ROLES AND CHARACTERISTICS OF PEDAGOGICAL AGENT EMBEDDED IN ELECTRONIC LEARNING ENVIRONMENT

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ABSTRACT

Electronic learning environment has become the threshold for access to good resources for learners. The design and development of electronic learning materials has been increasing in number. However, there is a need to question to what extent textual materials transferred to an electronic environment improve learning. In order to address this chasm, intelligent tutoring system has to be designed to adapt itself to meet the individual learning characteristics of the learner. This will also address the issue of personalization principles in e-learning environment. Research has shown that personalized speech by an on-screen pedagogical agent which guides the learning process during an e-learning episode significantly aides learning among students. E-learning environment should not only support the cognitive aspect but also knowledge construction by facilitating interaction with the learners hence opening the door to social aspects of learning. Thus, this paper highlights the benefits of pedagogical agents embedded in learning environment. It also list out the various roles assumed by pedagogical agents and their positive characters that aide the learning process in students.

INTRODUCTION

Lately computers and technology has been accepted and recognized as useful enabler for learning and teaching. Due to the complexities of learning and human psychology, designing curriculum that effectively integrate computers and technology to support innovative teaching and learning has become a challenge. Previously, the inclusion of social modalities has been left void in electronic learning environment. The element of classroom instructor should be leveraged in a virtual environment to support learning. E-learning environment should not only support the cognitive aspects but also knowledge construction by facilitating interaction with the learners hence opening the door to social aspects of learning.

Constructivist approaches which have been found to be beneficial for developing meaningful learning activities and engaging students in higher-order thinking, propose that learners actively construct meaning and knowledge by interacting with people and other object. Similarly social-cognitive theories emphasize that interaction with teachers, peers and instructional materials frames learner’s cognition and intellect. In the traditional classroom, students rely on teachers for their motivation, direction, goal setting, progress monitoring, self-assessment, and achievement. This reveals that the construction of meaning and knowledge is dependent on not only the learner and their prior knowledge but also the teacher-student interaction. It is warranted that e-learning environment should be designed to afford the social-cognitive dimension as interactivity and visualization present in this environment help improve acquisition of knowledge and skill. Hence, instructional designers must consider creating e-learning environment that fosters human computer interaction thus addressing the social learning theory (Bandura, 2001).

Social interaction has been argued as a critical component that increases learning and knowledge processing. Active social interaction between teacher and student with customized instructional speeches, dynamic and immediate feedback as well as motivational messages personalizes student’s learning experiences. It is well-documented that personalized or individualized instructions consistent with one-to-one tutoring are a powerful method of promoting knowledge construction. Though the evidence is substantial yet creating individual one-to-one tutoring for each and every student is not possible due to huge cost involved. Hence, the use of pedagogical agent environments has been recognized as the emerging
technology that supplements instruction for students with individual needs and bringing personal tutoring experience to a broader audience.

VIRTUAL PEDAGOGICAL AGENT - THE EMERGING TECHNOLOGY

At present, most web-based learning environment and CD ROM-based learning packages are designed as non-personalized monologue-style information delivery devices that occasionally employ unsophisticated reward systems as metrics of student understanding and achievement. These educational packages failed to provide situated learning which has been proven to significantly improve learning and motivation. Students’ acquisition of new knowledge and skills can be increased with the use of educational resources that simulate real-world behavior in an engaging and interactive multimedia environment. Hence recent researches in technological learning environments have begun to focus on the educational benefits of including pedagogical agents.

Pedagogical agents represent a new generation of human-computer interface (HCI) design. The inclusion of intelligent pedagogical agent in a dynamic conversational interface for effective instructional delivery in computer-based learning environment has been of growing interest and well documented by many empirical studies (Baylor & Ryu, 2003; Moreno, Mayer, Spires & Lester 2001). The cognitive functioning and affective characteristics of a learner are usually influenced by their social interaction and engagement with the teacher in the classroom (Skinner & Belmont 1993). In order to address this chasm, pedagogical agents are designed to serve in the same capacity as the teacher, playing well defined instructional roles, following specified social conventions, and responding to learners with affect. Reeves and Nass (1996) have presented evidence that people apply human social interaction rules to computer characters as they do to humans in the real world. In line with this, studies revealed that the simulated social presence of pedagogical agents in computing environments may provide learners with a sense of companionship, hence learning become more relevant and meaningful.

