchers also started to extend the value of chatbots from commercial usage to various different areas, such as facilitating collaboration

(*SearchBot* (Avula et al. 2018)), enhancing work performance (e.g., *SwitchBot* (Williams et al. 2018)), and promoting healthy lifestyle (e.g., *Pocket Skills* (Schroeder et al. 2018), *AI-bot* for healthy lifestyle (Fadhil and Gabrielli 2017)). Besides that, *Ethnobot* (Tallyn et al. 2018) leverages chatbots to gather ethnographic data for scientific research. Researchers also design chatbots to address other issues to enhance the equality of data communication. For example, *FarmChat* (Jain et al. 2018) was designed to help farmers in rural India better access information; *Consejero Automatico* (Wong-Villacres et al. 2019) aimed at supporting Latino parents' educational engagement.

A number of studies have explored the possibility of introducing chatbots in education. A study conducted by Patrick et al. (Bii 2013) revealed that the interactive nature of chatbots provides opportunities for social interaction, which plays a critical role in the development of cognition and contributing to the process of learning. A recent survey (Winkler and Soellner 2018) showed that chatbots are mainly used in the education of health and wellbeing, language learning, facilitating feedback and metacognitive thinking, and asking students challenging questions. As an example, Fadhil et al. presented a chatbot called *CiboPoliBot* (Fadhil and Villafiorita 2017) that teaches children about a healthy lifestyle through an interactive social game. In another project, *@dawebot* trains students in learning using multiple-question quizzes (Pereira and Juanan 2016). During a 15-week long study, students considered using the chatbot as a practice test as an engaging way of studying. *Jill Watson*, developed by Georgia Institute of Technology, served as a teaching assistant to answer student questions in an online artificial intelligence course (Goel and Polepeddi 2016).

In the field of information systems (AIS conferences), a number of studies have focused on human-chatbot interaction and the value of chatbots. In order to design the humanness of chatbots, researchers have demonstrated the importance of considering typing speed, typefaces, emoji of a chatbot during the conversation. Meanwhile, studies have applied the social presence theory to indicate the importance of relevance, presence, and engagement of chatbot conversations (Schuetzler et al. 2018), as well as the strengthen users' autonomy, competence, and social relatedness, according to the self-determination theory (Sidorova 2018). In general, chatbots might make services more accessible, available and affordable (Følstad et al. 2018). In sum, prior work has demonstrated the opportunities for using chatbots in various scenarios, including education. However, a systematic study on user needs and expectation of how chatbot might be used for student learning is understudied.

Methodology

In this research in progress, we conducted a need assessment study on using chatbots for learning in higher education. We developed a chatbot called "Sammy" (Figure 1) as an experimental platform for three reasons. First, chatbots serve as a convenient tool to collect a large number of interview data with minimal human involvement (Tallyn et al. 2018); second, chatbots provide a more interactive way than standard survey methods (Tallyn et al. 2018); third, chatting with a chatbot helps participants contextualize the concept of "chatbots", which could be unfamiliar to participants. We developed Sammy using services provided by Juji Inc.[1] [8], a company that allows users to easily create chatbots for personalized needs. We carefully designed the questions, dialog flow and wording of the Sammy using colloquial language to engage students. The participants were students recruited from five upper division undergraduate MIS classes. Their task was to participate in a chatbot-led interview with Sammy around the opportunities and challenges of using chatbot in assisting learning. They could participate in the "interview" on their own laptop at a place of their choice. The study was approved by the university's Institution Review Board.

Results

We collected chat responses from 215 students, including 211 from business majors (e.g. MIS, accounting, marketing, finance, entrepreneurship) and 4 from non-Business majors, 132 males and 83

[1] Juji Inc. Juji Inc. https://juji.io/

females. We then conducted a thematic analysis using the grounded theory approach (Öhman 2005), a well-established qualitative data analysis method. The analysis was conducted around each of the three research questions on the chat log data we collected, which we present below.

Q1: What are the opportunities for designing a chatbot as an intelligent tutor?

