

Animated Pedagogical Agent in a Learning Environment

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Abstract: Artificial Intelligence is an important area in the field of Computing applied to Education in terms of technological implementation. This paper describes IVTE, Intelligent Virtual Teaching Environment, implemented by Multi-Agents technology including pedagogical features, represented by *Guilly*. *Guilly* is a Animated Pedagogical Agent that acts based on a student model and teaching strategies.

Keyword: Computer Science, Education, Learning Environment, Cognition, Games.

Introduction

Computer Science has suffered modification in the last decades. In the same way, Artificial Intelligence in Education (AIED) has followed the same tendency.

Taking this aspect into consideration, AIED [Te99] changes its individual context to collaborative and social context. It is bringing a strong tendency in the collaborative process among software pieces. When somebody works with Intelligent Educational Software, these pieces are Tutor and Student. Students make the collaboration between Tutor/Student, Student/Student and Virtual Tutor/Student.

An Educational Software is considered efficient, according to John Self [Se99], 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) . Besides, an ITS should incorporate a specific Student Model Base and Teaching Strategies tied to that Base.

According to Paiva [PSH94], Student Model in a system can be considered like an explicit representation of some particular student feature, which allows Educational Software adaptable/personable teaching, to transform it into an ITS. 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.

According to Hietala [HN98], 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 [Nu98] in cooperation with students. Regarding Dimitrova's work [DSB00], 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 [Nu98].

With reference to MAS in ITS, Hietala [HN98] writes that the agents are represented by Teaching Agents or Co-learners called Tutors, which are divided into Reactive and Cognitive Agents. The main features of these agents are communication, capacity, autonomy and initiative.

Furthermore, in MAS, nowadays, a new type of agent called Animated Pedagogical Agent arises, when it acts in ITS, it supplies new features. The Animated Pedagogical Agent is considered the latest implementation paradigm used in an Educational Environment like ITS.

At the same time, considering Boulay [BL00], 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 it is necessary to build a Tutor, that is, a figure or a character that monitors the student action during system interaction, helping and stimulating the building knowledge process.

The main aim of the IVTE project is to make possible to programmers the ability to built an educational software which is, actually, related to student deficiency and that contributes to explore its potentialities

to make the cognitive process better. The IVTE is modeled and implemented like a pedagogical software to provide these features.

Regarding Demazeau's works [De00] there is a tendency in using MAS and Virtual Reality (VR) together. As a result, the IVTE Software - Intelligent Virtual Teaching Environment [Nu01, Nu00] was adapted to these technology, particularly, ITS, MAS, VR, Animated Pedagogical Agents.

An IVTE project is justified by new teaching, learning technologies that will be provided to ITS improving the efficiency level of teaching processes.

This paper is organized as follows: section 2 describes features of Animated Pedagogical Agent; section 3 describes the IVTE environment, secondly, in section 4, the Animated Pedagogical Agent, called Gully, 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.

Animated Pedagogical Agents

The Animated Pedagogical Agent model is recent in the Computing area. It has arisen from the need of new technologies to implement Educational Softwares. Considering MAS, the Animated Pedagogical Agents were created to bring more dynamism to Educational Software mainly in terms of pedagogical features. They are considered Alive Autonomous Characters cohabiting in teaching environments creating a rich interface face-to-face with the student. A Animated Pedagogical Agent interacts with a student through messages and gives interactive and dynamic feedback.

The Animated Pedagogical Agents are used in Educational Softwares to increase their pedagogical competence. In general, being capable of negotiating theirs and student decisions instead of just commanding them [Nu98]. They have autonomy to decide what is relevant to teach for each student based on a Student Model.

According to Johnson [JR00] an ITS Tutor, represented by Animated Pedagogical Agents, supplies feedback to student actions. It gives non-verbal feedback by using facial language, body language, and gestures. It also gives verbal feedback by using messages, and both, messages and facial body language; its purpose is motivate the student. The ability to use non-verbal feedback allows the Animated Pedagogical Agent to supply high feedback level for students. For instance, facial language feedback is subtler than verbal feedback.

