THE IMPACT OF STUDENT EXPECTATIONS AND TUTOR ACCEPTANCE ON COMPUTER-BASED LEARNING ENVIRONMENT ACCEPTANCE AND FUTURE USAGE INTENTIONS

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ABSTRACT
Computer-based tutoring systems should be designed to meet/exceed learners' expectations and maximize learners' technology acceptance to increase their satisfaction and future system usage intentions. Pedagogical Agents (PAs) are commonly incorporated into an Intelligent Tutoring System (ITS) to increase learners' satisfaction; however, empirical evidence on the impact of PAs on learner acceptance is limited. Additionally, few ITS researchers seek to understand learners' expectations and acceptance of both the agent and learning environment. This paper presents the results of a study that evaluates the relationships between learner expectations and acceptance of a PA and learning environment both before and after learners' system interactions.

Keywords: technology acceptance, technology expectations, Pedagogical Agents (PAs), Intelligent Tutoring Systems (ITS)

1. INTRODUCTION

Technology acceptance is a critical driver that influences user interactions with computer-based training platforms. The capability for a system to meet user expectations increases the probability of high user acceptance and promotes efficient knowledge transfer. Most research in the field of computer-based training lacks emphasis in understanding a trainee's expectations on the individual level and primarily focuses on performance outcomes.

ITSs are generally designed to produce significant learning gains; however, they are not designed with the intent to increase students' interest and motivation for future interactions. Although previous research shows assessment of users' perceptions and attitudes towards a technology, evaluation measurements of student expectations prior to ITS interaction is uncommon (Jackson, Graesser, and McNamera, 2009). This is important because previous work has shown initial technology expectations to significantly influence student perception of subsequent interactions (Jennings, 2000; Lindgaard, Ferrnandes, Dudek, and Brown, 2006; Jackson et al., 2009). Furthermore, students' expectations may increase as the perceived intelligence of a technology increases, and this relationship needs further awareness (Foner, 1997; Norman, 1994; Jackson et al., 2009).

In lieu of this issue, some ITS researchers incorporate PAs to the training interface in an effort to establish a virtual training companion to better facilitate the learning process. PAs provide a medium for delivering instructional content and feedback/support, and are incorporated to increase trainee satisfaction and acceptance of the learning experience.

Over the last decade, research has aimed to understand the different characteristics associated with a PA and how they impact training interactions. Empirical results have shown the presence of a PA alone can increase trainee self-efficacy, attitudes, and satisfaction with the learning environment (Junaidi 2007; Kim, Wei, Xu, Ko, & Ilieva, 2007; Rosenberg-Kima, Plant, Baylor, & Doeer, 2007; Fatahi and Ghasem-Aghaee 2010). However, the literature in this domain has shown an absence of evidence explaining the relationships between student acceptance, perceptions, and expectations of both the agent and learning environment.

This paper presents the results of a study evaluating expectations and technology acceptance associated with a PA and the learning environment it's embedded within. The experimental testbed trained participants on the rules and strategies for playing Sudoku. Measures were taken to assess system and agent expectations and acceptance both prior to system exposure and directly following interaction. Four experimental conditions were designed with the PA displaying varying degrees of competence and emotional support during the training experience. This study aims to answer what are the common user expectations when interacting with an instructional PA and how those expectations are met when a PA exhibits varying degrees of support. This is important because failing to meet minimal expectations for a user can have a negative effect on cognition and will reduce training effectiveness.

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Additionally, this study determines if there is a significant relationship between affect (mood) to student expectations and acceptance. Investigation of the influences of students' expectations could enable ITS researchers and developers to potentially better understand: (1) differences in performance and system evaluations; (2) possible affective, cognitive, and motivational restrictions of ITS usage; (3) factors which attribute to future usage intentions; and (4) methods to appropriately design and adapt instructional strategies to increase user acceptance and exceed user expectations.

2. RELATED LITERATURE

2.1. Expectations and Acceptance of a Computer-Based Tutor

An ideal trainee-PA relationship emulates the same benefits as the human relationship seen in one-to-one tutoring (Bloom 1984). A central component of human-to-human tutoring is social interaction. Teaching and learning are highly social activities, which attribute to trainees' cognitive and affective development (Kim and Baylor 2006). Social interaction builds trust, thereby strengthening the relationship between the instructor and trainee, and in turn influences motivation for learning (Baylor 2000).

