Survey on Understanding the Tutorial Actions based on Students' Affect

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Abstract. We have developed an affective behavior model for intelligent tutoring systems that considers both the affective and knowledge state of the student to generate tutorial actions. The affective behavior model was designed based on teachers' expertise obtained through a survey which 11 math teachers participated. The study focused in knowing how teachers manage the affective state of the students in order the students learn. During the survey, teachers watched a video of a student interacting with an educational game with an animated pedagogical agent. We asked them which agent's animation and which pedagogical actions are suitable for affect and knowledge of the student in each student's movement.

Keywords: Pedagogical agents, student affect, teachers' expertise, intelligent tutoring systems.

1 Introduction

Emotions have been recognized as an important component in motivation and learning. There is evidence that experienced human tutors monitor and react to the emotional state of the students in order to motivate them and to improve their learning process [5]. Recently there has been extensive work on modeling student emotions in intelligent tutoring systems, see [1]; however, there have been only limited attempts to integrate information on student affect in the tutorial decisions, e.g. [9, 2, 8]. If we want to consider the student affective state in the tutorial actions, an important problem is to identify the best tutorial action given both the students' affective and knowledge state. We conducted a survey consisting in to interview qualified teachers aimed at understanding which actions the teachers select according to the state of a student's affect and knowledge. The results are being used to develop an affective behavior model that considers both the affective and knowledge state of the student to generate tutorial actions. In this paper we describe the survey and our findings.

2 The Prime Climb Educational Game

To conduct the survey we use Prime Climb, an educational game to learn number factorization; t his game includes a pedagogical agent with a model of student's knowledge [6]. In Prime Climb, two players have to climb mountains in a collaborative way. Each mountain is composed by hexagons labeled with numbers. Players have to move to a number that does not have common factors with the partner's number, if not they fall off the mountain. To give adequate instruction, Prime Climb relies on a Bayesian pedagogical student model. The student model assesses the evolution of a student's factorization knowledge during interaction with the game. The pedagogical student model is used by an animated agent to deliver hints when it has evidence that the student is not learning from the game. The animated pedagogical agent is implemented through the Merlin character of Microsoft agent [7].

3 The Affective Model

Once the affective student state has been obtained, the tutor has to respond accordingly. The tutor needs an affective model which establishes parameters that enable a mapping from the affective and pedagogical student state to tutorial actions. The tutorial actions are composed by a pedagogical action and an affective action. The affective action tries to promote a positive affective student state and the pedagogical action to convey knowledge the student needs to know.

We consider as affective actions the way in which the pedagogical content is delivered to the student; e.g., the words, the facial expression, colors or sound included in the message. In the work presented here, an affective action is an animation of a pedagogical agent who delivers the pedagogical actions to students. In this way, the tutorial action is composed by an affective action and a pedagogical action.

Our main hypothesis is that the tutor action has a direct influence on learning and on the affective state of the student; and by selecting the appropriate tutorial action (i.e. according to the current student state), the tutor could improve the learning process and the affective state of the students. Given this hypothesis, we want to help students to learn and at the same time to foster a positive affective state.

4 The Teachers Survey

We conducted a survey with skilled teachers to validate our assumptions and refine our model. We wanted to know which actions the teachers do according with the affective and pedagogical student state and why they select those actions. Eleven math teachers participated in the survey, they have taught by 17.63 years in average from high school to post grade. These teachers have been trained in several teaching methodologies.

The survey consisted in to have teachers watching a video of a student interacting with Prime Climb and to ask them to say which affective and pedagogical actions and why they shall do in order to help student to learn.

The survey consisted in 1) we explained the teachers the aim of this study, and our main motivations, and hypothesis; 2) the teachers interacted freely with Prime Climb to familiarize themselves with the game; 3) teachers were shown the Microsoft agent animations, and were asked to say which animations they considered suitable to provide affective tutorial feedback as affective action in Prime Climb; 4) The teachers viewed a video of the interaction of one student with Prime Climb and were asked to say which affective and pedagogical actions they shall do according to specific student states and tutorial situations; 5) Teachers answered three general questions about the relationship between affect and teaching. Each complete teacher's session lasted 90 minutes approximately.

