Animated Pedagogical Agent in the Intelligent Virtual Teaching Environment


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Abstract

This paper presents the evolution description and relevance of IVTE- Intelligent Virtual Teaching Environment project in terms of Artificial Intelligence and Artificial Intelligence in Education field. Furthermore, it describes the importance of Multi-agents modeling used in the IVTE software and also gives emphasis in the Cognitive Agent Model represented by an Animated Pedagogical Agent. The purpose of IVTE software is to educate children to preserve the environment. The IVTE software is implemented with Multi-agent (MAS) and Intelligent Tutoring Systems (ITS) technology, which gives more adaptable information to the teaching process. The adaptable information is promoted by Tutor of ITS or, in other words, by Animated Pedagogical Agent. The Animated Pedagogical Agent monitors, guides and individualizes the learning process using student model and teaching strategies.

Keywords

Intelligent Tutoring Systems, Multi-agents Systems, Animated Pedagogical Agents, Student Model, Teaching Strategies.
1. Introduction

The Computer in Education area has been corroborated to the birth of new paradigm to model and implement Intelligent Educational Software. This new paradigm is called Animated Pedagogical Agents. They are considered lifelike autonomous character that cohabite the learning environment creating a rich interface face-to-face with student [JOH 00].

Educational Software is considered efficient, according to John Self [SEL 99], when it models the student cognitive capacities, and thus, gives personalized instructions adapting them. Educational Software in this context is considered an Intelligent Tutoring System (ITS) where Animated Pedagogical Agents could be inserted. According to Patel [PAT 00] an ITS could be an useful tool to provide efficient learning by representing the Knowledge domain at suitable granularity and providing interactive guidance to the student. For this reason, an ITS should incorporate a specific Student Model Base and Teaching Strategies tied to that Base.

Concerning Paiva [PAI 94], Student Model in a system can be considered like an explicit representation of some particular student feature, which allows Educational Software adaptable/personable teaching. The knowledge exchanges among students and system depends on what is inside the student model and teaching strategies. An ITS will be more efficient on condition that its student model and teaching strategies are more complete according to the Educational software needed.

Regarding to Hietala [HIE 98], an ITS provides effective teaching when it models students correctly and also when it selects adequate teaching strategies. Added to this, an ITS should be included in a social context, working as an autonomous agent [NUN 98] in cooperation with students. According to Dimitrova’s work [DIM 00], the system presents a student model to prove its adaptable features, adequate feedback and well-directed instruction knowledge, and then, the system is built to group model discarding the student model.

At the same time, considering Boulay [BOU 00], there is a considerable problem in the Educational Software. This is happening because it is necessary to know how humans learn and pass this information to the ITS generated. To create an ITS is necessary to build a Tutor, that is, a figure or a character that guides the student action during system interaction, helping and stimulating the building knowledge process.

An Animated Pedagogical Agent provides the student stimulation in the software interface. The Animated Pedagogical Agent has power to offer a wide spectrum of educational interaction with students. It fulfills needed features to ITS, developing complex tasks, using gestures and facial expressions to focus the student attention in relation to cognitive learning process. However, creating and developing an Animated Pedagogical Agent is not trivial because it is a recent multidisciplinary subject [BAE 99]. By using Animated Pedagogical Agent, the learning environment has migrated of simple training systems to more constructionist educational environment. The Pedagogical Agents have many ITS benefits, however they are more flexible due their ability to offer opportunistic instructions, personalizing the student learning. Thus, there is a positive impact in the learning process in the Intelligent Educational Software. A Pedagogical Agent provides a natural dialog interface between the student and the system.

An IVTE project is justified by new teaching, learning technologies that will be provided to ITS improving the efficiency level of teaching processes made by Animated Pedagogical Agent. It makes the cognitive process better.

This paper is organized as follows: section 2 describes features of Animated Pedagogical Agent; section 3 describes the IVTE environment; in section 4, the Animated Pedagogical Agent, called
Guilly, and its behavior in an IVTE environment are presented. Additionally, in section 4, student model base and teaching strategies are presented. The following section, is about conclusion and future works and finally the references are presented at the last section.