Our participants were asked what areas they need assistance with related to learning the course. Participants overwhelmingly supported the use of chatbots as intelligent tutors and mainly proposed the following functionalities.

a) Answering basic questions

Our participants resoundingly asserted that they frequently needed to check basic information, such as course materials, textbook information, due dates, study tips, and office hour information. They also wished chatbot could providing tutoring on course content. For example, one participant wrote: "*I think sometimes it's hard to pay attention to the lectures in class so I would ask questions from you related to the topics I don't understand."* Sometimes they were unable to get sufficient support from course instructors due to the low instructor/student ratio. This situation is worse if the students were too shy to directly communicate with their instructors. Nevertheless, students wished for a tutor that could answer their questions. For example, *"I think it would be great if you can be a platform for studying for a test, like a person to review exam materials with… Basically, it is like reviewing with a friend and test each other out."* These features would allow students to access information in conjunction with Canvas (the learning management system), by answering questions regarding course information and course content.

b) Supporting advanced learning

Participants emphasized the wish for chatbot in support of advanced learning beyond just understanding course content. This included responses for how students require an intelligent tutor to provide real-world applications to enhance learning. As one participant mentioned: *"It would be beneficial in providing real-world examples to certain applications and terms described in the textbook."* According to our participants, chatbots might provide unique ways for different types of learners as intelligent tutors by providing supplementary materials for course content. For example, students could be questioned about the material to ensure their understanding. Participants also wished they could further help them develop soft skills through interacting with the chatbot tutor, e.g., *"You could help me develop critical thinking skills by asking meaningful questions that provoke critical thought."* This shows the opportunities where chatbot might address different levels of learning goals, such as applying and critically thinking about course material.

c) Assisting career- and life-related issue

Besides academic needs, students also mentioned the need for interactive assistance to their career development and student life. From responses, a few participants asserted the need for career guidance and mental health tools from chatbots. Through interacting with the chatbots, students would be able to talk about their current issues without worrying about confidentiality and connect with professionals on campus who would be capable of interacting with students more and assist by addressing issues. As a student chatted: *"Would you be available for counseling students? I feel like you would be very useful to students who have depression or anxiety and don't have people to talk to."* Student consider health, daily life, and career development as essential supportive elements for their academic success.

Q2: What are the strengths of chatbots as an intelligent tutor?

We identified three themes from the chat log regarding the strengths of chatbot in supporting learning: accessibility, interactivity, and confidentiality, which we elaborate below.

a) Accessibility

Our subjects indicated the ease of access to the chatbot as it could be available online and can provide information about courses easily. Thus, students could be able to learn and understand the material outside of the class time at any place without any appointment. The accessibility also comes from the short response time, making it much faster than communications with a professor. As one participant mentioned: *"Your best strength as a potential course assistant is that you can answer my questions quickly and at any time, unlike a human, so I won't have to wait for someone to help me."* Additionally, participants supported the specific information provided by the chatbot to be a key strength of the chatbot.

b) Interactivity

Chatbots also have the potential to interact with students to help them learn key concepts through conversations compared with learning from learning by themselves outside of the classroom. Our participants mentioned the lack of social interactivity in learning outside the classroom, such as standard learning through the textbook or through Canvas. Our subjects also promoted the use of conversational bots as a type of interactive and engaging learning tool to provide resources for students to learn and receive feedback. As a participant mentioned: *"I like interactive activities so I think you can help enhance examples to get a better understanding by using videos and activities in our conversations."* Beyond being interactive, chatbots have the opportunity to introduce diverse formats of material in the conversation, such as videos, images, and audio files.

c) Confidentiality

Besides being interactive, some participants required more privacy during the interaction and learning. By using chatbots to help students with course information and services, the information about students might not be provided to instructors, but rather primarily a one-way shift of information from the chatbot to students. Some of our subjects outlined that student confidentiality is a key component of using AI for student services in the classroom. This might come from students who are hesitant to reveal their learning progress to their instructors or students who do not want to reveal sensitive information such as mental health issues. For example, one student expressed in the chat log: *"I think you can be of great help since you can keep conversations confidential and possibly help students with depression and anxiety."* Sometimes, students might want to seek help in an interactive way, but not necessarily with someone they know or their teachers.

Q3: What are the potential challenges of chatbots as an intelligent tutor?

