The Role of Intelligent Agents on Learner Performance

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Abstract: This paper explores the use of a male and a female intelligent agent in education. Qualitative analysis of learner performance, motivation, availability and support of the agents, agent gender, and human-like characteristics is presented. Our intelligent agents converse via speech and text with students on matters concerning the design and development of their electronic portfolio. Our contributions to the current literature are twofold. First, unlike current practices, we examine the use of intelligent agents over multiple sessions. Second, the dialogue between agents and learners is not predetermined. This allows the learners to be active participants in the learning process and interact with the agents as if they were interacting with an instructor, expert, or peer.

Introduction

Intelligent agents are software entities supported by an artificial intelligence engine and characterized by human-like characteristics, such as reasoning, reactivity, the ability to display emotion, and converse in either speech or text form. This study explores various facets of integrating intelligent agents in the classroom. More specifically, we examine how the agents impact learner performance and motivation, their availability and support to the learner, issues concerning agent gender, and how human-like the agents are perceived to be.

A male and a female intelligent agent (Fig. 1) were each employed in two preservice teacher courses. Their role was to converse with students to assist them in the design and development of their electronic portfolio over the duration of four weeks. The agents and the learners engage in a dynamic dialogue, in the sense that each discussion is not pre-determined. The learner types a question, which is in turn analyzed by the application, and through keywords matched to an answer from the agents' knowledge base. The agent then provides the answer both in text and speech form. Even though current teaching practices emphasize the importance of collaboration (Bransford et al., 1999) and active participation (Jonassen, 2000) in the learning process, previous studies utilized agent technology to present information in the form of a tutorial, which may or may not include the completion of a one-time task (Mayer et al., 2003; Atkinson, 2002; Craig et al., 2002). In such electronic learning environments, interactivity and dynamic discourse are minimal and the learner is a passive recipient of information.

Figure 1: The male, Alex, and female, Penelope, agents

In addition, examining intelligent agents over multiple sessions is not typical in the current literature (Cole et al., 2003). Even though results from single-session use of intelligent agents are informative and provide valuable

insights, an agent that students can use freely may generate further insights for improving the design and development of, and teaching and learning with, intelligent agents. Our preliminary results complement the existing literature by adding the perspective of learners when interacting with intelligent agents over time.

Method

In order to provide a context for the preliminary data of the present study, descriptions of the research methods are organized into several different sections. They include descriptions of the participants, materials, procedure, and data scoring.

Participants

The pool of available participants in this study consisted of 76 volunteer university preservice teachers (hereafter participants) who were enrolled in the post-baccalaureate teaching program at a large midwestern university. The participants were recruited from three sections of the EdHD 5007: Technology for Teaching and Learning course, a preservice teacher technology course.

Materials

The materials for this study consisted of an online portfolio system entitled eFolio; the Group Embedded Figures Test (GEFT) to measure a participant's field articulation (Witkin et al., 1977); two intelligent agents named Penelope and Alex; a technology and intelligent agent survey/demographic questionnaire; and a rubric for evaluating the online portfolios. All data were collected, however, this paper is reporting on the data from the focus groups.

Procedure

In a large midwestern university, three sections of an introductory technology course were instructed on the development of an electronic online portfolio called eFolio. Every preservice teacher must develop an eFolio showcasing their exemplary work within their program as well as how they have met the state board of teaching (BOT) standards. The eFolio is used by the students' advisors to evaluate how they have met the goals of the teacher education program leading to graduation. In the introductory technology course, students were evaluated on their success of developing their eFolio assessed on the rubric standards. The development of the eFolio is ongoing as this is one of the students' first courses in their program. The course prepares students how to use eFolio showing them how to do such actions such as populating necessary fields, showcasing they have met the BOT standards, adding graphics, and the like.

The same instructor taught all participants on how to use eFolio during a three-hour class period. All participants were also instructed on how to utilize paper-based tutorials, online video tutorials, and had access to a teaching assistant outside of the classroom. Moreover, two of the three sections were given access to an intelligent agent to ask questions at any time. One section interacted with Penelope, a female intelligent agent and a second section had access to Alex, a male intelligent agent. Students made a link directly to the intelligent agents from their eFolio page. The control group was a section with no access to an intelligent agent.

All participants took an online post-survey that asked questions ranging from how comfortable they are with technology to the development of an online portfolio to their interactions with the intelligent agent and also completed the Witkin's GEFT to measure their field articulation. Lastly, participants participated in a focus group.