Pedagogical agents are virtual instructors designed to interact with users by asking questions, offering assistance and providing contextualized advice and feedback in an e-learning environment. These agents guide learners through the presentation of content and convey additional conversational and emotional signals via facial expressions and body movements. It has been well documented that the inclusion of social cues in e-learning environment has strong impact on interest, communication and learning gains. Animated pedagogical agents are regarded as unique from conventional computer-based environments as they can autonomously simulate social interaction with the learner and perform tasks intelligently with consideration given to context and user preferences.

Pedagogical agents can take the form of humans, animals or life-like on-screen characters. Empirical studies revealed learners preference and likeability for animated agents with human-like persona in order to create a social context for more natural learning. Animated agents exhibit emotive behavior and expressions and simulate continuous instructor presence in e-learning environment hence forcing students to be active participants in the learning process. The employment of verbal instructional explanations together with nonverbal forms of communications such as gaze, gesture, facial and emotional expressions has been found to enhance the perceptions of credibility and engagement of the learner with the agent.

THE ROOT OF PEDAGOGICAL AGENT

Pedagogical agents technology is the continuation from previous research on intelligent tutoring systems (Wenger, 1987). Johnson, Rickel, & Lester (2000) defined pedagogical agent as a combination of knowledge-based engineering principles and animated interface to produce effective learning environments. Shaw, Johnson, & Ganeshan (1999) defined pedagogical agents as computerized characters that use knowledge engineering techniques and artificial intelligence to support or facilitate learning. In short, pedagogical agents combine artificial intelligence and sophisticated animation to improve learning effectiveness and efficiency.

The recent advancements in multimedia interfaces, text-to-speech software, and agent-generation technologies resulted in researchers explore the benefits of embodied agents.
which interacted with users in a believable fashion through the expression of emotional responses (Bates, 1994). Believability is a key feature of animated agents as it helps to make a better social contact with the learner and consequently provide more effective and engaging learning environment.

**INSTRUCTIONAL IMPACT OF PEDAGOGICAL AGENT**

Pedagogical agents are engineered with animated persona and key pedagogical functions, i.e.; presentation of domain knowledge, student monitoring, questioning, providing explanations, hints and feedback. With this expanded potential, pedagogical agents are able to simulate an effective instructional impact in computer based learning environment.

Johnson, Rickel, & Lester (2000) found that animated pedagogical agents have the potential to broaden the bandwidth of social communication between computers and students. Animated pedagogical agents are able to promote student motivation and engagement (Lester, FitzGerald, & Stone (1997), and engender affective as well as cognitive responses. Learners in animated pedagogical agent environment demonstrated deeper learning and higher motivation than learners without an agent (Moreno, Mayer, Spires, & Lester, 2001). These positive instructional impact of pedagogical agents on cognitive and motivational outcomes has been indicated by many studies. Student's also exhibited better retention, interest and transfer of knowledge with presence of pedagogical agent. Rickenberg & Reeves (2000) found that the agent environment can provide increased arousal, which is "consistent with the best preparation methods for exams in school."

Pedagogical agents are able to adapt the lesson plan according to the student's need and ability. Gilbert, Wilson, & Gupta (2005) in their study on the effect of pedagogical agent in adaptive instruction approach found that the presence of agents is more suitable for reaching large diverse groups of learners in e-learning environment. Pedagogical agent's presence has been found to reduce the learner's perception of the difficulty level of the material (Laural, 1990; Andre, Rist, & Muller, 1998). Atkinson (2002) in his study on the correlation between animated agent environment and worked-out examples found that students perceived worked-out examples as being less difficult in animated agent environment than did their counterparts in non-agent environment. Research has also proven that pedagogical agent based learning environments have the potential to facilitate the promotion of meta-cognitive awareness among students.

Pedagogical agents are capable of performing a wide spectrum of instructionally effective interactions with students, including multimodal dialog. In pedagogical agent environment multiple students and agents can interact in a shared environment thus supporting collaborative learning as well as individualized learning. White, Shimoda, & Frederiksen (2000) and Hietala and Niemirepo (1998a, 1998b) indicated in their study that multiple pedagogical agents with varying perspectives or domain specific skills increases learner's confidence in their ability to learn. This was in line with Bandura (1997) who argued that multiple agents as diversified social models with different characteristics may produce learners who belief in their ability to learn.