Social interaction in a tutoring environment is driven through communication, which is the primary medium a PA can utilize to establish trainee trust. Lee, Ahn, & Han (2006) defines trust as the product of three dimensions: ability, benevolence, and integrity. Core, Traum, Lane, Swartout, Gratch, van Lent, & Marsella (2006) considers trust as a linear combination of solidarity, credibility, and familiarity. Research has also found a significant connection of users' trust to their technology acceptance (Lee et al., 2006; Cho, Kwon, & Lee, 2007). It is hypothesized that the presence of a PA alone will increase trainees' self-efficacy, attitudes, and satisfaction of system interaction.

In addition to trust building, social interaction influences motivation and learning. A trainee who enjoys interaction with a PA will demonstrate a more positive perception of the overall learning experience and be more accepting to the learning environment (Johnson, Rickel, & Lester, 2000; Junaidi, 2007). Thus, theoretically the more trust a trainee has in the PA technology, the more trust he/she will have in the training experience. However, there is a lack of empirical evidence supporting this claim.

2.2. Expectations and Acceptance of an Intelligent Tutoring System

ITS researchers usually use measures of students' computer experiences and usage patterns to gauge students' attitudes and perceptions towards an ITS; however, research has found that such measures are insufficient indicators (Garland and Noyes, 2008). Research focusing on information technology acceptance typically uses the original or a revised Technology Acceptance Model (TAM) to gauge users' acceptance. The TAM is a theoretical model which predicts how a user comes to accept and use a given information technology by interpreting responses on cognitive, affective, and behavioral measures. It specifies causal relationships among external variables, belief and attitudinal constructs, and behaviors captured during initial system interactions (Hubona & Kennick, 1996). The model suggests that when users are presented with a particular information technology, a number of factors, notably *perceived usefulness* and *perceived ease of use*, influence their decision of how and when they will use the technology. These cognitive responses then influence the users' affect (attitude) towards using the technology, which ultimately drives their behavioral intentions (Burton-Jones & Hubona, 2005).

The key limitation to TAM is its inability to account for measures on system expectations prior to interaction with the system. Jackson et al. (2009) discovered that students' prior expectations of a technology's capability have a large effect on students' initial and post-levels of motivation and technology familiarity. Furthermore, meeting expectations can significantly increase the likelihood that students' will use the system again in the future. However, few if any, ITS researchers evaluate students' ITS acceptance.

3. METHODOLOGY

A 2x2 experiment was designed assessing the effect competency and emotional support has on meeting user expectations and system acceptance. The PA was given one of two definitions for each variable of interest: high and low. Participants were randomly assigned to one of four experimental conditions, each instantiating varying degrees of PA competency and PA emotional support. The PA was embedded into a testbed (i.e. learning environment) that teaches subjects the rules and strategies of Sudoku. The environment was designed with the ability to cater to any level of previous experience.

This study anticipates the following: (a) Students' assessment of a PA's qualities will have a strong, positive relationship to their acceptance of the learning environment; (b) The perceived notion that the PA is trusted by the learner will vary in relation to the participant's prior experience within the domain; and (c) The PA condition experienced by the participant will have a direct effect on reported Self-Assessment Mannequin (SAM) mood dimensions; and (d) PA's exhibiting either emotional support, competence, or both will produce significantly higher knowledge gains than a PA's that provides neither quality.

The experimental learning environment was developed with Microsoft Visual Basic.NET Express Edition. The PA embedded within the learning environment is the Microsoft Agent Audie, who is a

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representation of an animated computer. Figure 1 presents a screenshot of the experimental learning environment.

