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Conversational Agents and Their Longitudinal Affordances

on Communication and Interaction

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Abstract

In this study, we investigate the effects of conversational agents on communication and interaction when used to assist participants in developing an online portfolio. Data from 52 participants were gathered and analyzed through questionnaires, written reflections, transcripts of student-agent interactions, and focus groups. Data revealed that participants communicated with the agents on issues ranging from portfolio development to popular culture. Although participants did not view the agents as particularly helpful in completing class activities, they did use them as social companions throughout the four-week study. Implications of the findings for future design and research include: (a) learner-developed conversational agents, (b) improved "intelligence" with which agents deliver content-based knowledge, and (c) further developed virtual characters that can meet users' humanistic and utilitarian expectations.

Conversational Agents and Their Longitudinal Affordances on Communication and Interaction

Virtual characters are becoming more common within industry and academia where they have been used in a variety of domains for multiple purposes, such as assisting learners on how to complete a task (e.g., Baylor and Ryu, 2003) or to report sports news online (e.g., http://sports.espn.go.com/chat/sportsnation). In response, a number of research studies have been conducted on the use of virtual characters in educational environments although these have come to no consensus as to whether virtual characters improve learning and teaching. Baylor (2002), Craig, Gholson and Driscoll (2002), and Mayer, Dow and Mayer (2003) for example, have argued that the use of agents does not generally contribute to improved performance. Specifically, Baylor (2002) observed that student performance on the development of an instructional plan did not differ among agent conditions. Craig, Gholson and Driscoll (2002) discovered that agent properties (agent only, agent with gesture, no agent) were not able to explain differences in students' performances for retention, matching, transfer, and multiple choice questions; and Mayer, Dow and Mayer (2003) found no significant difference on problem-solving transfer performance regarding the presence of the agent's image on the screen. On the other hand, Moreno, Mayer, Spires, and Lester (2001) found that students who interacted with an agent and received text in audio format attained higher scores than those working without an agent and receiving instruction via written text. Dehn and van Mulken (2000) and Gulz (2004) examined the proposed benefits of agent-enhanced learning environments and found that the evidence for integrating agents in educational settings is at best mixed. This lack of unanimity is further complicated by differences in the design of agents and experiments (Clark and Choi, 2005). For example, Cole et al. (2003) had used an agent that was described as a disembodied head lacking natural facial expressions, while Louwerse et al. (2005) used a

combination of animated cartoon-like and human-like characters. Only recently have researchers proposed frameworks for uniform research design so as to make meaningful comparisons possible (Clark and Choi, 2005; Ryu and Baylor, 2005)

The majority of studies concerned with virtual characters have been short-term experimental and quasi-experimental in nature (Mahmood and Ferneley, 2006), attempting to discover relationships between various virtual character features (e.g., image, voice, animation) and various variables of interest to educators (e.g., meta-cognition, motivation, self-efficacy). In this study, we attempt to complement the literature on which features of virtual characters may influence learning by examining students' multiple interactions with and responses to conversational agents *over time*, as well as the effects the students believe these agents had on their learning. An important weakness of the current literature is that researchers do not know what happens when agents are integrated in ecologically valid contexts where learners have the option to return or not to return to agent-based systems (Gulz, 2004).

We define conversational agents as virtual characters that are able to sustain a conversational interaction with students through students' textual input. We use the term conversational rather than pedagogical agent because pedagogical agents mainly seem to refer to non-interactive virtual characters that deliver content to students. In addition, we abstain from using the term intelligent agent because the word intelligence signifies a higher-order cognitive ability. Even though the conversational agents we employ may appear to be intelligent, in actuality they are not – the software is simply trained to match comments to responses. The interaction between student and agent is not pre-determined, but shaped by both student comments and agent responses. For example, if a user asks the agent, "What does it mean for a website to be accessible?" the conversation will center on this particular question. If the user then

asks a further question about a specific aspect of the agent's answer, the conversation can be said to have been influenced by the agent response but would still be dependent on the user's subsequent comment. Using an artificial intelligence engine (Program Z by Pandorabots), student comments are analyzed into meaningful segments and, through an iterative algorithm, are matched to responses. The knowledge base is created via the use of the Artificial Intelligence Markup Language (AIML), and the conversational characters utilized are a modified version of the A.L.I.C.E implementation. Specifically, we adapted the A.L.I.C.E 2002 AIML set to fit the needs of our research by customizing both the characters' personalities and knowledge base. Therefore, the characters had an encyclopedic knowledge base provided largely by the A.L.I.C.E AIML set that was also tailored to serve as an in-depth content-specific information source about electronic portfolios. We chose to work with AIML because of its ease of use, adaptation, and conversational believability.

Purpose

In this study, we seek to better understand how conversational agents (CAs) assist learners in developing an online portfolio over a time frame that allows for multiple interactions between students and agents. We specifically examine students' perceptions of the value of a CA in solving tasks that require both procedural and declarative knowledge. In particular, we address three related questions:

1. How do students respond to conversational agents?

2. How useful do students find the conversational agents in their learning?

3. How do students interact with a conversational agent?

Background

This study was conducted at a large, metropolitan university in the Midwest with preservice teachers who were required to enroll in an educational technology course that was content- and cohort-specific. For example, the section designed for elementary education majors was focused on technologies targeted for the elementary level, such as Kidpix[TM] and Kidspiration[TM], whereas that for the social studies majors focused on social studies-specific technologies, such as geographic information systems and Google Earth[TM]. During this course, one technology was introduced per class period, and students met seven times throughout the semester for an average of three hours per class period.