Participants also expressed concerns about the use of chatbots as intelligent agents and areas for improvements: requiring a learning curve and lacking social-emotional interaction.

a) Enhanced dialog flow

Among the potential challenges of using chatbots for learning, participants noted the chatbot may require a learning curve as to what services it can offer and how it has to be tailored to students. Among them, a major theme is the concern of if chatbots could fully understand and process the conversation like a human. As a participant said: "*I think as an AI, and learning the kinks of this program, your greatest weakness is the flow of the conversation. It's a good conversation for the most part but sometimes the flow of it can have awkward replies. Besides that, the potential is great to have a possible easily accessible course assistant."* Nevertheless, by using machine learning, the chatbot might be able to understand the student needs through an increased amount of interaction. This will allow the chatbot to determine the areas where key concepts in courses are weaker to help students understand and enhance learning outcomes.

b) Enhanced emotional interaction

The second area of potential limitations of chatbots is the emotional interaction. Participants explained the preference to interact with a human and some of our subjects concluded that chatbots might lack human emotions, but rather keep conversations transactional, e.g., *"You are not human."* In particular, some students believed that teacher-student interaction is beyond content and sometimes have the emotional connection. A participant wrote: *"You can improve on expressing feelings, you are a robot and robots do not understand human emotions."* Not being able to fully support emotional expression and exchange could be one limitation of chatbots as intelligent tutors.

Discussions

As presented in the related work section, chatbot has been receiving increasing amount of attention for the opportunities to augment human tasks in various areas. Chatbots have the potential of making services more accessible, available, and affordable (Følstad et al. 2018). In particular, a few studies started to investigate the role of chatbots for education, such as offering multiple-choice quizzes (Pereira and Juanan 2016) and answering student frequently asked questions as an online teaching assistant (Goel and Polepeddi 2016). Through a chatbot-led need assessment interview study among undergraduate students in a business college, we found that students saw the opportunities of chatbots in answering basic course and content information, providing supplementary course materials and asking in-depth questions, as well as offering support for student life and wellbeing. Chatbots were reported to offer accessibility, interactivity, and confidentiality, while needing improvement in machine learning as well as emotional communication. We derived the following design implications:

Designing chatbots for supporting holistic academic success. Even though we originally aimed at designing chatbot to support student learning course content, our findings show that students expect more opportunities to gain a deeper understanding of course material and cultivate a broader set of skills. As an emerging field of study, chatbots were currently mainly used in answering student basic and frequently asked questions. Our studies highlighted the importance of a holistic view of academic success and student life, which includes advanced learning, developing soft skills, and wellbeing.

Designing chatbots to augment teacher-student interaction. From the findings, we repeatedly observed students' need for a timely answer from teachers and in an interactive way. Chatbots, which are machines, are able to serve as an intelligent tutor who works 24/7. Meanwhile, instead of reading or studying alone, participants prefer interactive way, which mimics and extends the classroom setting. Surprisingly, we also found that students sometimes wished for social interaction (i.e., chatting) for professional support but without revealing their own identities. Our findings thus reflected the opportunities for both timely and interactive chatbot tutor, as well as one that protects their privacy for student identity and sensitive information.

Designing chatbot tutors with enhanced IQ and EQ. One issue that some participants pointed out is the ability for chatbots to be more "intelligent" in understanding dialog flows and learning each individual student over time. This requires further advances in natural language processing and deep learning to enhance the "IQ" of the chatbot. Meanwhile, emotions play a significant role in human-human interaction, and our findings indicate such demand in human-chatbot interaction. This shows the opportunities of developing more emotionally intelligent chatbots for higher education.

Based on our findings of a need assessment study, we plan to create a chatbot that touches three aspects of a learning: basic information, advanced learning, and student life. With this chatbot, our goal is to enable students to have more accessible and interactive e-tutor who protects student identity. Figure 2 shows an example screen capture of the proof-of-concept of such system.

Conclusions

This research in progress aims to understand the opportunities and challenges in using chatbots as an intelligent course tutor. We created a chatbot to interview student participants around these questions. Through a study of 215 students at a large public university, we found out that chatbots might have

potential in providing basic course information, interactive course material to help students review and enhance learning concepts, as well as being a safe place for students to communicate personal issues. Benefits of using chatbots as intelligent tutors include the accessibility, interactivity, as well as confidentiality, while potential issues include the time needed for training and lack of interpersonal emotional communication. Finally, we discussed the opportunities of designing chatbots to support holistic student academic success with accessible, interactive and privacy-enhanced "tutors."