The goal of the study was to answer the following questions from the data we collected.

1. What are participants' impressions of various available scaffolds when completing eFolio, the online portfolio system?
2. What impact does the availability of an intelligent agent have on student learning?
3. Does the gender of an intelligent agent have an impact on student learning?
4. Does field articulation have any impact on the use of an intelligent agent and/or the development of an online portfolio system?

Data Scoring

At this point in our data analyses, only the focus group data have been analyzed. A constant comparative method (Glaser & Strauss, 1967) was used to guide the development of the salient categories and patterns in the data of the focus groups. First, compiling the data that pertained to each group developed an individual data set for each focus group. Then, the data was read noting emerging patterns across individuals. The patterns were compiled, shared among authors, and reread searching for confirming and disconfirming evidence for the patterns. A consensus on the salient patterns that emerged from the data was identified.

Discussion

Learner Performance – "He can be helpful in general."

While empirical research has revealed no increased learning performance with the use of agents (Baylor, 2002; Mayer et al., 2003; Craig et al., 2002), more recent studies found that learner performance could be improved when the agent is employed in a well-structured learning environment. The experiments of Atkison (2002) and Moreno et al. (2001) revealed increased scores for participants who interacted with an agent compared to those working on their own. In addition, a research study conducted by Cole et al. (2003), concluded that even though their intelligent agent was a disembodied head lacking natural facial expressions, it still engaged and helped participants learn.

Over the period of this study, the agents were asked numerous questions on a variety of topics not limited to electronic portfolios. Results revealed both the efficacy of the intelligent agents and their limitations. A participant was pleased when the agent "…knew how to upload a picture to [her] efolio". The following example shows how the agent provided the requested help to the learner:

User: Can you please help me add a picture?
Agent: To add an image to your efolio you need to follow these steps:
1. In Admin mode, go to the section in that you want to add the image (e.g. Home).
2. Click on the Image link on the right hand side.
3. Click Browse to find the image you want to add.
4. Find the file and click open to select it.
5. Click Upload to add it to your efolio.
6. Give your image a title and a descriptive caption and press Apply.
7. If you are satisfied PRESS Finished.

On the other hand, we encountered many instances where the agent was not able to support the learner. There may be a number of factors that influence whether or not the agents respond correctly to a question. First, questions asked by learners may have been too complex or oversimplified and did not match to any answers in the agents' knowledge base. One student commented, "*Maybe his answers have to do with how we ask the questions.*" Second, in the development of the knowledge base, we did not account for all possible questions that could have been asked by the participants. Third, grammatical or spelling errors in the questions may generate the wrong response. Finally, different keywords in the question may match a wrong response. For instance, keywords in the following example were incorrectly identified to mean 'What is efolio?' Hence, the following answer was given to the question 'what is the address for efolio?':

User: what is the address for efolio?
Agent: Electronic portfolios are similar to "hard copy" portfolios, except that they are created in a virtual environment and can be accessed any time from anywhere. eFolio Minnesota gives you the flexibility to access your electronic portfolio site in order to change or add content. You can upload documents, pictures, graphics, audio, and video files into your electronic portfolio to give your audience an actual look at what you can do. It is easy to design the parts of your eFolio; it is as easy as using a word processor.

These problems caused frustration to participants. One participant commented, "I asked her five times in the beginning of class. She couldn't answer so I stopped using her," and another stated, "The fact that he couldn't help me made me really angry…"

Motivation – "I asked him [the agent] everything I could think of!"

Intelligent agents can be motivating for a number of reasons. Agents, when well designed, can interact socially with the learner. They are able to converse on a variety of subjects and engage the user in a discourse that goes beyond the passive presentation of information. A conversation that is geared towards the learner's interests and not towards the interests of the computer application is likely to motivate the learner to interact more frequently with the agent. Mayer and Moreno (2004) argue that social interaction is likely to actively engage the learner in the learning process while Lester et al. (1997, p. 359) hypothesize that, *"by creating the illusion of life, the captivating presence of the agents can motivate students to interact more frequently with agent-based educational software."* Another factor that may motivate learners to frequently interact with intelligent agents is the novelty effect. Artificial entities are not widely adopted in today's classrooms (Craig, Gholson, & Driscoll, 2002). Therefore, such tools may incite curiosity among participants and motivate them to interact frequently with the agents.