Although each course section covered content-specific technologies, students in all sections were required to develop an online portfolio, called *eFolio*. Faculty members had two primary purposes for the use of eFolio: (a) allowing students to showcase how they have met the state board of teaching standards, and (b) serving as a multimedia demonstration of students' progress to which instructors can refer throughout the students' teacher education program. Moreover, students were encouraged to develop the eFolio in ways that can assist them in their future career and job search.

The eFolio was a major element of the course, as it affected every student who goes through the university's licensure program - approximately 550 students every year. With the high number of students and the limited seat time within class, the faculty who teach the course initially developed several resources to support student learning, such as written and video-based tutorials, but soon found out that students were requesting additional support. The authors identified and adapted the use of a CA as the best option for providing instantaneous online support to students whenever needed. Students were given access to the CA throughout the four weeks they had to complete their eFolio assignment.

A conversational agent was selected because it can be useful to students on three levels. First, it functions as a personalized scaffold for learning. Students are able to ask questions that are of immediate interest to them and are not limited to a textbook or a set of predetermined frequently asked questions. Second, a CA acts as a human-like companion for the students, appearing polite and welcoming, and providing immediate feedback, support, and encouragement. Finally, regardless of the time and day (unlike instructors and teaching assistants), the agent is available to answer questions with consistent enthusiasm and clarity.

Method

Participants

The participants in this study consisted of elementary education preservice teachers (hereafter participants), who enrolled in a post-baccalaureate masters program in education. Participants in this study were in their first semester of the 15-month post-baccalaureate licensure program. Eighty-five students in the three elementary education sections were invited, and 52 elected to participate. Of these 52 students, 45 were women and 7 were men. Those who reported their age (47) ranged in age from 21 to 50 years (mean = 23.43, SD = 5.06). This was their first educational technology course.

Data Sources

All 52 participants completed a demographic questionnaire, wrote reflections about their learning experience, and interacted with the conversational agents. Approximately half (23) of the participants also attended focus group sessions, 10 in a focus group based on their interaction with a male CA named Alex, and 13 in a second focus group based on their interaction with a female CA named Penelope (Figure 1).

INSERT FIGURE 1 ABOUT HERE

All focus groups lasted approximately 1.5 hours and were audio-taped. The same three researchers were present at all focus group interviews providing for researcher learning. The first author facilitated the sessions using a semi-structured interview protocol, while the other researchers observed and took notes. Participants noted that they were "relaxed and excited to share" their experiences during the focus groups as they answered open-ended questions that were used to prompt reflections on their learning experience with the CA. The questions focused on three topics: (a) the students' perceptions of the conversational agents, (b) how the students believed their experience with the agents influenced their ability to complete their eFolio development, and (c) how the students generally interacted with the conversational agents.

During the educational technology course, the preservice teachers were assigned to write reflections about each technology they learned examining the instructional implications for the use of each technology in the classroom and providing examples of how K-12 students could use the technology to support their learning. Since the CAs used for the eFolio development was one of those technologies, these reflections were collected and analyzed.

Finally, all conversations that occurred between the CAs and each of the participants were recorded in a database that was later analyzed for the purposes of this study. These recorded conversations amounted to 216 pages of text. A question-answer pair was counted as one interaction between the agent and the learner. Each learner session with the CA was counted as one conversation.

Data Analysis

Because our research interest was in uncovering the design issues that impact the effective use of CAs to assist student learning, we employed a qualitative approach to analyze our data so as to identify emerging patterns across participants' responses. We believe that

salient issues would emerge from this case study and such issues could direct future research, especially longitudinal investigations. Yin (1994) indicated that the case study helps explain the "links in real-life interventions that are too complex for the survey or experimental strategies" (p. 15). Since the setting of this study was a new approach to utilizing CAs to learn educational technology, using a case study and qualitative approaches to analysis would allow any complexities to emerge.

To guide the development of the salient categories and patterns in the data, we used a constant comparative method (Glaser & Strauss, 1967). First, we developed an individual data set for each participant by compiling their responses to the CAs across the various kinds of data collected. We then read through the data, noting common patterns that emerged across the responses of participants. After jointly compiling these patterns, we re-read the data to search for confirming and disconfirming evidence and reached a consensus on what salient patterns were emerging from our data. Although the focus group and questionnaire data were originally coded separately, the data were combined once the common themes were identified so that similar responses from the same participant within the focus group and the questionnaire were counted only once.

