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The role of animated agents in web-based distance education

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Abstract

The purpose of this literature review is to determine the roles of animated agents in web-based distance education. The review was organized according to such themes as the structure and creation of animated agents, their cognitive and affective benefits, the importance of facial appearance and reality of animated agents in web-based distance learning and communication, and online animated agents. The instructional roles of animated agents were explored through a variety of experimental studies. The findings revealed that animated agents could take instructional roles such as a teacher, a mentor, a coach or an assistant in learning environments. Besides, multidisciplinary instructional environments enriched with animated agents could significantly contribute to the related literature in terms of the pedagogical outcomes they supply. The initiatives on the related context could be useful in order to fill the gap in Turkey. Therefore, it is suggested that animated agents should be integrated into web-based learning environments via considering the pedagogical elements in future studies.

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1. Introduction

With its roots being traced back to ancient times, distance education is a system that enables new concepts to be developed over time. Diversified interaction is the primary factor in the emergence of new concepts. Distance education allocates importance to interaction, thus establishing several distance education environments.

Physical participation is not enough on its own to enable students to experience active learning. In contrast, mental participation is considerably more important than physical presence in a learning environment. Interactive applications are the best way of ensuring the use of mental processes and development of cognitive activities (Mayer, 2001). A basic level of interaction might prove to be insufficient to realize new learning in cognitive, affective and psychomotor domains. Therefore, interaction should not be confined to clicking a simple button or menu selection on the Internet but should include much more different activities (Liu, 2001).

Although there are some nuances in distance education materials on the Internet, they generally fall under the following headings: “web-based learning”, “web-based education”, “e-learning”, “internet-based education”. Enabling students, teachers, and instructional materials to converge on Tim Berners Lee’s WWW network, web-

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based learning is the type of learning that takes place on electronic environments that provide people in different places with the opportunity to share such elements as texts, data, graphics and animations (Khan, 2001).

In accordance with the importance of interaction in distance learning, multimedia learning provides a general framework for distance education. Multimedia learning enables learning to take place through the use of instructional materials that will enrich the learning environment and concretize learning in accordance with the course and subject matter (Altınışık & Orhan, 2002, p.42). Multimedia learning is an effective learning tool by which both visual and auditory information are presented (Mayer, 2009). The more interaction exists between students and instructional materials, the more effectively multimedia learning is used in the development of web-based distance education environments.

As an instructional tool, animated agents are characters similar to the ones found in our daily lives and facilitate the learning process (Johnson et al., 1998). Animated agents might make learners think that online educational materials are less difficult (Andre et al., 1998). Educational software with animated agents presents a multimedia learning in which learners can acquire information not only in a visual but also in an auditory manner. Such software can be conveyed to students in such storage devices as CDs or DVDs. In addition, they can be integrated into web-based distance education environments. The present paper is a review of literature on the role, efficacy and uses of animated agents integrated into web-based distance education environments and a presentation of implications.

2. Methodology

A review of literature was conducted on the roles of animated agents that are used in web-based distance education environments. The sources reviewed included online databases which Suleyman Demirel University had a subscription to (ERIC, ScienceDirect, Ebscohost, Wiley, etc.), online journals of educational technologies and other sources included on Google. The keywords used during the search were combinations of “animated agents” with web-based learning, web-based training, distance education and distance learning. The sources had been published between 1986 and 2007. The parts of the publications that were especially reviewed were their abstracts, methodologies and conclusions. The data that were regarded suitable for inclusion in this study were organized under five headings, namely the nature of animated agents, the generation of animated agents in web-based distance education, cognitive and affective advantages of animated agents in web-based distance education, the importance of facial expressions of animated agents and reality in web-based distance education and communication, and online animated agents. In this way, it was possible to access to the roles of animated agents in web-based distance education.