Many empirical studies broadly demonstrated that the presence of a pedagogical agent with an interesting personality has a strong positive effect on student's perception of the learning experience. Considering the well documented results of learning-outcome from pedagogical agent learning environment studies, the future for pedagogical agents looks quite promising.

**ROLES ASSUMED BY PEDAGOGICAL AGENTS**

Pedagogical agents have effectively adapted various human metaphors; as an expert, a motivator, a tutor and a mentor serving distinct instructional functions. Various studies focused on pedagogical agents' instructional role as variables; such as expert (Johnson, Rickel, & Lester 2000), tutor (Grasser, Moreno, & Marineau, 2003), mentor (Baylor & Kim, 2005), and peer (Chan & Baskin, 1990; Hietala & Niemirepo, 1998a; Kim, 2003b).

Expert-agent exhibits mastery or extensive knowledge, delivering contextualized problem solving advice in a professional manner. While presenting timely and accurate information and comments, expert agent emotionally detach himself from the learners. The motivator-
agent provided verbal persuasion and encouragement, emphasizing affective domain to deal with learner’s efficacy beliefs. Motivator agent expressed emotion while verbally encouraging the learner to sustain the tasks and by asking questions, stimulated the learners to reflect on their personal experiences. The mentor-agent simulated mentoring learning model. The mentor guided the learners with knowledge and experience in the pursuit for achieving learning goals. The mentor-agent with the ability to provide information and knowledge as well as stimulate motivation in the learner, has been defined as ideal pedagogical agent by many empirical studies. Pedagogical agents have also adapted a peer metaphor where the agent’s function is to learn with the learner and act as a simulated peer. Pedagogical agent has also assumed the role of a coach; coaching students to monitor their learning.

Pedagogical agent must be designed to best represent as well as achieve its intended functionality (Odell et al., 2003; Prendinger & Ishizuka, 2001). Therefore, designers of pedagogical agent environment should carefully design the agents instructional role within the learning environment to serve the intended educational purposes. According to Norman (1997) a viable relationship build upon trust can be sustained if learners perceive that the pedagogical agent is truly representing its instructional role and functionality.

Some of the high-profile pedagogical agent systems that have been developed are as below:

- **ALI** is an automated laboratory instructor that monitors and guides undergraduates as they solve problems while interacting with chemistry simulations.
- **ADELE** (Agent for Distance Learning - Light Edition) helps students work through problem-solving exercises for courses that are delivered over the Internet. ADELE-based courses have been developed for continuing medical education and geriatric dentistry.
- **Auto Tutor** simulates the dialogue moves of human tutors while participating in conversations with students. Auto Tutor is currently designed to help college students learn about topics in computer literacy and conceptual physics.
- **Cosmo** exploits deictic behaviors to offer problem-solving advice to students learning about network routing mechanisms in the Internet Advisor learning environment.
- **Herman the Bug** inhabits the Design-A-Plant learning environment and helps children learn about botanical anatomy and physiology.
- **PPP Persona** provides online help instructions while helping users navigate through web-based materials.
- **STEVE** (Soar Training Expert for Virtual Environments) interacts with learners in an immersive virtual environment and has been used in naval training tasks such as operating engines on U.S. Navy surface ships.
- **Vincent** helps workers in shoemaking factories learn about production-line control time.
- **MIMIC under PALS (Pedagogical Agents Learning System)** played the role of mentor to offer feedback from a constructivist theoretical perspective.
- **PIVoT (The Physics Interactive Video Tutor)** is a web-based multimedia resource for college-level Newtonian mechanics.