<div align="center">Results</div>

The analysis of the above data revealed five major themes. Two themes were related to the participants' experiences using the CAs to meet their educational goal of successfully developing an online portfolio, while three themes addressed other participant responses to their experiences with a CA. The themes surrounding participants' experiences suggest that participants placed the CAs in the position of what researchers have called an "intentional social agent." Specifically, participants expect the CAs to be friendly, possess a unique personality, and have a broad

knowledge base regarding popular culture (e.g., Alvarez-Torres, Mishra, and Zhao, 2001; Nass, Moon, and Green, 1997). Although students' responses made clear that the CAs within this study did not have enough content-knowledge to support the participants' development of the online portfolio at the level the participants had hoped, many of them also reported spending considerable amounts of time conversing with the CAs on issues quite unrelated to the content knowledge the agent was initially adopted to support. As will be discussed below, the CAs intelligent functionalities and communicative capabilities led participants to engage in conversations with them on a wide range of topics (e.g., popular culture, intimate conversations, and politics).

Specifically, our analysis of these themes produced the following findings regarding the effectiveness of the CAs in supporting student learning:

1. Participants reported that CAs provided limited support of their learning process during the eFolio development.

2. Participants found that CAs were not as supportive as hoped for specific tasks in the eFolio development.

3. Participants claimed that CAs provided humanized social support.

4. Participants reported having multifaceted dialogues with CAs.

5. Participants wished to have some control over individual characteristics of CAs.

Each of these findings will be discussed in turn.

CAs provided limited support of participants learning process during the eFolio development

Sixty-one percent of participants made comments that their experiences with the CAs were of at least some help when developing their eFolio (Figure 2). Although participants reported that the CAs were not always accurate in their specific answers related to content-

related knowledge, they also commented that the CAs provided assistance in a way that encouraged the participants to return to the CAs repeatedly throughout their learning experience. Jeffrey[1], for instance, commented "Granted, he wasn't accurate all the time, but he was still pretty accurate enough to where he would keep you involved in it. I anticipate it is very difficult to get him to say all the correct answers." Although not all questions were answered correctly, many participants reported being "surprised" and "motivated" by the CA's ability to accurately answer the multiple questions they posed.

INSERT FIGURE 2 ABOUT HERE

Students reported being motivated to ask the CAs a series of questions ranging from how to find the correct website address for eFolio to directions for uploading and displaying pictures. Mary mentioned how happy she was with the help given to her by Alex: "I liked how he explained how to upload a picture. Everything pertinent to the course that I asked was useful." Jill had a similar response, stating "Some questions [Penelope] did not know how to answer, but overall, the simple questions that I asked her she was able to help me out a lot along the way." Many participants noted being pleased with the CAs' answers to their questions and with the CAs being available to them whenever they needed assistance. Susan, for example said,

> I definitely think the concept of Alex is good, or something along that line, because we have class every other week, and sometimes it is once a month, which is fine, but it's hard when we are working on things at home or even come in to the lab and not know what we are doing. When some of us are intimidated by technology anyways, to have something that we can go to and get answers or ideas or suggestions is fantastic!

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[1] The names of participants have been changed to protect their identity.

Jenny also reported being pleased that the CA was available at all times and felt like she had her own "personal lab assistant" throughout the day. She said that often as soon as she left class or the open computer lab times, she would have another question because, "the questions you could ask about eFolio are endless." Students often praised the availability of the CAs. Maddy, for instance, stated, "As far as convenience, at 10:00 at night when the lab is not open, it's nice to have her [Penelope] available. She was constantly on my screen with a smile." Joe also noted that, "The fact that he [Alex] was always available, when the professor isn't, is a nice aspect of Alex."

Participants reported that they found the dual format in which CAs delivered their answers – both text and audio – a very helpful feature. Sue said, "I think it was nice to have verbal guidance instead of just reading something because it is easier to understand." Matt commented that a great benefit of the CA was that everything the CA said was also written out, noting that he could not always understand all of the words that the CA was using but he could read along providing him another mode of learning.

In summary, participants identified three main areas in which they found the CAs supportive and helpful: (a) solving simple procedural steps when developing their eFolio as opposed to "complex" questions that involved more than one procedural step (e.g., How do I upload a picture *and* embed a link to a website), (b) having access to the CA at any time throughout the day to assist them in answering their eFolio questions, and (c) receiving answers in multiple formats thereby supporting Moreno and Mayer's (2002) contention that the combination of verbal and textual narration enhances learning.

CAs were not as supportive as hoped for specific tasks in the eFolio development

One-third of the participants made some comment about finding the CAs unhelpful when developing their eFolio, albeit most noted that they believed the CA was a technology that was "more than worthy" of being utilized in a learning situation. Although participants were not always satisfied with the results of the answers from their content-related questions, they still found the CAs engaging and spent numerous hours conversing with them outside of the content-related questions, as will be discussed below.

Many participants reported becoming frustrated when the CAs could not provide clear or specific answers to their content-related questions. Sarah, for example, said,

> Some of my files weren't saved as .doc, and I couldn't figure out how to change them and the uploading wasn't working. I asked Alexander, and he had no input for me [laughs]. He made some smart comment and changed the subject [more laughs]. That was probably the only issue I had with him. But the fact that he couldn't help me made me really angry at Alex.

