ASSISTING LEARNING USING COMPUTERS THROUGH THE APPLICATION OF ANIMATED PEDAGOGICAL AGENTS (APA) OR INTELLIGENT AGENTS

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ABSTRACT

This paper is a concept paper that will mainly discuss the on idea of applying Animated Pedagogical Agents (APA) or also known as Intelligent Agents into learning process. The paper intends to emphasise on the definition, the development overview of APA, its application in learning and the question of does it improve learning. The main field of discussion is Computer Based Learning, because APAs are implemented in learning using computers. It is hoped that this paper is a kickstart that will give a useful input to those interested in Artificial Intelligence in education.

INTRODUCTION: WHAT ARE PEDAGOGICAL AGENTS?

Pedagogical agents are on-screen coaches that help learners negotiate and mediate e-learning programs. Research has shown that not only do pedagogical agents enhance the appearance of e-learning programs and make them more interesting and "human" but when used properly these agents actually improve and facilitate learning.

Pedagogical agents can take the shape of a cartoon character, a talking head, an animated character, an avatar or even an interactive, artificial intelligence driven 2-D or 3-D image. They can offer help, give hints, demonstrate principles and procedures, and show worked through examples to help learners process and store information.

Microsoft has developed several agent characters, like the Wizard at left. They can be used for many functions but are easily employed as pedagogical agents to interact with students as they work through e-learning units.

COMPUTER BASED LEARNING

While the people we interact with every day have distinct personalities, volatile emotions and fascinating quirks, our computers remain the eminently logical boxes they were in the days of vacuum tubes. But people still treat their computers as if they were people. How many times do you beg your computer for mercy, hoping to retrieve some lost data, or curse at it when it gives you an error message? After years of computers forcing humans to think like machines, autonomous animated agents hold promise for a better way: allowing machines to interact like people (David Slater, 2000).

The propensity for people to interact with computers in a social way (Reeves and Nass, 1996), as if they were other people, has been explored for a number of years in a variety of areas, such as Health Care, Psychology, and Education. Now, computers have been used in education for over 20 years. Computer-based training (CBT) and computer aided instruction (CAI) were the first such systems deployed as an attempt to teach using computers. In these kinds of systems, the instruction was not individualized to the learner's needs. Instead, the decisions about how to move a student through the material were script-like, such as ``if question 21 is answered correctly, proceed to question 54; otherwise go to question 32.'' The learner's abilities were not taken into account.

While both CBT and CAI may be somewhat effective in helping learners, they do not provide the same kind of individualized attention that a student would receive from a human tutor (Bloom,1984). For a computer based educational system to provide such attention, it must reason about the domain and the learner. This has prompted research in the field of

Intelligent Tutoring System (ITS) that aims to enable computers to respond to people in a social way (Bickmore, 2004; Mishra and Hershey, 2004). ITS offers considerable flexibility in presentation of material and a greater ability to respond to idiosyncratic student needs. These systems achieve their *intelligence* by representing pedagogical decisions about how to teach as well as information about the learner. This allows for greater versatility by altering the system's interactions with the student.

In several research, Intelligent Tutoring System have been shown to be highly effective at increasing students' performance and motivation. For example, students using Smithtown, an ITS for economics, performed equally well as students taking a traditional economics course, but required half as much time covering the material (Shute et.al, 1989). Consequently the semantic component of social interaction, most frequently expressed as speech, is often accompanied by the affective component of social interaction, which is considered equally or sometimes even more important then the semantic component (Bickmore, 2004). This suggests that a failure to include the emotional component in human-computer interaction (HCI) is comparable to trimming the potential bandwidth of the communication channel.

APPLICATION OF APA
Intelligent tutoring systems have been shown to be highly effective at increasing students' performance and motivation. For example, students using Smithtown, an ITS for economics, performed equally well as students taking a traditional economics course, but required half as much time covering the material (Shute, V., R. Glaser, and K. Raghaven. 1989).