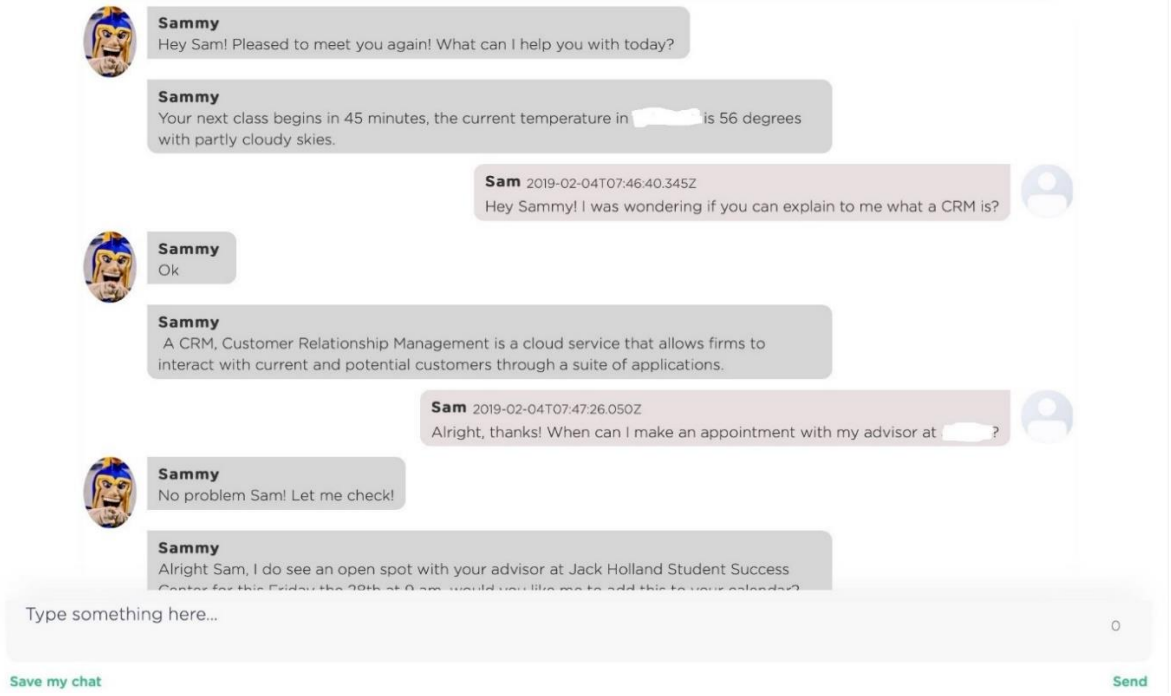

Figure 2. Screenshot of proposed Artificially Intelligent tutor based on the need assessment.

Acknowledgement

We thank Michelle Zhou and Wenxi Chen at Juji Inc. for their constant support for this project.

References

Allaire, J. 2018. "Five Issues Facing Higher Education in 2018." (https://www.cornerstone.edu/blogs/lifelong-learning-matters/post/five-issues-facing-higher-education-in-2018, accessed February 25, 2019).

Avula, S., Chadwick, G., Arguello, J., and Capra, R. 2018. "SearchBots: User Engagement with ChatBots during Collaborative Search Sandeep," in *Proceedings of the 2018 Conference on Human Information Interaction&Retrieval - CHIIR '18*, New York, New York, USA: ACM .

Bii, P. 2013. "Chatbot Technology: A Possible Means of Unlocking Student Potential to Learn How to Learn," *Educational Research (ISSN: 2141-5161)* (4:February), pp. 218–221.

Fadhil, A., and Gabrielli, S. 2017. "Addressing Challenges in Promoting Healthy Lifestyles: The AI-Chatbot Approach," in *Proceedings of the 11th EAI International Conference on Pervasive Computing Technologies for Healthcare - PervasiveHealth '17*, New York, New York, USA: ACM Press, pp. 261–265. (https://doi.org/10.1145/3154862.3154914).

Fadhil, A., and Villafiorita, A. 2017. "An Adaptive Learning with Gamification & Conversational UIs: The Rise of CiboPoliBot," *UMAP 2017 - Adjunct Publication of the 25th Conference on User Modeling, Adaptation and Personalization*, pp. 408–412.

Følstad, A., Brandtzaeg, P. B., Feltwell, T., Law, E. L.-C., Tscheligi, M., and Luger, E. A. 2018. "Chatbots for Social Good," *Extended Abstracts of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, pp. 1–4. (https://doi.org/10.1145/3170427.3185372).

Goel, A. K., and Polepeddi, L. 2016. *Jill Watson: A Virtual Teaching Assistant for Online Education*, Georgia Institute of Technology. (https://smartech.gatech.edu/handle/1853/59104).