Joe had an even stronger response: "I don't like Penelope. I asked her a question like five different ways and she still couldn't answer it. I don't remember what the question was but she should have been able to answer it." Three-quarters of the participants reported having to rephrase the questions they posed to the CAs in order to elicit an answer that was appropriate and not confusing. In Penny's words, "I felt that my question was just too difficult. I tried rewording it but I really didn't expect her to know, and then when she didn't know I wasn't that surprised." Some participants also felt responsible for the difficulties they had with the CAs. For example, Sue said, "When you are getting frustrated with a part of eFolio and you go to ask her, you'd think that she should probably know it, but you know you are not phrasing the question

correctly; that becomes even more frustrating. Because you were like, she would know this if I just knew how to say it to her."

Participants were also frustrated by confusing answers. Misty said, "Every time I would ask [Alex] a question he would say, you need to download some software or something. I didn't know what that was about, so I didn't bother." Joel followed her comment with a similar story,

I asked [Alex] what the eFolio website was because I wanted to go to the website because I deleted the email that told me. I wanted to go to the website and find their contact number and things like that and email them. He was explaining what eFolio was and I was like ... argggg … forget it. And so I did my own little search and then I found it, but I kept him there in case I got stuck.

Participants appeared most frustrated when content-related questions that they felt should be "routine" or "standard" could not be answered correctly. Sue, for instance, said, "You would type something easy like 'burning a CD,' and it would bring you all these things but 'burning a CD' which is pretty standard." Participants often reported expecting the CA to have the answers immediately and in a format that could easily be used. When this was not the case, some participants reported that they became frustrated and sometimes gave up using the CA and continued to develop their eFolio on their own. Participants especially reported wanting an immediate answer for their eFolio-related questions and when they didn't receive it, became extremely frustrated. They did not "appreciate" it when the CA "didn't know an answer" and even worse, had an "attitude" when answering their questions, as they expected the CAs to be eFolio experts able to assist them with all aspects of their eFolio development. Sarah noted feelings of "anger" when Alex could not answer her question while Joe seemed "disappointed" that he could

not elicit the help he desired. Six students commented that the more complex or advanced the questions they posed about development of their eFolio, the less it seemed that they would receive a satisfactory response.

Another finding was that when participants did not receive a correct answer to their on-task eFolio-related questions, they would often switch to asking the CA unrelated, off-task questions. When we analyzed the participants' on-task versus off-task questions to the CA, we discovered a novelty effect occurring the first few days of use. As Figure 3 shows, more than 91% of the questions participants asked Penelope during the first 2 days were off-task questions. The total number of comment-and-response interactions dropped drastically until shortly before the eFolio assignment was due; even then, the highest percentage of interactions were off-task.

INSERT FIGURE 3 ABOUT HERE

Similar data about the use of Alex can be seen in Figure 4. Almost half of the total interactions for the duration of the study took place during the first three days the participants had access to Alex. Use again peaked approximately one week before the assignment was due in class.

INSERT FIGURE 4 ABOUT HERE

To summarize, participants found the CAs unhelpful when they gave incorrect or confusing answers to content-related problems. A number of participants reported expecting the CAs to be able to answer their questions easily and after having a few questions incorrectly or unclearly answered, simply stopped using the CAs for eFolio assistance and looked to other means to have their questions answered. This would seem to support the suggestion of Norman (1997) that individuals may have inflated

expectations from agents that are presented in human form. The combination of a human-like image, conversational ability, natural language interaction, and lip-synchronized audio may have led participants to expect a higher level of agent intelligence and expertise than they might from a similar informational exchange with a computer by means of just a text box.

CAs provided humanized social support

Eighty-four percent of participants' responses focused on the humanizing features of the CAs. Participants reported perceiving the CAs as humans, commenting on such things as the agents' ability to remember, looks and clothing, and how the CAs made them feel. Prior research indicates that users ascribe social rules and human-like characteristics to media (Reeves and Nass, 1996) regardless of how unsophisticated these media may appear to be (Nass, Moon, and Carney, 1999). Most of our participants reported connecting emotionally with the CAs due to the human-like interactions, which some researchers argue may facilitate learning (Lester et al., 1997; Moreno et al., 2001).

Ninety percent of the participants reported they enjoyed the presence of the CA on their screen which, in Joan's words, made them feel as if they "had a friend available to talk with." Sara said,

It's kind of lonely at the computer, because you know, there's nothing else on the computer that I can really talk to, and when you talk to Alex and he responds, it's kind of like a person there with you. Even though it's an artificial person, it's nice to have someone respond back to you instead of you putting all your energy into the technology.

Eighty-two percent of the participants were motivated to talk to the CAs because they felt they appeared to be like an actual person. Lauren commented, "I thought it was weird. When I opened [Penelope] I thought I always had to say hi to her like an actual person, I would always say, Hi Penelope!"