Some of the pedagogical agent technology that has been developed:

<table>
<thead>
<tr>
<th>Herman</th>
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<tr>
<td>Herman the Bug is a talkative, quirky, somewhat churlish insect with a propensity to fly about the screen and dive into the plant's structures as it provides students with problem-solving advice. Herman was developed by the IntelliMedia Project at North Carolina State University.</td>
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<tr>
<td><strong>Linda</strong></td>
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<td>Linda is the first of a series of &quot;Learning Guides&quot; from Extempo Systems. The Learning Guides Project is a 3-year R &amp; D study to develop and commercialize animated pedagogical agents.</td>
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| **Steve** |  
| Steve can demonstrate skills to students, answer student questions, watch the students as they perform the tasks, and give advice if the students run into difficulties. Steve was developed by the Center for Advanced Research in Technology for Education at the USC Information Sciences Institute. |

| **Cosmo** |  
| Cosmo was designed by the IntelliMedia Project at North Carolina State University to study the ability of agents to dynamically combine gesture, locomotion, and speech to refer to objects in the environment while they deliver problem-solving advice. Helpful, encouraging, and with a bit of an attitude, Cosmo explains how computers are connected, how routing is performed, and how data traffic considerations interplay. |

| **Peddy** |  
| Peddy is a multi-purpose agent from Microsoft. He is an easily-programmable animated character with hooks for speech recognition and synthesis. Microsoft's intent is that he can be authored for educational and a variety of other uses. |

| **Einstein** |  
| The Albert Einstein-ALife is the first commercial application of ALife-PersonalTutor, Artifical Life's natural language processing program that gives agents the intelligence to formulate responses to users' inquiries. These agents are geared mostly for a question-and-answer mode of examination. |

| **Adele** |  
| Adele supports students working through problem-solving exercises that are integrated into instructional materials delivered over the internet. Adele, like Steve, was developed by the Center for Advanced Research in Technology for Education at the USC Information Sciences Institute. |
DESIRABLE CHARACTERISTICS OF A PEDAGOGICAL AGENT

Pedagogical agents should display effective characteristics in order to establish human computer interaction. There are important qualities that need to be addressed when designers create agents that conform to the desired instructional role of the pedagogical agent. Each student is individual in their own way. They exhibit a variety of aptitudes, level of proficiency and learning styles. Pedagogical agents can be considered as value-added entities of computer-based learning environments if they are adaptive and dynamic in their teaching strategies, accommodating to students’ individuality. Pedagogical agents should be able to ask and answer questions, provide hints and explanations, monitor students’ understanding, provide appropriate feedback and keep track of students progress.

Empirical studies have shown that pedagogical agents who exhibit lifelike behaviors (facial expression and verbal communication) have the potential to bolster student-learning outcomes by exploiting both the auditory and visual channels of the learner. In general, animated pedagogical agent which execute behaviors that involve emotive responses, interactive communication and effective pedagogy promotes learning gains.

A study by Kim (2004) recorded that participants in a agent-peer environment suggested that competency, interaction control and personality of the agent as important characteristics to be addressed. According to Baylor (1999), a good and effective agent constructs three aspects; that are conversation/pedagogy, attitude toward student and student interest/attention. Studies related to pedagogical agent environment has considered issues such as ability to respond in natural language, learner engagement and motivation in the task as the focused research variable.

Though the conversational behaviors and design features of embodied agents have become the focal point in designing, it is important to get a clearer understanding of the end users’ expectations of pedagogical agents in computer-based learning environment.

PERSONA OF PEDAGOGICAL AGENT

Norman (1997) suggested, learners interact with agents as represented through their interface (e.g. persona) and not through their underlying computer algorithms. Xiao, Stasko, & Catrambone, (2004) pointed out that learners tend to assume that pre scripted agents are providing dynamically generated and adaptive responses in real time. A pedagogical agent should possess rich and interesting personality, so that it can simply make learning more fun. A student who enjoys interacting with a pedagogical agent will have an increased positive view of the whole learning experience and stay on in the learning environment which is likely to increase learning (Lester et al. 1997). Pedagogical agents should be visually expressive to clearly communicate problem-solving advice and simultaneously have a strong motivational effect on students. Factors such as eye contact, body language and emotional expressions should be modeled and exploited for instructional purposes. An effective agent should posses the ability to increase the student’s attention to learning (Lester et al. 1997).

In computer based learning environment, facial expressions, gestures, locomotion, and intonation variations exhibited by an agent can be used to indicate important and relevant information. The face animation controls (nonverbal feedback) allow the developer to manipulate the agent’s emotions in real time. Small changes in facial expressions have been shown to significantly change learner’s perception of an agent (Johnson, Rickel, & Lester, 2000). The quality of the agents voice and facial expressions influenced student’s perception on the friendliness and likeability of the agent (Xiao, Stasko, & Catrambone, 2004).