Gonda, D., Lei, C.-U., Chai, Y., Hou, X., and Tam, V. 2018. "TALE2018 Pre-Conference Workshop: Chatbot Tutors for Blended Learning: Why Bother? And Where to Start? : VTools Events." (https://meetings.vtools.ieee.org/m/179815, accessed February 25, 2019).

Jain, M., Kumar, P., Bhansali, I., Liao, Q. V., Truong, K., and Patel, S. 2018. "FarmChat : A Conversational Agent to Answer Farmer Queries," *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies* (2:4), p. 22.

Johannsen, and Florian. 2018. "Comparison of Commercial Chatbot Solutions for Supporting Customer Interaction." (http://ecis2018.eu/wp-content/uploads/2018/09/1904-doc.pdf).

Kerlyl, A., Hall, P., and Bull, S. 2007. "Bringing Chatbots into Education: Towards Natural Language Negotiation of Open Learner Models," in *Applications and Innovations in Intelligent Systems XIV*, London: Springer London, pp. 179–192. (https://doi.org/10.1007/978-1-84628-666-7_14).

Kerry, A., Ellis, R., and Bull, S. 2009. "Conversational Agents in E-Learning," in *Applications and Innovations in Intelligent Systems XVI*, London: Springer London, pp. 169–182.

Luger, E., and Sellen, A. 2016. "'Like Having a Really Bad PA': The Gulf between User Expectation and Experience of Conversational Agents," *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*, pp. 5286–5297. (https://doi.org/10.1145/2858036.2858288).

Öhman, A. 2005. "Qualitative Methodology for Rehabilitation Research," *Journal of Rehabilitation Medicine* (37:5), pp. 273–280. (https://doi.org/10.1080/16501970510040056).

Pereira, J., and Juanan. 2016. "Leveraging Chatbots to Improve Self-Guided Learning through Conversational Quizzes," in *Proceedings of the Fourth International Conference on Technological Ecosystems for Enhancing Multiculturality - TEEM '16*, New York, New York, USA: ACM Press, pp. 911–918. (https://doi.org/10.1145/3012430.3012625).

Schlesinger, A., O'Hara, K. P., and Taylor, A. S. 2018. "Let's Talk About Race: Identity, Chatbots, and AI," in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, New York, New York, USA: ACM Press, pp. 1–14.

Schroeder, J., Wilkes, C., Rowan, K., Toledo, A., Paradiso, A., Czerwinski, M., Mark, G., and Linehan, M. M. 2018. "Pocket Skills: A Conversational Mobile Web App to Support Dialectical Behavioral Therapy," in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, New York, New York, USA: ACM Press, pp. 1–15.

Schuetzler, R. M., Grimes, G. M., and Giboney, J. S. 2018. "An Investigation of Conversational Agent Relevance , Presence , and Engagement," *Twenty-Fourth Americas Conference on Information Systems*, pp. 1–10.

Sidorova, A. 2018. *Understanding User Interactions with a Chatbot : A Self-Determination Theory Approach*, pp. 1–5.

Tallyn, E., Fried, H., Gianni, R., Isard, A., and Speed, C. 2018. "The Ethnobot: Gathering Ethnographies in the Age of IoT," in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, New York, New York, USA: ACM Press, pp. 1–13.

Williams, A. C., Kaur, H., Mark, G., Thompson, A. L., Iqbal, S. T., and Teevan, J. 2018. "Supporting Workplace Detachment and Reattachment with Conversational Intelligence," in *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems - CHI '18*, New York, New York, USA: ACM Press, pp. 1–13. (https://doi.org/10.1145/3173574.3173662).

Winkler, R., and Soellner, M. 2018. "Unleashing the Potential of Chatbots in Education: A State-Of-The-Art Analysis," *Academy of Management Proceedings* (2018:1), Academy of Management Briarcliff Manor, NY 10510, p. 15903. (https://doi.org/10.5465/AMBPP.2018.15903abstract).

Wong-Villacres, M., Evans, H., Schechter, D., DiSalvo, B., and Kumar, N. 2019. "Consejero Automatico: Chatbots for Supporting Latino Parents' Educational Engagement Marisol," in *Proceedings of the Tenth International Conference on Information and Communication Technologies and Development - ICTDX '19*, New York, New York, USA: ACM Press, pp. 1–5.

Xu, A., Liu, Z., Guo, Y., Sinha, V., and Akkiraju, R. 2017. "A New Chatbot for Customer Service on Social Media," in *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems - CHI '17*, New York, New York, USA: ACM Press, pp. 3506–3510.