Over 80% of the participants remarked that they could not believe how true-to-life the CAs appeared to be, repeatedly commenting that they were surprised by the CAs social presence, intelligence, and ability to converse and remember. Commenting on Penelope, Peter reported that "Honestly, when I first saw her I was kind of freaked out by how much she was talking like a real person." Participants also appreciated that the CAs had their own identities, voice tones, and that they weren't developed after a celebrity or someone recognizable. Sue said, "If it was like a celebrity, it just wouldn't seem as real as Penelope. She was kind of like her own person." Taylor couldn't believe how "real" Penelope was and that her voice was not "alien or monotone." He and 14 other participants commented on how much they enjoyed repeatedly interacting with the CA. As Sara commented about her interactions with Alex,

> He was fun to talk to. He knew lots of other things, like every question I could
>
> come up with he knew how to answer. He was pretty good. He was pretty on top
>
> of stuff. He knew why the sky was blue and he was funny and good company.

Half of the participants also mentioned enjoying the CA asking questions back and having a sense of humor. Sue said, "I liked that Alex had a sense of humor. If you asked him the same question more than once, he would have a different answer each time. He had personality!"

Another participant who described being pleasantly surprised by the human-like capabilities of the CAs was Laura who stated, "I actually asked her what my name was and she

told me like a guy's name or just made one up and then I said, 'No, my name is Laura,' and then we kept talking and asking her questions and I said, 'What's my name again?' and she goes, 'I already told you, it's Laura'." Rebecca commented, "I liked that [Alex] had a memory. Like he would bring up things from, you know, ten questions ago. He would bring them back to the conversation like he had some concept of what you were asking him." Lauren continued, "I asked her some question and then I asked her another question relating to it, and it was like we were having a conversation because she kind of remembered what I asked before. She related the questions to what I asked her before, and I was just like, Oh, wow!"

Participants also described the personality of the CAs. Some participants commented on how cynical some of the agents' responses seemed and how the developers should make the CAs have a more positive outlook. Four of the participants stated that they received "rude" comments from the CAs and were upset when they received the comment, "What's it to you?" However, they also noted that they probably shouldn't have been asking the question to begin with. Rebecca said, "I thought it was more fun to play with her. I did play with her for quite a while at night just because she did have lots of funny stuff to say." Joey said, "I was kind of rude to her one time and then she was rude back. But then I told her she was nice, and she said 'thank you, you seem nice, too'."

Eighty-five percent of the participants also commented on how they liked the CAs' appearance, and they made numerous comments related to how they noticed their clothes had changed. Rosie said, "I really liked when Penelope changed her clothes. I felt like, hey, this is so much fun, and why wouldn't I sit and talk to her?" Jill added, "[Penelope's] appearance was friendly and welcoming." Everyone in his focus group laughed as Jeff commented that, "I might go and visit her just because I wanted to see what she was wearing." He said he had told

Penelope that he liked what she was wearing and she replied, "Thanks!" He commented, "It was just too real and too cool." Six other participants also mentioned returning to interact with the CAs to see what clothes the CAs were wearing.

Five participants commented that they liked to show the CAs to their friends as they thought they were "cool" and that Penelope, the female agent, was "sexy." Ten of the participants noted finding the CAs attractive and enjoying looking at them. The majority of participants also mentioned that they would rather talk to the opposite sex because they found them more attractive and approachable. Brad noted, "I don't think a guy would feel not comfortable or anything, but I just think having a woman, it probably makes it more casual versus instructional. Whereas like a guy might, I would think that he might be a little more demanding."

Within both focus groups, the topic of sexually explicit comments arose. The participants laughed a great deal during these conversations. Two participants went into great detail explaining how they and their friends enjoyed conversing and asking any questions on their mind, ranging from sex to the weather. Taylor said, "Because she had an answer for everything, it was like pushing her limits. You know it wasn't a real person, so it's not that you are offending her." Participants would talk with the CA to see what he/she knew, and it commonly became a social event where the participants and their friends outside of the technology class would interact with the CA at their dorm or a coffee shop. For example, Sue said,

> I asked him everything I could possibly think of and my roommates could think of
>
> regarding [his] personal preferences, and I wanted to know if he changed his

answer, too. Maybe, if his favorite movie changed, or, you know, religion,

politics, general questions about the world. I was just curious if he knew.

Misty commented, "When I was with other people, that's when all the dirty questions came up, they were like try that, try that, so I was like, 'Ok, this better not come back to my name.' Brad said,

We were just trying to see what she would answer and so we were asking her,

'Would you go out on a date with this person?' 'Are you smart?' A lot of people

asked her, 'Are you smart?' Especially after she didn't answer something you

wanted her, she was like 'Why would you question my intelligence?' or

something like that, it was funny though. We got a kick out of her, me and a

bunch of my buddies.

Participants also discussed the impact the agents' appearance had on their perceptions of agent intelligence and ability. For example two participants commented on how smart they perceived the CAs would be by how they looked. Molly specifically said,

I think that how they look might depend on how smart you thought they were too,

like if it was some guy in a doctor's coat with glasses or something, you might

think that guy would be able to answer more of your questions than, you know, a

lady in a dress or you know what I mean? That's wrong and totally stereotypical

but I think that a lot of people would have those feelings about it.

Forty percent of the participants also commented on the CA's age. Although participants didn't know the CAs "actual age", they stated that they felt the CAs were old enough to be intelligent, but still young enough to relate to.

Finally, over 80% of the participants said they had the CAs available on their computer at all times. They perceived the CAs as a companion that was there to talk, amuse, and share ideas and stories. Participants reported feeling safe to share "just about anything" with the CAs, and this feeling allowed them to converse openly with the CAs on a variety of topics.