In general it is recommended that a pedagogical agent should have a human-like persona, the defining feature of pedagogical agent, to better simulate social contexts and to promote learner-agent interaction. Lifelike pedagogical agents can have a strong motivational effect due to the range of social behavior it can exhibit (Lester et. al, 1997) and promote deeper cognitive engagement (Johnson, Rickel, & Lester, 2000; Mayer, Sobko, & Mautone, 2003).
The findings of Baylor & Ryu (2003) suggest that the inclusion of agent properties that are not life-like may actually detract students from learning. This is inline with the findings of Dewey (1913) and Rutter (1984) on the impact of social cues in education. Therefore, in order to establish a viable relationship with the learner, the agents must be perceived as “person-like”. Agents that are not lifelike, does not exhibit social behaviors and that are more mechanical in their behaviors and voice may actually impede the learning experience.

COMPETENCY OF PEDAGOGICAL AGENT
A pedagogical agent must be equipped with appropriate level of competency (domain knowledge) to effectively simulate human-computer interaction and facilitate learning and motivation. Competency level of pedagogical agents has been well documented by many empirical studies.

Studies on student-expert metaphor (pedagogical agent as an expert) revealed that learners prefer an element of expertise and motivational dialog from agents. Students also favor agents who give the impression of infallible knowledge. Highly competent agents increased applications of acquired knowledge whereas low competent agent increased students’ self efficacy beliefs in the domain (Kim & Baylor 2005b). Similarly Hietala and Niemirepo (1998a) found that when the given task was demanding, high IQ students preferred highly competent agents whereas weak students preferred less competent agents.

Findings from student-peer metaphor suggest that, students who worked with low competent agents reported significantly greater self-efficacy beliefs in the task than students who worked with the high-competent agent. According to Schunk (1987) learners tended to increase self-efficacy in the task after they observed student peer models with low competency. Students’ affective characteristics such as self esteem, confidence and sense of responsibility were significantly enhanced in less competent agent environment (Uresti & Boulay 2004). In general, based on empirical findings, less competent agent increased self efficacy beliefs of novice learners and highly competent agents increased knowledge acquisition of high IQ students.

Piagetian’s perspective suggest that pedagogical agent designed with a low to moderate competency could simulate an equal partner to instigate the learner’s cognitive conflict. Findings by Bandura (2001) claim that a highly competent pedagogical agent could sometimes impede the cultivation of learner competencies because the learner might unduly rely on the agent’s competency. This has been supported by studies that recorded that students prefer and motivated to interact with agents who present information in a casual manner. Agents who do not appear as confident with their knowledge were more likeable than agents who appear very confident with their knowledge. Students have rated the less knowledgeable agent higher in measures of likeability and motivation.

PEDAGOGICAL AGENT’S INTERACTION TYPE
Learning is based on the engagement of the learner with the content of the instruction. The type of interaction present in agent environment significantly enhances learning outcome among students.

Empirical studies suggest that during interaction, the social aspects of interaction becomes the most motivating and engaging properties of the pedagogical agent environment. The use of conversational language through an agent seems to stimulate deeper learning. The findings by Moreno, Mayer, Spires, & Lester (2001) shows evidence that learning improves when agents provide natural speech comments. Research also suggest that learning packages that engage the learner directly by using first and second person language yield better learning than the same packages that use more formal language. Research on the effect of learning companion dialogue (virtual tutor and virtual tutee interaction) versus monologue found that students in the dialogue type interaction recalled more information during writing and asked significantly more questions in the transfer task. These students also showed deeper-level reasoning.

Kim (2003b) suggested in her studies that interaction type of an agent has become the crucial design variables. The agent’s interaction with the learner should aid the accomplishment of
the desired learning goals. Kim and Baylor (2006) suggested that the type interaction present in agent environment can be examined from two angles, ie: the content of interaction and the control of interaction.