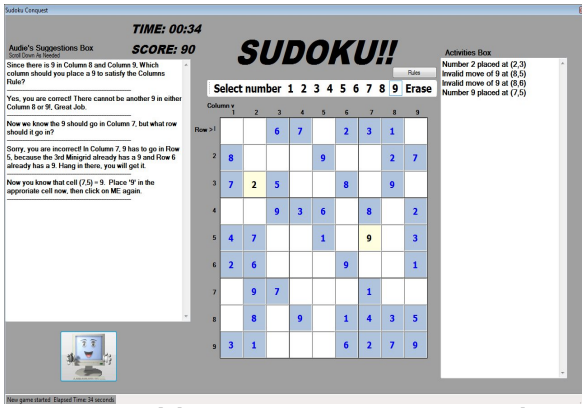

Figure 1: Sudoku Learning Environment Screenshot

3.1. Sample Population

Although participation in this experiment was open to the general community, the population for this study was a sample of convenience. Thirty-five volunteers participated in the study. The participants consisted of 22 males and 14 females between the ages of 19 and 63. Eighty-six percent of the sample reported having advanced computer experience, and ninety-one percent of the sample believed that computers can help them learn difficult concepts.

3.2. Procedure and Instrumentation:

After obtaining informed consent, participants completed a pre-experiment survey. The instrument collected information on demographics (i.e. age, gender, and education); mood (Self-Assessment Mannequin (SAM) Lang, 1985); expectations of a computer-based tutor; and expectations of a computer-based learning environment. Expectation measures associated with the PA were collected from the 12-item Attitude toward Tutoring Agent Scale (ATTAS: Adcock & Van Eck, 2005; Jackson et. al, 2009). The instrument assessing participant expectations of a computer-based learning environment consisted of 9 questions adapted from Davis (1989) and Holden & Rada (2011). This construct is composed of seven items on Perceived Ease of Use (PEU), one item on Perceived Usefulness (PU), and one item on future Usage Intentions (UI). For both expectation constructs, participants were asked to rate the importance of each item on a Likert scale from 1 (not at all important) to 9 (totally important) and to rank the order from least important to most important.

Following the pre-experiment survey, participant interaction with the learning environment was initiated. The instructional sequence was divided into four phases: a Sudoku tutorial, an interface tutorial, game 1, and game 2. All phases were guided by an assigned conditional PA reflecting the appropriate variance of competency and emotional support, except during the interface tutorial where the PA exhibited the same habits for all four experimental conditions. For novice and beginner Sudoku players, participants were given an easy Sudoku puzzle for the first game, while intermediate and experts were given a medium puzzle for the first game. A hard Sudoku puzzle was given for the second game across all groups. Participants had 15 minutes to complete as much of the 9x9 grid as possible.

Following, participants' completed a post-experiment survey. The survey inquired about participants' mood (SAM); perceptions of the PA tutor; and perceptions of the learning environment. The perceptions of the PA and learning environment constructs consisted of the same measures from the expectations constructs in the pre-experiment survey. However, participants were asked to rate their agreeableness for each item on a Likert scale from 1 (Strongly Disagree) to 9 (Strongly Agree). These constructs measure participants' acceptance of the PA and learning environment.

4. RESULTS

4.1. Pre-Interaction Analysis:

Survey data was collected prior to system interaction to gage experience with the domain and expectations towards computer-based tutoring. This data was analyzed as a whole to identify trends and similarities associated with PA implementation. In regards to previous Sudoku experience among participants, 31% reported no knowledge or familiarity of the domain, 31% reported basic experience initially, and 37% reported having advanced experience. Participant interest and motivation was also assessed. Of the sample, 86% were excited about learning new topics, 65% were interested in increasing their Sudoku knowledge, and 86% were motivated to participate in the experiment.

Additionally, participants were instructed to rate and rank the importance of their ideal computer-based tutor qualities. These items (derived from ATTAS) were used to gage initial expectations of a PA. Items were based on qualities/characteristics associated with human tutors. Table 1 presents the results of the overall sample.

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Table 1: Initial Expectations of a PA's Qualities

Statement: A tutor that…	Min., Max.	Mean	Std. Dev.	Ranked Most Imp.	Ranked Least Imp.
…you would use again	4,9	7.91	1.463	40%	40%
…you would strongly recommend to others	4,9	7.71	1.447	29%	54%
…you would enjoy working with	6,9	8.31	0.963	34%	34%
…you feel motivated to work with	5,9	8.14	1.264	14%	51%
…helps you better understand the learning content	7,9	8.60	0.604	49%	26%
…lets you know how well you are doing	2,9	8.06	1.434	37%	20%
…keeps you updated on your progress	5,9	8.11	1.022	31%	23%
…understood how much you knew	6,9	8.43	0.815	31%	31%
…provided you helpful feedback	5,9	8.51	0.853	49%	17%
…Increases your interested in the learning content	5,9	7.91	1.380	31%	34%
…holds your interest	5,9	8.14	1.264	14%	34%
…you're satisfied with his performance	5,9	8.09	1.147	40%	34%

Participants were also asked to rate and rank the important attributes of their ideal learning environment. These items were used gauge the participants initial expectations of what is deemed necessary for computer-based instruction. Table 2 presents the results.