Firstly, we explain teachers the context of the survey, we explained what "affective action" is our work, and we want to use the Merlin's animations as affective action trying to promote a positive affective state. We explain that the affective action in conjunction with a pedagogical action compose a tutorial action to be delivered to students. Then, the teachers interacted with Prime Climb as much time as they wanted to familiarize with the environment and to see different situations could present in a student interaction.

After that, teachers were shown the Microsoft Agent animations with the character Merlin (Microsoft Agent Merlin Character is a copyrighted work of Microsoft Corporation), and were asked to say which animations they considered suitable to provide affective tutorial feedback in Prime Climb. The character Merlin supports 73 animations some examples are listed in the table 1.

Table 1. Examples of the character Merlin of Microsoft Agent. It is listed the name of the animation and adescription of what the agent do when the animation is played.

Merlin´s Animation	Animation Description
Decline	Raises hands and shakes head
DontRecognize	Holds hand to ear
Process	Stirs caldron
Read	Opens book, reads and looks up
Search	Looks into crystal ball
Suggest	Displays lightbulb
Sad	Sad expression
Think	Looks up with hand on chin
Wave	Waves

The aim of this phase is teachers could see the potential of the animated agent and they could select the animations they wanted to use in the survey next phase, but if they wanted they could have available the complete animations. Two professors wanted to have all the animations available they said they did not know the situations they will find and they could discard any animation.

The teachers selected the animations that they deemed to be generally appropriate to convey affective elements via a program; in Fig. 1 we show a screenshot of the

program used in this phase; they could select any animation they want the animated agent perform as many times as they wanted.

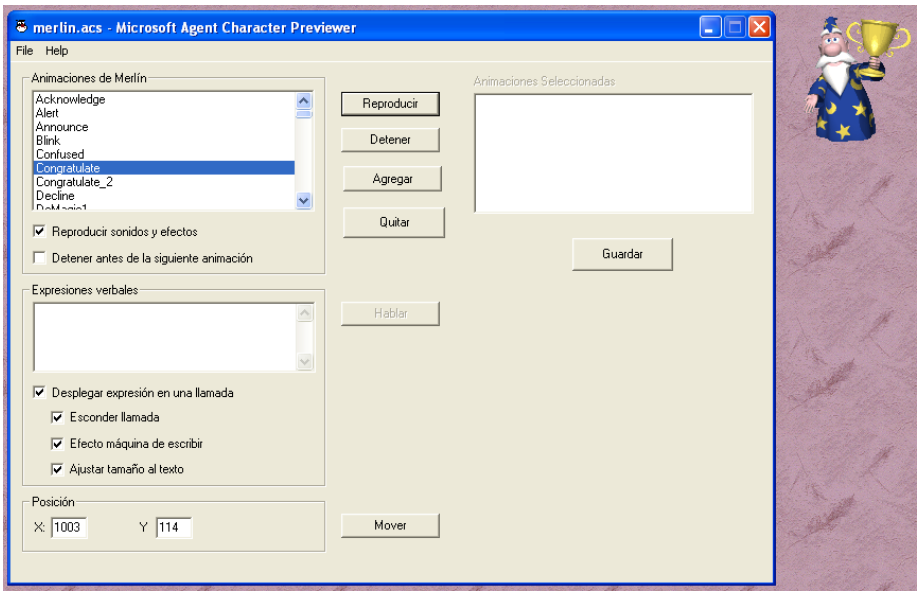

Fig. 1. Screenshot of the program used to see the character and animations of Microsoft Agent (Mostly in Spanish). In the combo list on the left they can select the animations to be play by the character, and when they found an interesting animation they can select it to add it to the combo list on the right. The agent is playing "congratulate" animation.