2. Animated Pedagogical Agents

According to FitzGerald [FIT 98], the newest generation in educational software technology is endowed of great power including features of Artificial Intelligence (AI), Interactive 3D in the immersive environment, Animated Intelligent Agents and Image and Animation. Using the state-of-art of this technology, designers of agents’ technology should integrate AI with Animated character to produce a new level of interactivity. 3D environments offer new educational opportunities integrated to multimedia and software design. A multimedia information can be much more efficient in the learning process because it is remember after long time of software interaction. Digital animation (2D-3D) offers perceptive advantages in the environment with animated character. It happens because it can exaggerate or be subtle when shows information during the software interaction. Designer should stress important knowledge features by using the exaggeration or should be subtle in information without importance. The animation gives sensitive information through gestures, voice intonation, facial and body expression and posture. It provides a clear communication between student and software.

Animated Pedagogical agents represent the newest generation of Human-Computer Interface’s design. They are different from Pedagogical Agent because their appearance is like an animated character. They have the digital guide personality and appearance. They are autonomous agents that support the human learning interacting with students in the interactive learning environment.

Considering Johnson [JOH 98] research, the Animated Pedagogical Agents adapt their behavior taking into consideration the learning opportunities that emerges during the software interaction. They individualize the learning process and promote the student motivation. They give to user an impression of alive and believable character that is similar to natural/real one. They engage into continuous dialog copying human dialog aspects.

Regarding to Graesser [GRA 00], a pedagogical agent must simulate the discourse pattern and pedagogical strategies of typical human tutor. The interaction between agents and student/environment must coincide considering the agent appearance and the internal state. It can crate animation to represent a natural feedback to student that coincides to specific internal state. The Pedagogical Agent works in interactive way with the user by using dialog. When the student interacts in the environment the Pedagogical Agent gives feedback. The feedback happens through dialog, facial expression, gesture and intonation.

According to Lieberman [LIE 97] the Pedagogical Agent has some features related with human intelligence: learning, inference, adaptability, independence, creativity…

Concerning Slater [SLA 00] an Interactive Animated Pedagogical Agent can:

1. Adapt - A pedagogical agent evaluates the learner's understanding throughout the interaction, just as a human teacher would, and adapts the lesson plan accordingly. Pedagogical agents will not move on to more sophisticated concepts until it is clear that the learner has a good understanding of the basics. If learners continue to have difficulty, the agent can provide additional instruction;

2. Motivate - Pedagogical agents can prompt students to interact by asking questions, offering encouragement and giving feedback. They present relevant information, offer memorable examples, interpret student responses, and even tell a clever joke or two;
3. Engage - Pedagogical agents have colorful personalities, interesting life histories, and specific areas of expertise. They can be designed to be the coolest teachers in school;

4. Evolve - Pedagogical agents can be revised and updated as frequently as necessary to keep learners current in a rapidly accelerating culture. They can search out the best or most current content available on the web to enrich the lessons that someone else has previously designed.

Regarding to Baer [BAE 00], autonomous agent is a program that executes in parallel with the user. The interaction between the agent and the learning environment takes place when agent receives environment events, and then asks information about the Environment State or sends commands to the environment.

The Animated Pedagogical Agent interface face-to-face creates an affective link with user/student. The emotion has influence in the student learning cognitive process. It reflects in enormously in the level of student learning. Regarding to Russel [RUS 97], the face is the key for emotion understanding. The face transforms the emotion in something measurable and understandable. For this reason, it is extremely relevant to produce Animated Pedagogical Agent interaction by using face-to-face interface. Some important points to use face-to-face interface are described as follow: the same patterns of facial movements occur in all humans group; specific emotions has Universal facial patterns; facial patterns are manifestation of many emotions in all human societies. The facial expressions can be used as a link in the educational cognitive process. Spontaneous expressions are adapted like natural or involuntary. In dialogs, for example, spontaneously, it uses facial expressions providing a symbolic and natural communication.