Regarding the content of interaction, Lester et al., (1997) reported that a pedagogical agent can utilize a variety of discourse functions, such as suggestion, argument, confirmation and questioning to scaffold learners understanding on the content. Goodman, Soller, Linton, & Gaimari (1998) suggested that agents should clarify, critique, explain, question, evaluate, articulate, reinforce and justify when interacting with student. Furthermore pedagogical agent should also give performance feedback during discourse. Tudge, Winterhoff, & Hogan (1996) argued that clear informative feedback to a learner’s performance facilitates cognitive growth in peer collaboration. Schunk and Lily (1984) showed that the different types of performance feedback had differential effects on learner self-efficacy.

Research also suggest that designers should consider learner content expertise when deciding how instructional messages should be delivered. Instructional messages designed with detail explanation can be detrimental for high expertise learners but beneficial for low expertise learners (Kalyuga, Ayres, Chandler & Sweller, 2003).

Regarding the control of interaction, an agent can either be proactive or responsive. Proactive agents provided explanations, critiques and answers without being invoked by the learner. Responsive agents only responded to the call of the learner. According to Large (1996) and Ross, Morrison, & O’dell (1989), information or advice should be provided proactively to enhance learning. This positive impact of a proactive agent was also indicated by Xiao, Staso, & Catrambone (2004) in their studies. Study also indicated that novice learners who worked with proactive agent attain higher learning compared to those who worked with responsive agent.

Kim and Baylor (2006) in their studies in agent-peer metaphor found that proactive agent had a more positive impact on academically strong students. Students showed more positive attitudes toward proactive agents and achieved higher recall than students who worked with agents who responded only to the learner’s request.

Despite all the evidences on the positive impact of pedagogical agent’s proactive interaction to students’ comprehension of learning material, some empirical study did find that the interaction type of an agent environment can alternately impede learning. Many users of “Microsoft Office have considered Microsoft Clippy”, a built in virtual character, as an unwelcome intrusion that actually interfere in the learning process. Perkins (2001) findings suggested that learners should be active initiators in their cognitive activities. His study revealed that students highlighted the desire to be in control of the agents, ie to be able to determine when to engage with them. Participants in his study also showed positive attitudes toward an agent when it responds to their request but remains silent and unobtrusive otherwise.

**AFFECT IN PEDAGOGICAL AGENT**

Affective experience is a natural process of learning (Damasio, 1994; Forgas, 2001). Bates (1994) found that the inclusion of affect in pedagogical agent environment has been shown to make agents more believable and natural and subsequently may help establish social bond between the learner and the agent. This recent affective awareness is leading designers and human computer interaction researchers to try and understand the subtleties of emotion and its effect on our behaviors. When employing agents as teachers, it is important to attend to affective measures as well as learning gains. The role of affective variables such as mood, motivation, emotion and attitude been considered as factors as important as direct measures of learning gains.

Students perceived pedagogical agents as more interesting and engaging when the agents expressed positive affect (Elliot, Rickel & Lester, 1999; Okonkow, 2003). Meyer and Turner (2002) reported that students of a negatively affective instructor experienced negative affect and handicapped themselves significantly compared to students of a positively affective
instructor. Thus the role of affect is an important component for learning in agent environments.

Motivation which is an element of affect has been considered a key ingredient for learning. Without motivation from the teacher, interest towards learning tend to wane. Therefore regardless of their instructional role, pedagogical agents should always encourage and persuade students to stay on in the learning environment. This verbal persuasion increases the learner’s self efficacy belief, a key construct of motivation (Bandura, 1997).

Emotion, an affect domain has been addressed in detail in pedagogical agent related studies. Emotion plays an important role in our interactions with people and computers in everyday life. Pedagogical agents should be designed to address a learner’s emotional states and subsequently build empathetic relations with the learner (Dautenhahn et. al, 2002). Bower and Forges (2001) found that emotions and moods had an impact on social memories and their reconstruction. When learners’ moods in learning tasks were matched with their moods in retrieval, the amount of retrieved information was significantly increased. Pedagogical agent could express its own emotions and respond to learner’s emotions in order to elicit a learner’s positive emotions and to diminish negative emotions in learning contexts (Hudlicka, 2003). This findings were supported by Picard (1997) who further suggested that a agent designed to express positive emotions about the task will in fact stimulate a learner’s positive affect. Pedagogical agent should also convey enthusiasm for the subject matter, in order to foster similar enthusiasm in the student. Animated agents displaying concern over students’ progress may convince students to take learning seriously and agents who display sensitivity to learners’ emotions can provide feedback that prevents students from losing interest (Elliott, Rickel & Lester, 1999).