Subsequently, the teachers viewed a video of the interaction of one student with Prime Climb. The interaction lasted approximately five minutes, during this time the student climbed three mountains (levels). This specific video was selected because it showed a variety of tutorial situations based on a mix of student's correct and incorrect behaviors. While it would have been more principled to show the teachers interactions of several different students with Prime Climb, this was not possible because of constraints on the teachers' availability. Fig. 2 shows a screenshot of the program use in this phase of the study.

Teachers were provided with facilities to stop and replay the video as many times as they wanted. After each student's move, they were asked to rate the student's affective state and to establish the pedagogical and affective components of the tutorial action that they considered adequate at that particular point. We also asked teachers to say how they thought the selected action improved the student's affect and knowledge. An example teacher's report is presented in Fig. 3.

This phase of the study is very important because it provides information about how the teachers choose their actions considering the affective and the knowledge states of the students; we assume that teachers selected actions that they believed would improve a student's affective state and knowledge.

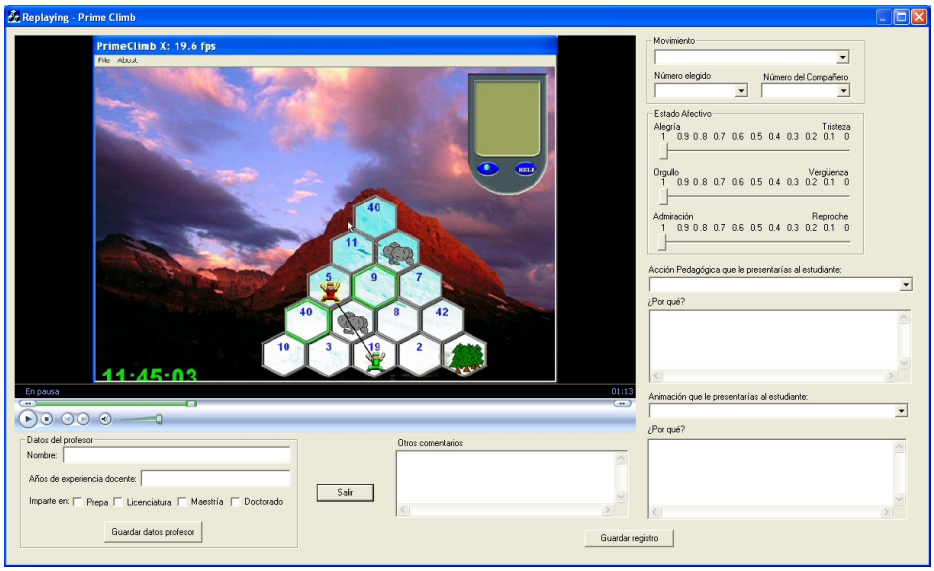

Fig. 2. Interface of the program for the teachers' survey (in Spanish). Left: Video of a student interacting with Prime Climb. Right and bottom: options for the teachers. The teachers were asked to establish the affective and pedagogical action to be presented to students taking into account the affective and knowledge state, according to student performance in the video.

Affective state:	**Pride/Shame**	75/25
	Admiration/Reproach	70/30
	Joy/Distress	73/27
Knowledge state:	Student knows the numbers factorization	
Pedagogical action	Right, these numbers do not share factors	
Affective action	Congratulate_2	
Pedagogical action explanation	Student made a correct click	
Affective action explanation	Student is having success	
Comments	I try to motivate the student	

Fig. 3. Example of a teacher's report from the second phase of the teachers survey. The teachers said what they should do and why according to the student state.

We also want to know more about the relationship between affect and teaching; therefore at the end we asked teachers the next three questions: 1) Do you take into account the students' current knowledge and affective state when you are teaching? Why? 2) Which is more important for you, knowledge or affect? Why? and 3) Can you group your actions into some categories?

5 Results

From the complete group of animations some of them were not used because those animations compose an animation loop, for example, "read" and "continue reading",

therefore we had 58 animations to evaluate. In this phase we obtain 53 animations was selected at least once, 46 animations was selected at least twice, and 17 animations was selected more than five time. In the Table 2, we present the animations selected more than 5 times.