As mentioned, CBT and CAI do not provide the same kind of individualized attention that a student would receive from a human tutor. Frustrating interaction with a computer system can often leave a user feeling negatively disposed toward the system and its makers. Since humans are predisposed to respond socially to computers, such negative experiences could alter perceptions of trust, cooperation and good faith on the part of the user (Klein et al., 2002). On the other hand, enabling computers to recognise and adapt to the user's affective state can, in theory, improve the quality of interaction in a variety of ways. It is fair to say that not all computers need to be aware of the user's emotions, because most machines need only remain rigid straightforward tools (Picard, 2000).

However, there is a range of areas in HCI where computers need to adapt to their users. The inevitable and unchangeable truth is that humans are affective beings, guided by a complex system of emotions, drives, and needs (Myers, 1998). By ignoring human nature, computers force their users to act like machines themselves, which is an unrealistic expectation that contradicts the main assumption guiding HCI research:

People should not have to change radically to `fit in with the system'; the system should be designed to match their requirements

(Preece et al., 1994).

Research in applications of ITS in Education aims at developing means of cognitive adaptation and support. Learners vary in their amount of prior knowledge, motivation, learning style, natural pace and working memory capacity. Consequently, a uniform predefined instructional sequence can not provide the optimal learning environment for all learners (Holt et al., 1994). Educational research results published over two decades ago (Bloom, 1984) single out one-to-one tutoring as the most effective model of instruction. Success of one-to-one tutoring is based on the ability of human tutors to adjust their feedback based on their interaction with the learner. Real-life human tutors under one-to-one tutoring conditions are aware of the learner's cognitive state; this aspect of one-to-one tutoring has been successfully captured by ITSs. However, in one-to-one tutoring the tutor is aware of the emotional state of the learner; this may be immediately interpreted in certain ways in order to change the pedagogical approach.

ANIMATED PEDAGOGICAL AGENT
Pedagogical software agents in instructional environments draw upon human-human social communication scripts by embodying observable human characteristics such as the use of gestures and facial expressions. Several studies show that animated agents can improve

student's learning, engagement and motivation (Johnson et al., 2000; Mishra and Hershey, 2004; Mitrovic and Suraweera, 2000). A learner who enjoys interacting with a pedagogical agent has a more positive perception of the overall learning experience and consequently opts to spend more time in the learning environment (Johnson et al., 2000). However, the design of feedback in current computer-based educational systems is often based on simplistic and erroneous framework where praise is assumed to affect behaviour positively irrespective of context (Mishra and Hershey, 2004).

There have been studies showing that being praised for success in a task perceived as easy may have negative effect on a student's self-confidence, while being blamed for failing in a task perceived as difficult may lead to a positive effect (Henderlong and Lepper, 2002). Topffer's law (Mishra and Hershey, 2004) states:

All interfaces, however badly developed, have personality.
On the other hand, overall the users' perception of agents, as well as their effectiveness, depend on multiple characteristics of agents, such as agent realism, gender, ethnicity and instructional role (Baylor and Kim, 2004; Lester et al., 1999b). STEVE, ADELE, Herman the Bug, Cosmo, and Smart Egg are examples of pedagogical agents. STEVE (Soar Training Expert for Virtual Environments) teaches students how to perform procedural tasks, such as operating or repairing complex devices (Johnson et al., 2000; Rickel and Johnson, 1997).

ADELE (Agent for Distance Education: Light Edition) is designed to support students solving exercises delivered over the World Wide Web (Shaw et al., 1999). In the application of a case based clinical diagnosis, ADELE can highlight interesting aspects of the case, as well as monitor and provide feedback as the student works through a case. Herman the Bug is a pedagogical agent introduced in Design-A-Plant, a learning environment for the domain of botanical anatomy and physiology (Lester et al., 1999a). The agent exhibits life-like behaviour as it provides advice to students solving problems.

Cosmo inhabits the Internet Protocol Adviser, which is a learning environment for the domain of Internet packet routing (Lester et al., 1999b). He provides advice to learners as they decide how to ship packets through the network to the specified destination. Smart Egg (Mitrovic and Suraweera, 2000) assists students in learning Structured Query Language (SQL) with the help of SQL-Tutor (Mitrovic, 2003). The agent explains the system's functions, provides feedback on students' actions and informs students about additional ways of getting help or background information.