Table 2: Initial Expectations of a Learning Environment

Statement: A learning environment that…	Min., Max.	Mean	Std. Dev.	Ranked Most Imp.	Ranked Least Imp.
…is easy to use. (PEU)	5,9	8.14	1.115	57%	26%
…is controllable. (PEU)	2,9	7.43	1.668	17%	34%
…is enjoyable. (PEU)	4,9	7.54	1.482	17%	51%
…does not require a lot of mental effort. (PEU)	2,9	6.74	2.049	26%	51%
…is easy to learn how to use. (PEU)	6,9	8.14	1.089	40%	31%
…is ease to intuitively navigate through. (PEU.	4,9	8.17	1.224	26%	17%
…has good functionality (features). (PEU)	5,9	8.06	1.211	37%	20%
…is useful for learning content. (PU)	5,9	8.40	1.006	51%	17%
…is reusable for learning other content in the future. (UI)	4,9	7.43	1.720	29%	51%

Note: Perceived Ease of Use (PEU), Perceived Usefulness (PU), and Future Usage Intentions (UI)

4.2. Post-Interaction Analysis:

Responses of post-interaction perceptions/acceptance are segmented by experimental condition and Sudoku experience. Both are compared against one another as well as analyzed as a whole. This section addresses the three hypotheses mentioned at the beginning of the methodology section. During the experiment, participants were subjected one of four versions of a PA: an Emotionally Supportive and Competent (ESC) agent (N = 9); an Emotionally Supportive Only (ESO) agent (N = 9); a Competent Only (CO) agent (N = 8); and a Neither Emotionally Supportive nor Competent (NESC) agent (N = 9). A between-condition analysis was conducted to assess the effect a PA's emotional support and knowledge level has on the learner's perception of the PA and learning environment.

The participants subjectively rated the PA's qualities/characteristics (same items assessed pre-interaction, see Table 1) and the learning environment based on their experience. Results convey the data had a significant positive relationship between acceptance of a PA and acceptance of the learning environment. Pearsons correlations showed the agent, regardless of condition, had a strong positive relationship to the learning environment's perceived ease of use ($r = .808$, $p<.001$), perceived usefulness ($r = .799$, $p<.001$), and future usage intentions ($r = .868$, $p<.001$). Although this relationship slightly varies across the independent experimental conditions, it still maintained its significance.

Next, we examined the influence prior experience has on perceived trust towards the PA. A univariate Analysis of Variance (ANOVA) was conducted and resulted in a main effect between an individual's Sudoku experience and their perceived trust of the tutor agent, $F(2,32) = 5.531$, $p<.05$. Upon further analysis, a multiple comparisons revealed a significant difference in overall perceived trust between participants with basic ($M = 7.672$, $SD = 1.401$) and advanced ($M = 5.123$, $SD = 2.069$), $p<.01$. We found that agent condition to not have a significant effect within this sample on a PA's characteristics used to evaluate trust.

Furthermore, we evaluated the impact that the PA condition had on the self-reported SAM mood dimensions. A univariate ANOVA showed the agent condition the learner interacted with had a main effect on reported levels of Arousal, $F(3,31) = 8.713$, $p<.01$. The other two dimensions (Pleasure, Dominance) were not significantly affected by the PA condition experienced across participants. A pairwise comparison identified learners in the Emotionally Supportive and Competent Tutor (ESC) environment reported significantly higher arousal levels ($M = 3.3$, $SD = .686$) over learners in the control condition with the neither emotionally supportive or competent tutor (NESC) ($M = 6.111$, $SD = .776$), $F(1, 33)$, $p = .012$. The pairwise comparison of the remaining agent conditions were found to be non-significant.