3. Findings

3.1. The nature of animated agents

A graphical representation of characters, animated agents are often computer interfaces used to provide a more customized interaction between human beings and computers (Morton and Jack, 2005). These agents might assume the role of an information presenter (Noma & Badler, 1997; Badler et al., 2000; Ishizuka et al., 2000), a desktop assistant, a personal assistant, a teaching guide, a mentor, a counselor and a virtual reality assistant (Dehn & Van Mulken, 2000). An example of animated agents used as an information presenter would be the system of animated agents called Vaxholm, which was developed at a Center of Speaking Technology. The system was used to introduce tourists to the boat traffic of Stockholm islands (Granström & House, 2005). Furthermore, animated agents can be used as sales representatives (Andre et al., 2000; Baldes et al., 2002; Morton & Jack, 2005; Bickmore et al., 2000; Cassell et al., 2002; Kitamura et al., 2002) or real estate agents (Cassell et al., 1999; Granström & House, 2006). As an instructional tool, animated agents are characters similar to the ones found in our daily lives and facilitate the learning process (Johnson et al., 1998). There are differences in the way animated agents are used in teaching. For instance, Johnson and Shaw used a two-dimensional animated agent in medicine training in 1997, when computer technologies were not as developed as today. Similarly, Johnson et al. used a three-dimensional animated agent on a virtual environment designed for training students of engineering (Morton & Jack, 2005).

Naturally, a sufficient level of interaction will not be available in two-dimensional agents seeing that there is not a harmony between their static movements and voices.

Considering the speed at which computers and web technologies are advanced, it is inevitable that most of the animated agents will be three dimensional. There might be differences in the forms of these three-dimensional animated agents. For example, some animated agents are scenario-based. It is usual to observe the use of such animated agents especially in language teaching.

Morton and Jack (2005) used the SPEEL system (Spoken Electronic Language Learning), which had been developed to provide computer-assisted language education. The system includes three forms of scenarios, namely observational, one-to-one and interactive. With this software, those students who can move to the interactive scenario after passing through the first two stages are provided with a learning environment that resembles “second life”. What makes the system different from others is that students are able to get involved in communication, gain courage and have communicative experiences that are similar to the ones in their daily lives as well as the kind of communication found in all learning environments with animated agents.

3.2. The generation of animated agents in web-based distance education

Animated agents should be generated with a consideration into the interaction between human beings and computers, and pedagogic elements. An animated pedagogical agent is an animated character that lives in computer-based learning environments and helps students by guiding or instructing them (Choi & Clark, 2006).

The most commonly used type is web-based trainers animated through the Flash Player. However, their positive influences on learning might be limited, for such trainers cannot go beyond a one-way communication. Nevertheless, certain organization styles in web courses have shifted from old frameworks to user-controlled hyper environments. Therefore, approaches that require increased harmony and communication and satisfy customized learning needs and characteristics make learning processes easier while courses are developed (Song et al., 2004). Web-based distance education environments with animated agents are representatives of such an approach. Presenting the advantages of face-to-face interaction and virtual learning, these representatives are one of the new products of today’s technology.

Animated agents can be generated through certain three-dimensional designing programs. These agents may or may not be human-like. Research shows that human-like animated agents are more influential in attracting users’ attention and enabling them to focus on active tasks than those that are not human-like (Dehn & VanMulken, 2000).

There are organizations that provide online services for the generation of animated agents. The websites of these organizations include optional animated agents that can be integrated into any e-learning environment. Some of them are Media Semantics Character Building© (<http://www.mediasemantics.com/Product.htm>), Cantoche (<http://www.cantoche.com>) and OddCast (<http://www.oddcast.com/home/>) (Reategui et al.). It can be concluded from the software included on these websites that there is a harmony between the words of animated agents and their tongue movements. This factor is especially important to the education provided for the hearing-impaired.

3.3. Cognitive and affective advantages of animated agents

According to Bandura (1986), perceived self-efficacy is a driving force behind motivation. The reason for this is that self-efficacy (one’s confidence in his/her ability to do something) is one of the internal audit mechanisms that help one exhibit a particular behavior, or focus on learning. The higher one’s self-efficacy is, the higher his/her tendency to exhibit a behavior is. One of the greatest advantages of animated pedagogical agents is that they can motivate and entertain students at a higher level than any other learning environments and that they can encourage them to make efforts to understand the learning material (Choi & Clark, 2006.). In this way, instead of avoiding getting involved into the learning environment, students will be able to consider their teaching agents as a friend and go through the stages of data processing in a problem-free and efficient manner by actively participating in the learning process.