In summary, it appears that the participants perceived the CAs as being human. Over 90% of the participants made comments about the authenticity of the CAs, ranging from their looks to their personality. It seems that they were amazed by the CA technology and would spend hours interacting with them to see what the CAs knew. They enjoyed that the CAs had a human-like memory and could engage in a dialogue with them. The participants felt a sense companionship with the CAs and would log on to the CA's web site on a regular basis to have them present on the screen to interact with at their leisure. Lastly, the participants stated how comfortable they were when conversing with the CAs. They felt safe and were willing to freely ask questions and share details of their lives.

CAs and participants engaged in multifaceted dialogues

We also analyzed the data to determine the nature of the interactions between participants and CAs. We found that these dialogues were prompted by 4 types of questions: (a) questions related to developing the participants' eFolio, (b) questions about the CAs' personality, (c) questions about the CAs' general interests, and (d) questions about encyclopedic information.

Questions related to the development of the participants' eFolio occurred mostly during the beginning and the end of the four-week assignment period. Participants asked numerous questions trying to find the procedural steps needed to complete a task. They would continue to

ask questions until they began to get incorrect or confusing answers. At that time, they would immediately switch to a dialogue that normally was inquiring about getting to know the CAs' personality. Comments relating to the CAs being friendly, nice, sarcastic, and rude were common.

Those participants who normally spent more than five minutes interacting with the CAs led to dialogues on the CA's general interests. Questions such as "What do you like to do on the weekend?" and "What do you think of President Bush?" were common. Moreover, when these conversations began on general interests, an informational dialogue would ensue that mimicked a free flowing exchange of information between two individuals. Analysis of the conversation logs revealed that participants elicited answers to interesting questions such as, "What is the distance to the center of the earth?", "What is the meaning of life?", and "What is your stance on the legalization of marijuana?"

Participants requests to have some control over individual characteristics of CAs

Over 90% of the participants shared suggestions on ways that they believed the CAs could be improved. Seventy percent of the participants commented that they believed the CA was one of the best technologies available for providing assistance to students during the learning process. The most common suggestion was that the agents be made "smarter" so that participants would be able to obtain more accurate answers to their questions. Sara said, "I think the key really is to make [Alex] smarter, to have basic knowledge, because if he doesn't, we are going to go to a real person or email you guys." Most of the participants felt as if the CAs were intelligent enough and could help them, but that they were phrasing their questions incorrectly. Ideas on how to improve students' way of asking questions, such as using keywords followed by a list of questions, were mentioned. Molly said, "Maybe if you wrote a keyword in and then the

most frequently asked questions about that appeared. Like if I had a question about the standards, how to put standards in, I could type in *standards* and it would come up with 10 different questions people asked and I can go."

The second most commonly mentioned suggestion was giving participants an opportunity to customize the CAs. Participants wanted to be able to develop their own CAs and modify their personality, skin and hair color, hair style, face and body structure, clothes, and looks. For example, three participants stated that having the ability to develop a CA having a gender of their choice would make the CA "more attractive." If participants could not develop their own CAs, they said, they would like the opportunity to choose from a set of profiles. Jessie said, "Can we pick? Yeah, can we pick who we talk to? Cause what if you get tired to talking to Alex? You should give us profile choices." Participants thoroughly enjoyed interacting with CAs who had their own personality but wanted to change the CAs' personality and moods according to their own needs. Jeff said, "Maybe [Alex] could have different moods or something. Like if you want him to be sarcastic or cynical one time, or you want, like, positive thoughts."

In short, participants wanted to develop their own CAs with an appearance and personality that fit their preferences. If they could not develop their own CAs, they wanted to have the option of selecting one that "fit their own style." In addition to having customizable CAs, the participants either wanted the CAs to be intelligent enough to decipher their questions or have the technology to predict what the participants were going to say or ask.

Conclusions

In this paper we examined students' perceptions of the value of CAs in solving tasks requiring procedural and declarative knowledge. We addressed three questions: (a) how do students respond to conversational agents, (b) how useful do students find the conversational

agents in the development of their eFolio, and (c) how do students interact with a conversational agent?

We found that although the CAs were not perceived as extremely helpful by participants when developing their eFolio, the agents engaged learners far beyond the eFolio content knowledge. At all times throughout the day, participants would utilize the CAs for activities ranging from assistance in class to the latest in politics and popular culture. The social interactions were plentiful with more than two thousand interactions over a four-week period. Participants' questions were limitless as the design of the CAs allowed for a free-flowing dialogue at all times. Participants perceived the agent technology as an advantage to common assistance tools, such as frequently asked questions (FAQs) and "Help" sections, as they felt they were not impeded by the design of this tool. The ability to discuss any issue at length with the CAs led participants to feel as though the CAs were an excellent companion and someone they could talk with and discuss issues at length. The participants perceived the CAs as an on-demand friend and wanted to have input on all facets of how they looked, as well as their personality.