DEVELOPING AN ANIMATED PEDAGOGICAL AGENT IN AN INTELLIGENT TUTORING SYSTEM
People are known to be irritated by the constant *helpful* interventions and bouncing of Microsoft's Paper Clip and other agents supplied with some editions of Microsoft Office. Unfortunately, there is no *cookbook* defining all the rules for Human-Human Interactions (HHI) that Human-Computer Interactions (HCI) developers can simply implement (Bickmore, 2004). However, many of the most fundamental rules have been defined in work by linguists, sociolinguists and social psychologists. The behaviour of the agent will be guided by these findings to ensure it is as similar as possible to relevant behaviour in HHI. In this research, the HHI rules and experiment with how the students interest of study are influenced by the emotions expressed by the agent will be explored.

To date, there are several software packages that might help to develop the intended APA. One of which the researcher find to be suitable to be used is PeoplePutty. PeoplePutty is a relatively new commercial tool for building dynamic three-dimensional virtual characters. The agent will be presented in the role of a tutor, since this has been described as the most effective role to connect with the users (Prendinger et al., 2005; Baylor and Kim, 2004). The agent will be capable of displaying the basic human emotions and facial expressions such as joy, sadness, interest, boredom, excitement, sympathy, etc.

Dimensional approach will be applied to ease the correlation between the agent's and participant's emotions, provided the flexibility of the software package used for developing the agent allows for this. It will also allow for a finer control over the intensity of the agent's

emotions. However, the lack of flexibility in the agent's emotions might force the researcher to use the categorical approach, in which case establishing an approximate mapping between the two approaches will be needed. A suitable behaviour space will be developed, which will consist of a pool of animations and messages to be triggered by the system in response to user actions. In this way the agent will interact with the user through visual behaviours and text messages. Both of these channels will carry cognitive and emotional feedback.

CAN PEDAGOGICAL AGENTS ASSIST TO IMPROVE LEARNING?
Several studies (reviewed in Clark and Mayer, 2003) have shown that pedagogical agents can improve instruction and it is worth the expense to include them in e-learning courses.

In two separate studies (Moreno, Mayer, Spires and Lester, 2001) students interacted with Herman-the-Bug (an interactive agent) in the Design-A-Plant instructional game. The students were taken to planets with different ecological and environmental conditions. They had to choose which parts of a plant would survive on that planet. Herman was their guide, posing problems and offering feedback. Students who interacted with Herman generated 24-48% more solutions in transfer tests than students that had the same text and graphics for the lesson but did not have Herman as a guide.
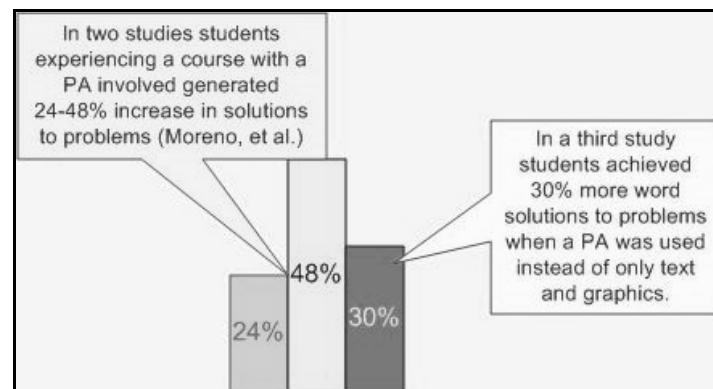
The table shows that students that interacted with pedagogical agents in their lessons generated between 24-48% more correct solutions to problems than students covering that same content with only text or graphics for instructional materials.

In related research (Atkinson, 2002) students working on math problems that saw examples that were worked through with the help of an agent produced 30% more correct solutions to word problems than students that had the same instruction without the help of an agent to work the problems through. Although more work is needed on the specifics of using pedagogical agents, they clearly can help improve instruction and student learning.

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