The first day of introducing the intelligent agents in the classroom, we observed 996 interactions between the participants and the agents, where each interaction refers to a question-answer pair. Participants showed excitement and interest in interacting with the intelligent agents. Motivation also came up frequently during our focus group discussions. One student commented that she interacted frequently with the agent because she "was curious of how much he knew." She was fascinated by the fact that the agent could "remember" what had been discussed and refer back to it in the conversation. Furthermore, five of the participants noted how the conversation went beyond the development of eFolio and into areas they "really didn't want to share." Regarding the novelty effect, a student mentioned that she "had never seen anything like that". An interesting remark related to the social presence of the agents was that, "It felt real! I always said hi and then asked a question… Like a real person."

Availability and Support – "It's kind of lonely at the computer and it's nice to have someone respond to you"

Instructors and teaching assistants (TAs) may currently be the best source of information for learners but they are not always available every time participants decide to work on their electronic portfolio. Frequently Asked Questions (FAQs) may partly solve this problem but, as Veletsianos and Yerasimou (2005) argue, they may not necessarily support participants and do not provide a venue to discover participants' needs and difficulties. Intelligent agents, unlike instructors and teaching assistants, are available to answer questions at any time the learner needs support. Moreover, intelligent agent technology allows for the recording of interactions, thereby enabling the instructor to monitor learner needs and difficulties.

Predictably enough, participants mostly worked on their assignment late at night. When asked what time of the day they utilized the agents more, they responded that they used them, "late at night", "after 8 p.m.", and "between 12 a.m. and 2 a.m." At those times, neither instructors nor TAs could have been able to provide immediate support to learners. The intelligent agents, however, were available at all times: "[I] loved the fact that she was always available", "It's good to have someone there all the time." Another student remarked, "I like the concept [of the agent]. Working at home can be tough especially when one is intimidated by technology." Participants also seemed to prefer to find answers to their questions through the agents rather than searching the FAQs. They stated that FAQs are more generalized while they could ask the agents specific questions. Even though a student noted that she "went to [the agent] first and then to the frequently asked questions", someone else mentioned that she "definitely got better answers from other people."

Agent Gender – "Can we pick with whom to interact with?"

Individuals have different learning preferences. Some are visual, others are auditory, yet others are tactile. In the same way, learners may prefer to interact with agents that have different characteristics in terms of gender, ethnicity, age, or even attractiveness. We also examined participants' perceptions of the gender of the intelligent agents. Baylor and Kim (2003), argue that learners who interact with agents sharing the same gender *"…may better engage in interaction with the agent and enhance learning and motivation, accordingly"*. Their findings suggest that

learners found male agents to be more outgoing and agreeable than female agents. In addition, learners who were paired with the male agents were also more satisfied with their performance than learners who were paired with female agents, even though both agents were using the same knowledge base. These results support Moreno et al. (2001).

Discussions with participants did not reveal much about gender. The group with the female agent seemed to like interacting with a female character: "Having a woman made it more casual." While the consensus in the group with the male agent was that "it's more inviting to have a male", the only two male participants said that we should "make him a woman." It should be noted here that each group only interacted with one agent – either a female or a male. Therefore, we cannot draw any conclusions on gender preference.

Software or Human? – "She freaked me out: She was too human!"

During the discussions, we noted that participants were referring to the agents as if they were human beings, i.e. either using the pronouns he/she or the agents' names. It was interesting to listen to participants talk about the agents' human like characteristics: "I liked the way she looked. She was friendly and approachable", "he changed clothes", "the aura of Alex [the agent] is that he has a personality". In addition, participants were impressed by various other characteristics exhibited by the intelligent agents. For example, one student commented that she liked the agent's "cynical personality" while another found it "interesting that he [the agent] could ask questions back". Finally, various participants commented that they were amazed that the agents could remember their name and other issues they talked about during their conversations.

Conclusion

In this paper, we examined various themes that emerged from a preliminary analysis of integrating intelligent agents in the classroom. The qualitative data presented above may prove beneficial to other researchers and educators who may want to implement intelligent agents to support teaching and learning. It is important to note that intelligent agent technology has the potential to impact learning beyond the current setting of creating electronic portfolios. Equally importantly is the light that this research study throws on the use of intelligent agents over a longer time frame. Some of the results presented above may not have been reported had the agents been used only once. Researchers may further want to investigate the design of intelligent agents, examining variables such as gender, age, and appearance, and their impact on learning.

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