Kim (2004) in her studies found that agents who expressed positive mood were perceived as significantly facilitate learning, more engaging, more motivating and more intelligent compared to agents who expressed negative moods. Students’ preference to work longer with these agents than agents with negative mood. In another experiment examining the impact of affective response, students showed significantly more interest and higher efficacy in the task when the agent empathetically responded to their affect (Kim & Baylor, 2006).

GENDER OF PEDAGOGICAL AGENT
According to Bandura (1997) the success of social modeling often dependent on the similarities of personal characteristics between a social model and a learner. Similar personal characteristics had also influenced the learner’s efficacy beliefs. This principle may be applied when designing pedagogical agent learning environment, given the consistency between human-computer interaction and human-to-human interaction.

Moreno et al. (2002) found that students applied gender stereotypes to animated tutor agents and that stereotypic expectations affected learning. In a study that examined the effects of pedagogical agent’s gender on students social judgment, motivation, and learning, Kim and Baylor (2005a) found that students perceived the pesona of a male pedagogical agent more positively than that of a female agent. Students also showed increased recall and higher motivation after they worked with male agents (Kim & Baylor, 2005b).

Baylor & Kim (2004) also found that male agents were perceived as more extroverted, agreeable and satisfying than female agents. Preference towards a male pedagogical agent has also been indicated through the findings of Jeong & Davidson-Shivers, (2003) in online discussions.

ETHNICITY OF PEDAGOGICAL AGENT
Ethnicity plays a critical role in the social interaction between the learner and the agent (Nass, Isbister, & Lee, 2000). Identification with the agent by the learner provides significant and consistent effects on the learner’s behaviors and attitudes. Students perceive agents with similar ethnicity as more socially attractive and trustworthy (Nass et al., 1999).
Lee & Nass (1998) found that students with similar ethnicity agents as learning partners presented more persuasive arguments and elicited more conformity to the agents' opinions. They also perceived these agents as more attractive and trustworthy. Baylor & Kim (2004) found that when the ethnicity of the students and the agents were matched, students perceived pedagogical agents as more credible, more engaging and more affable. Contradicting this notion was the findings by Moreno et al. (2002) that the ethnicity of pedagogical agents did not influence students stereotypic expectations and learning. In short, designers of pedagogical agent environment should manipulate pedagogical agents ethnicity to match or mismatch with the learner ethnicity to serve instructional purposes.

CONCLUSION

Interactive learning activities are able to enhance student’s understanding on the content and subsequently increase learning gains. Pedagogical agents simulating human instructional roles has become a useful tool for creating social environments in computer-based learning. Adding an animated pedagogical agent in e-learning environment will make human computer interaction more enjoyable, engaging and productive.

Though the positive impact of pedagogical agent embedded learning environment is overwhelming yet some empirical investigations on the effect of pedagogical agents in computer-based learning environment has revealed that the presence of agents may divert attention from content of a page and hence hamper the learning process (Dehn, 2000; Ruttkay & Pelachaud, 2004). Dehn & Mulken, (2000) and Moundridou (2002) argued that the value of pedagogical agents has no clear evidence that they can enhance communication or understanding.

Most CDROM based learning environment which take the form of content representation are developed as a network of static hypertext pages with simple and basic animation. The development of such products involves simple and cheap process. On the contrary the design of highly interactive and multimedia rich learning environment with embedded pedagogical agent is a difficult task, more time consuming and costly. It involves many processes such as creating 3D graphics, real-time three dimensional animation, pre-rendered animation, voice recognition, high-level object-oriented language programming and many more to make it highly interactive. These technical complexity and high cost of development has become the primary obstacles for the expansion of pedagogical agent based learning environment.

Pedagogical agent is an emerging technology that has shaped a new paradigm in computer based learning and may keep evolving with technological advancement and subsequent research. As such the use of pedagogical agents in e-learning environments and their contribution to the efficiency and effectiveness of learning continues to be an open research agenda. Pedagogical etiquette which addresses appropriate agent behavior and instructional role must be carefully framed for educational value, otherwise, the use of agent technology can actually detract from the learning.

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