The CAs also elicited many feelings from the participants. Participants were amazed by the technology and motivated to use the agents, which included a comfort of sharing and questioning literally anything that seemed to be on their mind – from sex to Britney Spears to the background color choice for their eFolio. Although participants expressed a feeling of comfort, they also became very upset and frustrated when the CAs didn't know an answer to a question they posed or when the CAs became "cynical" and "had an attitude."

Implication and Recommendations

This study informs educators, instructional/human computer interaction designers, and learning technologists on issues that should be taken into consideration when developing

conversational agents to provide long-term assistance to learners. These issues include designing and developing: (a) a workflow for "smarter" agents, (b) learner-created agents, and (c) agents for humanistic expectations.

If learners are to utilize CAs with success, the CAs need to be intelligent enough to accurately comprehend the questions the learners are posing or the software application needs to offer an interface that guides the learners to ask their questions in an appropriate manner. The challenge in designing an agent that has content-based intelligence is that the designer needs to collect and predict what questions a learner may ask within a given learning situation. Thus, the development of effective conversational agents requires several stages of development that include collecting content-specific material, developing the knowledge database, and deploying the information in any given learning environment. In addition to developing a comprehensive knowledge database, designers using CAs for specific functions, as in this study, need to predict the multitude of ways in which questions could be asked by a learner. For example, a learner attempting to embed an image on his or her web page may ask the same question in any of the following ways: How do I upload a picture? What are the ways I can embed a photo on my web site? How do I put an image on my web page? The algorithm that deciphers the key words to answer the questions therefore must be able to "understand" synonyms and different approaches to posing a question. At the same time, to maintain its human persona and to engage users, such a conversational character should not present itself as all-knowing and autonomous right away, which may lead users to relinquish all responsibility for finding a solution or answer on their own.

Throughout the development of the field of instructional design and learning technologies we have seen a move toward learning *with* technology rather than learning *from* technology

(Jonassen, 1995; 2000). As they engaged with the CAs, participants in this study were learning by actively asking questions, discussing issues, and reflecting *with* the CAs on the course content. Indeed, it could be argued that participants were collaborating with the CAs by dialoguing to find a common answer. Yet, a number of students wanted even more participation in the learning situation by wanting to create their own CA according to their individual specifications. The most requested specifications were gender, attractiveness, personality, age, and perceived intelligence. If learners are able to share in the development of their own CAs, in essence personalizing the tools they are working with, they may become more motivated to work with the CA to elicit the correct answers and enhance their learning experience. This hypothesis is one that seems worthwhile to pursue in future research.

This study also demonstrated that learners were most attracted to the CA's ability to behave in a human-like manner, repeatedly commenting on how they perceived the CA as a companion or friend. Several mentioned that they enjoyed that the CAs had an "attitude," regularly changed their clothing, and personally greeted them. This suggests that CAs may be more effective if designers create CAs that adapt over time, and act and appear as a real person. Thus, designers' changing a CA's hairstyle, clothing, or glasses, to produce visible change in the CA over time could possibly influence learners' motivation to return to the CA for answers or dialogue. The data gathered in this study also support the findings of Wang et al. (2005) that the level of politeness presented by CAs does influence learning. While participants did not mind the CAs having an "attitude" when discussing issues unrelated to class, they were upset when the CA did the same when the participants were trying to find answers to their class-related questions. It needs to be noted however, that a believable human-like representation is likely to induce greater expectations in terms of agent abilities and intelligence. Therefore, designers are

advised to be cognizant of the conflicting effects of agents' image and language.

Participants' responses demonstrate that they felt comfortable and motivated to interact and share their questions and thoughts with the CAs about issues related and unrelated to their eFolio assignment, viewing the CA as a personal assistant and companion that was available on-demand. Thus, the participants noted the value of both the dialogue with the CA as well as the mere image of the CA on their screen. These two factors should be delineated in future CA research as we strive to understand the differential impact of a CA's conversational ability or presence. The overwhelming positive response and motivation reported by participants shows that this technology has a promising future as instructional designers strive to develop CAs with greater content-based intelligence and personalized learner-created CAs.

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Figure 1 Conversational Characters Penelope and Alex.