As well, a learner's perception of knowledge gained in the Sudoku domain following interaction was assessed. In the post-survey, participants were asked if they felt their knowledge/understanding of Sudoku increased following the experience. A univariate ANOVA shows the agent condition assigned to have a significant main effect on the reported knowledge increase item $F(3, 31) = 11.346$, $p<.001$. When comparing all conditions against one another in a pairwise comparison, results show significantly more learners reported increased Sudoku knowledge in the ESC ($M = 1.867$, $SD = .161$, $p<.05$) and ESO ($M = 1.917$, $SD = .153$, $p<.05$) tutor conditions when

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compared to the condition with a NESC tutor (M = 1.356, SD = .182, p<.05). The CO tutor (M = 1.889, SD = .185) is approaching significance, p=.05, with a larger sample believed to produce a reliable difference.

5. DISCUSSION

A result of this study is better understanding what attributes of a PA and learning environment is most important to a learner. According to the pre-interaction survey, participants most preferred a PA which helps them better understand content and provide helpful feedback. Particularly, participants with less Sudoku experience (e.g. none or beginner) thought these PA qualities to be of more importance than advanced Sudoku players. Additionally, there was an equal distribution in the reusability ranking of a computer-based tutor. A majority of participants with little or no Sudoku experience ranked the idea of using the tutor again as least important, while a majority of advanced Sudoku players rated this quality as most important. Furthermore, a PA that is enjoyable to work with varied between experience, with the advanced participants ranking it most important and the novice/beginners ranking it least important. Thus, a learner's prior knowledge of a domain might result in different desired expectations of a computer-based tutor. Interestingly, all participants reported having a tutor that they were motivated to work with or could strongly recommend to others as least important.

In regard to the learning environment, the sample most preferred an environment that is easy to use and useful for learning content, and reported the reusability of a learning environment as least important. Perhaps when learners enter training experiences, they focus on the current experience and do not consider how it can impact future learning interactions. Conversely, our sample may have developed a domain-specific (Sudoku) conceptual model of the learning environment at the time of this question and could not perceive it to be scalable to other domains. More research is needed to identify the appropriate conclusion. Sudoku experience did not have an impact on learners' preferences of the learning environment.

According to the post-interaction analysis, there is a significant relationship between acceptance of the PA and the learning environment they are interacting within. This supports the theoretical basis and importance of PA research. Thus, PAs have the ability to minimize trainee resistance to the utilization of intelligent tutoring systems.

Additionally, a learner's initial domain knowledge may influence their trust for using a PA. We found that beginner Sudoku players were significantly more trusting of the PA than advanced players, regardless of the agent condition given. This outcome could be based on the generalization that advanced participants heavily relied on their prior domain knowledge and used the PA only as a supplement to achieve the game objectives, while less experienced participants relied more on the PA to better understand the domain and complete the game. This notion also becomes more apparent as we observed the differences in initial expectations of each group.

In terms of affect, mood dimensions (e.g. Pleasure, Dominance, and Arousal) were found not to have an impact on learner's acceptance of a PA or the learning environment; however, learners interacting with the PA exhibiting emotional support and competency reported a higher increase in arousal when compared across conditions. Determining whether this type of arousal was based on engagement, excitement, fear, or anger is difficult to interpret from this data set. Correlations show pleasure to decrease among participants in this condition as arousal increases, but this does not hold true among the remaining groups.

Results also show characteristics of support and competency in a PA to impact a learners perceived knowledge gain. This suggests agents must provide relevant and supportive feedback to promote higher efficacy and commitment for using a PA. The results of the study support this assertion by showing all conditions exhibiting some level of competent or emotional support to report a higher perceived understanding of Sudoku than participants in the condition designed with neither.

6. CONCLUSIONS

This study supports the importance of understanding learners' initial expectations prior to system interaction. Future related research should consider expectations in addition to assessing the impact of different PA characteristics on learning outcomes. Our results demonstrate that learners' perceptions of a PA can have a direct impact on their acceptance of the learning environment the agent is embedded within. The study consisted of a small sample size. Several findings identified during data analysis were approaching significance and may be noteworthy with a larger sample population. In addition to increasing or sample for future studies, assessment questions to help explain mood outcomes will be incorporated.

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