According to Lester apud in [SLA 00], creating life-like pedagogical agents potentially provides four important educational benefits: A pedagogical agent that appears to care about a learner's progress may convey to the learner that it and she are “in things together” and may encourage the learner to care more about her own progress; An emotive pedagogical agent that is in some way sensitive to the learner's progress may intervene when she becomes frustrated and before she begins to lose interest; An emotive pedagogical agent may convey enthusiasm for the subject matter at hand and may foster similar levels of enthusiasm in the learner; A pedagogical agent with a rich and interesting personality may simply make learning more fun. A learner that enjoys interacting with a pedagogical agent may have a more positive perception of the overall learning experience and may consequently opt to spend more time in the learning environment.

3. IVTE – Intelligent Virtual Teaching Environment

IVTE is educational software developed for children aged from 8 to 10. IVTE [NUN 00, NUN 01] software makes children aware of urban garbage correct selection.

The environment is simulated by a small village where the child makes his/her way home after a hard day at school choosing one of the possible suggested itineraries. This microworld shows characteristics that are similar to reality. The context into which the microworld is inserted represents actions that occur in the daily routine of Brazilian children.

Inside the IVTE, just like in real life, the child may follow different directions (itineraries, heuristics) from school to his/her home. All these ways give the children a chance to interact and to keep contact with the kinds of garbage from daily life and, most crucially, these ways give the child a chance to select them correctly.

The environment operates on a non-immersed Virtual Reality where the student has the clear sensation of being into a real environment. However, the student is only entitled to a partial
view of the environment as the technology like Virtual Reality allows the student to see just what is quite close to him. The student action into the environment is adjusted by the existing elements in the scenery. The scenery is made of several ways between the school and the student residence. In the ways we can find trees, bushes, building faces, different kinds of garbage spread on the ground, peddlers (figure 1).

![IVTE environment](image)

**Figure 1 – IVTE environment:**
Pedagogical Agent Guilly, Meter and Map locate

IVTE Software time can be configured by teacher. Therefore default time is 15 minutes.

Student actions happen in two different environments, they is consider like outside environment and inside environment. Outside environment consists many ways where students can walk from school to then home. In these way students come across with different type of garbage found in the environment or produced by them during the interaction.

The interaction is made by student through of buying sweets, drinks, etc in the vendors who is in the environment way.

However, inside environment presented by student home, where there are same interaction with garlics said before. In the student home there are different trash bins to correct garlic selection.

When students are navigating in IVTE environment, they need to localize themselves and their colleges, for this reason, there is a student localization map. This map is interesting to make possible the direction sense for students and teacher when monitories them. (Figure 1)

Students are monitored by pedagogical agent called *Guilly* (Figure 1). *Guilly* gives students feedback through clues. These clues are made by messages, body and facial expressions. This work will present Guilly’s model.

IVTE environment is ludic, for this reason, student performance is measured for the “Meter”, according figure 1. A tree represents the Meter, growing up or keeping it in same depends on student behavior in IVTE environment.

Afterwards, another IVTE important features are the Zoom tool. Zoom is implicit in IVTE environment, but it is appear when pedagogical agent asks or student actives. It is used to show to student environmental impacts of his/her action, in other words, student could think about
his/her action done in the environment. This procedure helps student in the knowledge construction.

4. Guilly - Animated Pedagogical Agent Model

The Animated Pedagogical Agent is inserted at IVTE to promote adapted teaching through Teaching Strategies based on Student Model Base. The main aim to insert Animated Pedagogical Agent in the IVTE is reach high pedagogical level, because he works like a Tutor in the teaching-learning process.

According to Oliveira [OLI 00], the Animated Pedagogical Agent of IVTE software is a Cognitive Agent, taking into consideration his autonomy, memory of past actions, he knows the environment and the others society agents, makes plans to his future, he is pro-active. Cognitive agents are based on knowledge, its mean, he has intelligent behavior in front of many situations, he has implicit and explicit knowledge.

In the IVTE, a worm, called Guilly represents the Animated Pedagogical Agent.

4.1 Guilly Architecture

The Animated Pedagogical Agent, Guilly, was designed by using a generic architecture to animated agent based on Baer [BAE 99] concepts. The architecture has 3 modules: Agent Module Control, it coordinates the agents actions and reactions, processes entrances sent by Reactive Agents in the IVTE environment; Domain Base, it represents the knowledge base divided in two sub-modules: Student Model and Teaching Strategies, they should select the correct student model and teaching strategies to be used by Animated Pedagogical Agent; Agent Interface, it does the representation of environment reaction presented by messages, dialog, gesture, facial and body expression. The Guilly architecture is presented in figure 2.