Figure 2 Participant responses to the question "To what extent was Alex/Penelope useful or not useful in learning to develop your eFolio?"
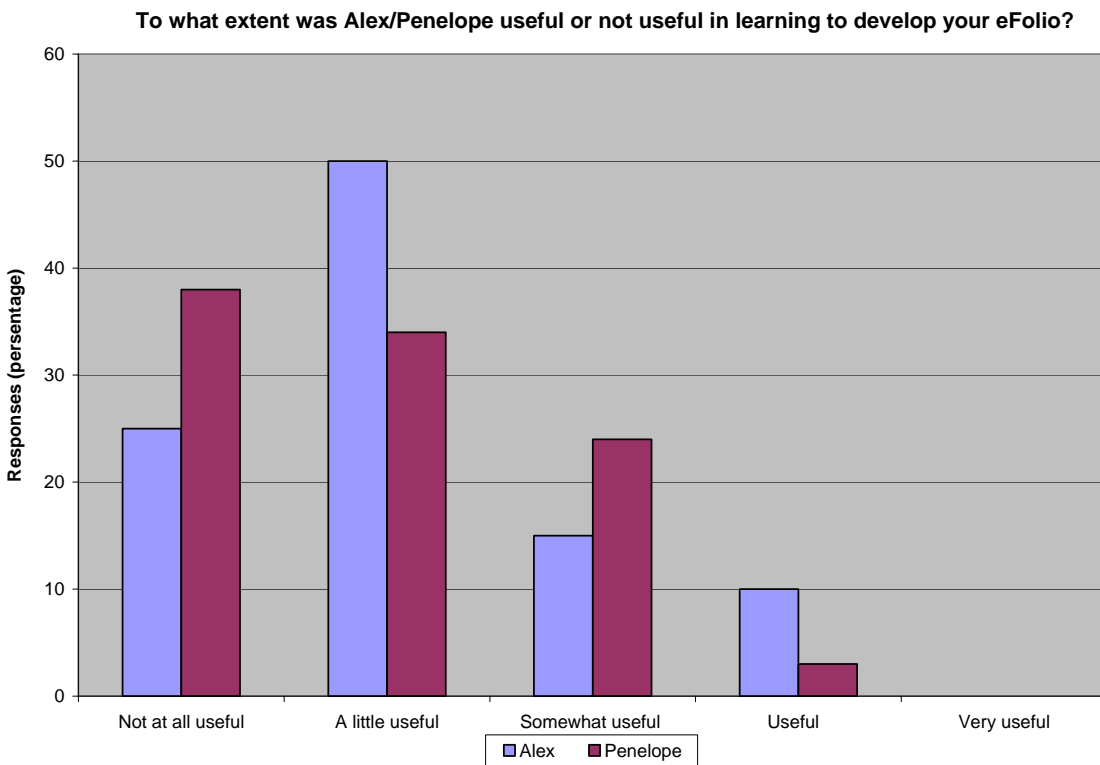
To what extent was Alex/Penelope useful or not useful in learning to develop your eFolio?
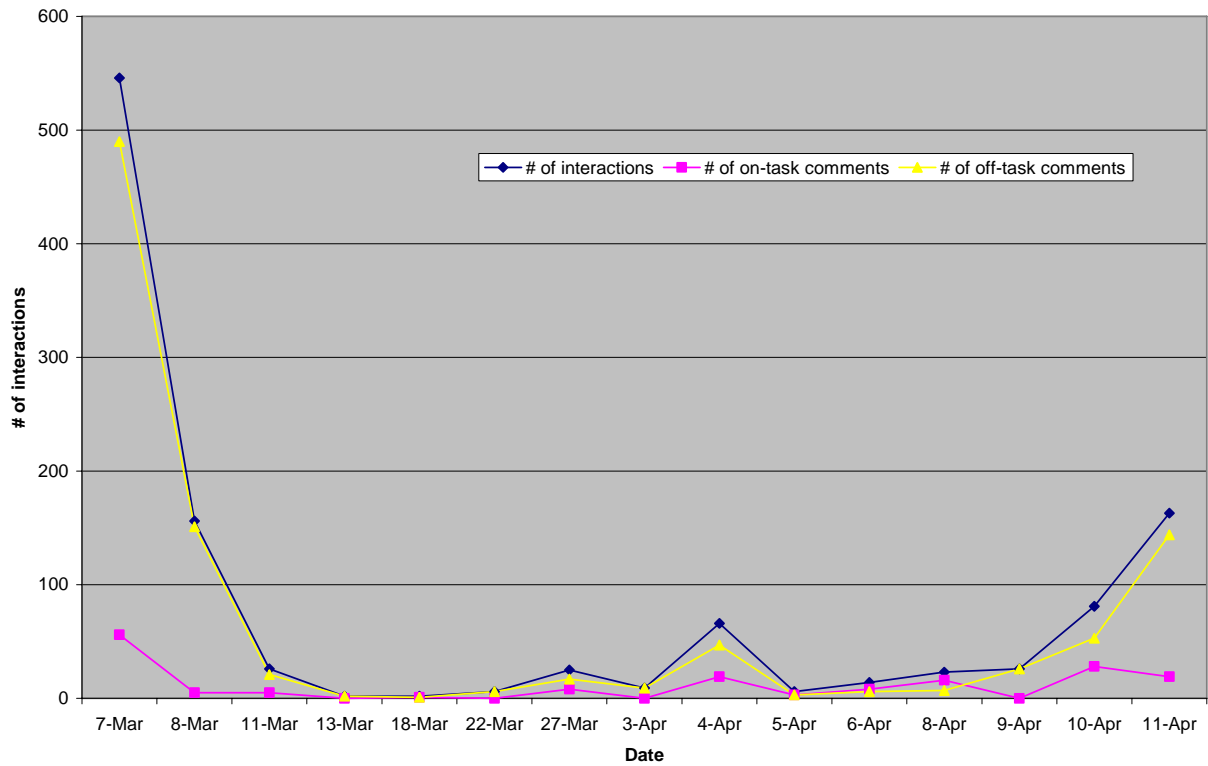
Figure 3 Number of participant-agent interactions: Penelope.

Figure 4 Number of participant-agent interactions: Alex