In addition to self-efficacy and motivation, animated agents are associated with another concept in the literature: “the Persona Effect”. The Persona effect is the positive impact of animated agents on students’ learning experiences (Kim et al., 2007; Lester et al., 1997; Moreno, Mayer, Spires & Lester, 2001; Choi & Clark, 2006). However, it

should be noted that this emotional connection between animated agents and students does not necessarily lead to a direct effect on learning outputs. In other words, entertaining and positive communication between agents and students does not necessarily prove that learners learn better (Lester et al., 1997). In fact, Choi and Clark (2006) investigated whether simulated agents as a media tool facilitated learning or not. Their study was based on the conflicting views of Clark and Kozma. The results supported the views of the latter. It was concluded that the role of simulated agents in teaching subordinate clauses in English was not more effective when compared to other multimedia instruments. During the study, 74 ESL (English as a Second Learner) students were taught subordinate clauses in English in two different learning environments, one with simulated agents and the other with electronic arrows with voice. It was observed that simulated agents were not more effective in cognitive and affective ways. Furthermore, it was discovered that learning performance did not require the use of an ornamental or expensive learning instrument, and that such instruments were not more interesting or motivating. Similarly, Van Mulken, Andre and Muller (1998) reported the same interesting result. Based on animated agents and text-object animation, the study found that animated agents, contrary to expectations, were not more efficient in enabling adults to recall information. However, Moreno, Mayer and Lester (2000) conducted a series of studies on the social roles (like pictures, sound and speaking styles) of animated agents in learners' motivation and performance. They discovered that animated agents had a positive influence on students' motivation and information recall levels. Their justification was not the pure images of agents but the fact that agents were auditory stimuli. The study concluded that students were more successful in storing information in their minds and got higher scores when the animated agent used a speaking style similar to conversation when compared to monologues. The authors described the effect as "the dialogue effect".

3.4. The importance of facial expressions of animated agents and reality in web-based distance education and communication

The literature on e-learning environments, including studies on the acceptance of educational software, is getting more and more intensive (Russell, 1999). Animated agents, enabling students of distance education to learn things, need to have certain characteristics. As an autonomous agent, animated agents need to exhibit dynamic responses during their dialogues with users (Mahmood & Ferneley, 2006). There are currently significant studies on instilling such communicative behaviors and characteristics as emotions, personalities, gestures and facial expressions into animated agents.

According to a study conducted by House et al. in 2001, eyebrows and heads of animated agents can move in a way that will serve as independent clues. Therefore, it is important that there syllables must synchronize with visual movements (House et al., 2001). The authors carried out another study in 2006 as an extension of the one in 2001. In this study, they focused on visual components that must be taken into account while animated agents are generated for language teaching. It is essential to specify how their eyes, eyebrows or heads should move to express surprise, unhappiness or anger. The reason for this is that an efficient use of these expressions may make language teaching easier. The study emphasized that agents should exhibit communicative behaviors in a realistic way.

In their study on male students, Baylor and Kim (2004) found that those students who were taught through animated agents with a realistic appearance (i.e. similar to human beings) learned better than those who were taught through animated agents with an unrealistic appearance (i.e. similar to cartoon characters). However, there was not a similar discrepancy between groups of female students. Baylor (2005) discovered that female students had a higher tendency to choose iconic agents than male students. Similarly, Gulz and Haake (2005) studied the preferences of students concerning the reality of pedagogical agents. They observed that female students first chose iconic agents, then intermediately realistic agents and finally highly realistic agents. Nevertheless, this was not the case for male students. On the other hand, Moreno et al. (2001) concluded that students' learning accomplishments did not significantly differ depending on whether they used highly realistic or hardly realistic agents. Based on all these findings, it can be argued that highly-realistic agents are not always an essential component of learning (Clark and Mayer, 2003).