The insertion of an Animated Pedagogical Agent in an Educational Environment is very important, mainly due to its feedback between environment and student during software interaction. Furthermore, it allows fluent communication, keeping track of students' performance and, thus, monitoring students. It creates a pleasant environment, easier to exchange messages, to talk, to have fun and to simulate cognitive reasoning. Consequently, the Animated Pedagogical Agent makes possible a quality jump in terms of pedagogical features in the Educational Software.

An Animated Pedagogical Agent into Educational Software is extremely important because it is responsible for giving student feedback during the interaction. Also, it makes the communication between student and environment more efficient, monitors student performance and guides the user/student. Finally, it transforms the dialog/communication more pleasant, funny and stimulant. These features allow the increase of pedagogical quality in the Educational Softwares.

According to Person [Pe01], innovation is necessary nowadays in terms of its modulate and implementation as it is done by using MAS architecture including Animated Pedagogical Agents in ITS.

IVTE – Intelligent Virtual Teaching Environment

The IVTE is an educational software developed for children aged from 8 to 10. The IVTE 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 and worldwide 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-immersive 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 pertaining 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, shown in figure 1, is made of several directions between the school and the student residence. Along these ways, we can find trees, bushes, buildings faces, different kinds of garbage spread on the ground and peddlers.

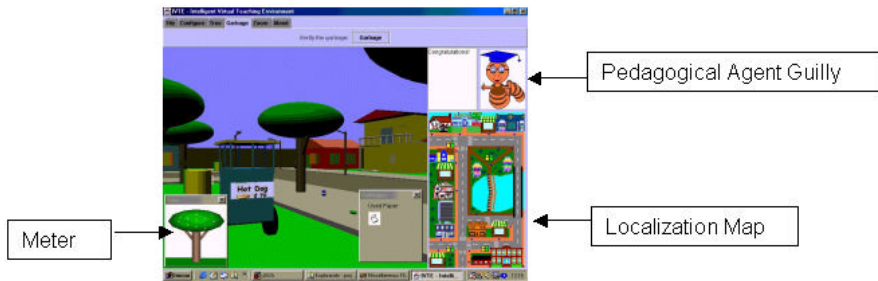


Figure 1 – IVTE Environment: Guilly Animated Pedagogical Agent, Meter and Localization Map

The IVTE game time may be configured by the teacher, therefore 15 minutes is default time.

Student action happens in two different environments. They consist of outside and inside environments. Outside environment consists of many ways where students can walk from school to their home. In these ways, students come across different types of garbage found in the environment or produced by themselves during interaction. The interaction is encouraged by the student when he buys sweets, drinks, etc from the vendors in the environment.

In addition, inside the home environment there is the same interaction with garbage as said before. At the student home, there are different trash bins to correct garbage selection.

When students are navigating in the IVTE environment, they need to identify themselves and their colleagues. For this reason, there is a student localization map. This map, showed in figure 1, is interesting to make the direction sense easier not only for the students but for teachers when monitoring the students.

Students are monitored by an Animated Pedagogical Agent called *Guilly*. *Guilly*, as showed in figure 1, gives a feedback to students through clues. These clues are given through messages, body and facial language. This work will present *Guilly's* model based on interdisciplinary research.

The IVTE environment is ludic, for this reason, student performance is measured by a “Meter” as shown in figure 1. The Meter is represented by a tree, growing up or keeping at the same stage, depending on student behavior in the IVTE environment.

Afterwards, another IVTE important feature is the Zoom tool. Zoom is a hidden tool in the IVTE environment, appearing when the Animated Pedagogical Agent calls it or when the student deliberately calls it. It is used to show the environmental impacts of the student actions. In other words, the student must think about his/her actions in the environment. This procedure helps the student in the knowledge construction process.