Table 2. Animations selected by the teachers. It is listed the animations selected more than 5 times (only five animations was not selected by the teachers).

Animation	Times it was selected
Confused	9
Congratulate_2	9
GetAttention	8
Hide	8
Read	8
Decline	7
Suggest	7
Announce	6
Congratulate	6
MoveDown	6
MoveLeft	6
MoveRight	6
MoveUp	6
Pleased	6
Process	6
Search	6
Show	6

Considering the previous, we believed Merlin is a character with the suitable expressivity to present the tutorial actions and it can be used in an educational environment, since more that 90% of its animations deemed suitable to the teachers.

In the next phase, the teachers mapped student states to affective actions. Based on the teachers' responses, we selected 14 of the 58 animations as those most potentially effective as affective components of Merlin's interventions. These 14 actions are listed in Table 3.

Finally, we asked teachers the next three questions: 1) Do you take into account the students' current knowledge and affective state when you are teaching? Why? 2) Which is more important for you, knowledge or affect? Why? and 3) Can you group together your actions into some categories?. The answers to these questions are presented in Table 4.

In the third question, we asked teachers to try to categorize their actions into some categories. The answers to this question were general and open, therefore it was difficult to obtain a teachers' actions classification; however, all the participating

teachers stated the aim of their actions is to motivate students, and the last aim is student learning. Some the categories mentioned by the teachers are in Table 5.

Table 3. Merlin's animations selected as affective action in a tutorial action.

Affective action	Animation Description
A1-Acknowledge	Nods head
A2-Announce	Raises trumpet and plays
A3-Congratulate	Displays trophy
A4-Congratulate2	Applauds
A5-DoMagic1	Raises magic wand
A6-DoMagic2	Lowers wand, clouds appear
A7-Greet	Bows
A8-Hide	Disappears under cap
A9-Pleased	Smiles and holds hands
A10-Alert	Straightens and raises eyebrows
A11-Confused	Scratches head
A12-Explain	Extends arms to side
A13-GetAttention	Leans forward and knocks
A14-Surprised	Looks surprised

Table 4. Answers to questions: Do you take into account the students' current knowledge and affective state when you are teaching? Which is more important for you, knowledge or affect?

Description	Times/%
Teachers who take into account only the students' knowledge	1/11 (9%)
Teachers who take into account only the students' affect	1/11 (9%)
Teachers who take into account both the students' knowledge and affect	9/11 (82%)
Teachers who think the students' knowledge is more important	4/11 (36%)
Teachers who think the students' affect is more important	4/11 (36%)
Teachers who think both states are important in the same way	3/11 (27%)

Table 5. Answers to question: Can you group together your actions into some categories?

Categories
Positive feedback
Negative feedback
Reward
Reprimand
Motivation
Get attention
Relax situation
Harder exercises

We used the teachers' reports to establish the probabilities describing the impact of the various affective and pedagogical components of an action on knowledge and affect, given the current student's state and outcome of student's action. These are the probabilities used by a dynamic decision network in the affective model to calculate the expected utility of actions. For example, when a student made a successful move but seemed not to know the numbers factorization, teachers often selected the verbal hint "You're right again! But do you know why? Here's an example", where the example is an explanation about the factorization of the relevant numbers. Thus, the CPTs describing the factorization knowledge of the numbers involved in a student's correct move at next time are set so that, if the knowledge is predicted to be low at current time.

6 Conclusions and Future Work

We present a survey we conducted to know what teachers to according with affect and knowledge of student in order students learn, we presented the results. We believed the results are encouraging because they show what teachers do when they are teaching, we need more data to have stronger findings. We use the results to build a model and conducted a user study to evaluate the affective behavior model, showing that for younger students there is positive impact on learning [3, 4]. We want to conduct another study, having more students interacting with the model, and in this way to complete the integration of the affective model with an educational environment.

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