3.5. Online animated agents

One of the earliest studies on animated agents with which students can be in constant communication was conducted by Shaw, Johnson and Ganeshan in 1999. In the study, Shaw et al. mentioned the characteristics, skills and online effects of the pedagogical agent they had developed at USC: Adele (Agents for Distance Education-Light Education). Adele was designed for the students of Medicine at USC School of Medicine for two courses, namely Clinical Diagnosis and Emergency Trauma Care. Serving as either a single-user individual learning tutor or multi-user cooperative learning tutor Adele enables students to do practice in a clinical environment to diagnose typical cases. In accordance with instructional objectives, Adele shows students in what ways a case should be studied and guides them through emphasis or clues towards the correct steps. It also provides contextual evaluation to test whether students have understood or not. Since Adele is one of the earliest examples of animated agents, it includes two-dimensional structured animated agents. However, it has been discovered that it is as good as 3D animated agents at user acceptance and motivation, for the details of its voice, facial expressions and posture have been successfully structured. Despite having limited interaction with users, Adele attracts students' attention and motivates them thanks to its appearance as a real human being (doctor).

PPP Persona is another animated agent that provides online instructions. The agent guides students through web-based learning materials. (Andre, Rist & Muller, 1999). It shows suitable ways of developing online learning materials and satisfies learner needs. Like Adele, PPP Persona has behaviors that are made up of the bitmaps of an agent in different postures.

CAPA, an animated agent, is an example of an animated agent that is used as an educational interface agent in a web-based course. Educational interface agents generally serve as page summarizers that help make courses less boring. Sabot et al. (2005) emphasized that CAPA interface agent, unlike real instructors, make students comfortable and help them avoid such negative anxieties as shyness or nervousness during the learning process.

In their study, Salim et al. (2007) focused on the elements that require the generation of animated agents in web-based learning environments. They studied the requirements within the context of Input-Process-Output (IPO) and reached some conclusions about the considerations for designing pedagogical agents. Developed for the study, a questionnaire was submitted to a total of 100 primary school science teachers. The questionnaire asked the participants what the suitable roles an agent had to perform (tutor, coach, presenter or guide) were and what kind of qualities agents had to have in order to be more realistic and motivating in their interaction with students. Nearly all the participants (98%) provided complete answers to the questions. According to the results, the authors evaluated the students' problems and the roles of agents within the context of Input, the behaviors of the characters within the context of Process, and advantages of animated agents within the context of Output. Afterwards, they tested the correlation among these three contexts. They concluded that the three contexts were dependent on each other. In other words, the roles and behaviors of animated agents had an influence on their advantages. All the requirements they had revealed were presented in a table under two headings, namely fundamental requirements and supplementary requirements. The authors investigated the pedagogical elements within the context of IPO in relation to each other, which enables us to observe the positive pedagogical effects of animated agents in a clear way.

4. Discussion and conclusion

It is generally accepted that two of the most important considerations in generating animated agents used in web-based learning are an evaluation of pedagogical elements and the age of a learner. Another factor in the effects of animated agents is whether they are realistic or not. In other words, their efficiency in language teaching is enhanced when they are like human beings, when their facial expressions (blinking, frowning, etc.) are in harmony with their speech and when their speech synchronizes with their tongue movements.

Contemporary educational systems enable the teaching process to be integrated into technology. Some scenario-based language teaching systems with animated agents present themselves as a teaching material that increases students' active participation in the learning environment. Some studies on the correlation between perceived self-efficacy, which is described as "the persona effect", and animated agents found that they are not correlated with each other.

It can be observed that animated agents in web-based distance education are used in a number of areas from science to medicine and from verbal lessons to psychomotor trainings. They also target a wide range of age groups. Nevertheless, a review of literature suggests that animated agents used in web-based education in Turkey only serve as educational interfaces. Thus, it is recommended that special emphasis should be put on and support should be provided for projects aiming to increase the interaction between students and animated agents.

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