Animated Pedagogical Agent Model in the IVTE

An Educational Software should have teaching instructions focused on students needs, taking care of different student categories or model teaching processes. It should be adapted to Student Models to satisfy specific difficulties of each student category.

The Animated Pedagogical Agent was inserted at the IVTE to promote adapted teaching through teaching strategies based on a Student Model Base. The main aim of inserting a Animated Pedagogical Agent in the IVTE is to reach a high pedagogical level, as it works as a Tutor at the teaching-learning process.

According to Oliveira [OI00], the Animated Pedagogical Agent of IVTE software is a cognitive agent, taking into consideration its autonomy, memory of past actions knowing the environment and other society agents, making plans for the future, being pro-active. Cognitive agents are based on knowledge, it means, they show intelligent behavior in many situations, and they have implicit and explicit knowledge representation.

In the IVTE software, the Animated Pedagogical Agent is represented by a “worm”, called *Guilly*, whose name was chosen during the field research.

The Field Research

In the IVTE software, the Animated Pedagogical Agent Guilly should select correct teaching strategies according to a specific Student Model. The Student Model Base was created in a field research. This field research involves children aged from 8 to 10 in three schools. The Schools were selected based on social aspects. The field research was carried out to investigate an ecological character, performance and teaching rhythms associated with different student activities. As a result, a search

and a collection of information which are used in the creation of a Student Model Base and Teaching Strategies will be accomplished.

Student activities happen at the University campus (similar to the IVTE Environment where there are identified trash bins) and students are consuming food, like sweets and drinks. They walk around the municipal garbage dumping area and in the sector of garbage selection where workers separate garbage for recycling; they produce an ecological book, where they write a story about garbage; watch a film and a lecture about the garbage issue, collection selection and recycling; answer a questionnaire helped by their parents.

Each child (user) receives a bonus based on his performance in each activity. This bonus is represented by a part of a tree (leaf, stem, branch, fruit). These parts together will produce a whole tree. Each child who gets the whole tree wins a prize. This way, the effect in the teaching process represented by the Meter in the IVTE Software is stimulated and proved successful.

This field research was important to identify difficulties faced by children in the selection garbage process, making possible the creation of more adequate strategies based on stimulus to help students reach their learning needs.

The Student Model

The Student Model is used in the field research described above. The Student Model Base will store 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 monitoration 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 minute 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 25% 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.

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.

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 [Ol00], 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 2:

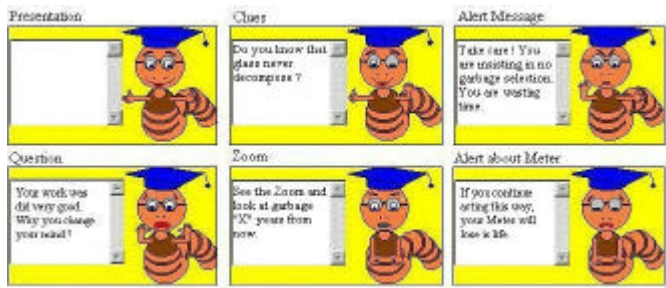


Figure 2 – Some used strategies

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.

Partial Conclusion and Future Works

The IVTE Software is an implemented tool to help students in their own knowledge construction in an efficient way. In this context, a Animated Pedagogical Agent is important when used in the ITS, because it supports many features that are suitable to student knowledge construction. These features are presented as personalized learning by using Teaching Strategies tied to a Dynamic Student Model. Teaching Strategies and Student Model are dynamic in the IVTE, it means, Student Model changes through student interaction in the IVTE environment and Teaching Strategies are applied according to Real Student Model. These features give more dynamism to Educational Software.

Regarding future works a research about 3D Animation Techniques will be carried out to be applied to Animated Pedagogical Agent, exploiting and making much better the interface and communication level into the Teaching Environment.

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