![Guilly Architecture](image)

The Guilly represents part of the action cycle started by user/student, changing the internal state of objects in the IVTE. These objects are Reactive Agents. They react according to user actions in the IVTE and the send information to Guilly. Guilly process the information in the Agent Module Control verifying in the Domain Base where it will select the correct Student Model to act during the software interaction. After that, teaching strategy is selected and sent to...
Agent Module Control and ten sent to Agent Interface. This process generates a face-to-face
interface and feedback to student.

4.2 Student Model

The Student Model Base stores information like percentage of marks and how many times the
students have used specific garbage for selection. The Student Model Base is also based on
student performance and game time.

The Student Model is dynamic in the software, in other words, the student plays in the IVTE
Software where he acts, through his actions. The agents on the IVTE Software selected the
correct Student Model from Student Model Base. When the software initialize the Student
Model, optimal Student Model is activated. While the student acts in the IVTE Software, he is
monitored. This monitoring verifies if it is necessary to change the Student Model. The
Student Model changes according to student behavior. Student behavior is controlled by error
percentage, game time, number of times that the student selects the same garbage and number of
times the student proceeds correctly with some garbage. According to this Student Model the
IVTE Software interaction must be adjusted.

Based on this data, the student should be classified in four specific grades of Student Model,
taking into consideration the field research and 15 minutes play time:

1. Optimal: From 100% to 75% in the correct trash bin selection; or just one selection
   error in the same type of garbage;
2. Medium: From 75% to 50% in the correct trash bin selection; or two selection errors in
   the same type of garbage;
3. Regular: From 50% to 75% in the correct trash bin selection; or three selection errors in
   the same type of garbage;
4. Weak: From 25% to 0% in the correct trash bin selection; or four selection errors in the
   same type of garbage.

The grades described are represented and manipulated internally by the IVTE Software and the
user/student does not know about it. Therefore, it is extremely necessary to select the correct
Teaching Strategy to make teaching into the IVTE more efficient.

4.3 Teaching Strategies

The fundamental principle to guarantee pedagogical quality in a Teaching Environment is by
using different Teaching Strategies. A Teaching Strategy is the way through which the Tutor
helps student in his knowledge construction. Teaching Strategy is defined as methods used to
help student during the educational software interaction changing his cognitive stage.

In the IVTE Software, Teaching Strategies will be applied by a Animated Pedagogical Agent
according to the selected Student Model. The IVTE Animated Pedagogical Agent selects the
Teaching Strategy based on a student cognitive stage, his knowledge level and learning rhythm.

Concerning Oliveira [OLI 00], Teaching Strategies used by Animated Pedagogical Agent in the
IVTE are divided in six categories: face and body language; clues about garbage; alert message;
questions; zoom and alert about Meter performance as shown in figure 3.
It is important to remember that when the student is acting correctly, Guilly will just use face and body language to preserve the student cognitive stage. Otherwise, if he has a bad performance, Teaching Strategies must be reinforced by using face and body language linked to other categories described before. Therefore, a well-prepared student can think and then makes his mind about his knowledge contradiction; thus, he can try again changing his behavior/performance in the IVTE environment.

5. Partial Conclusion And Future Works

The combination of Artificial Intelligence and 3D environment technologies with innovative interface design offers great opportunities for efficient, customized learning. According to this, Pedagogical Agents bridge the gap bringing believable agents based on face-to-face interface. Their behavior and expressions are deliberately designed in order to appear lifelike and responsive to the student supporting pedagogical capabilities.

IVTE Software is a tool implemented to helps students in himself knowledge construction in efficient way. In this context, Animated Pedagogical Agent is important when used in ITS, because support many features suitable to student knowledge construction. This features are presented as personalized learning by using Teaching Strategies tied to Dynamic Student Model giving more dynamism to Educational Software.

Regarding to future works will be done a research about Animation Techniques to be applyed to Pedagogical Agent, exploiting and making better the interface and communication level in the Teaching Environment.

References


