EMOTIONAL DIALOGUE IN A VIRTUAL TUTOR FOR EDUCATIONAL SOFTWARE

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Abstract. In this paper, we present an educational software used to enhance the skills of children in the area of math. This software has a tutor who guides the child in different activities. The tutor exhibits personality traits and emotions in the tutor dialogue in order to create an immersion sense in the student and thus catch his attention on the game. We adapted an Emotional Extension of the Artificial Intelligence Markup Language, structure here named as EE-AIML.

Keywords: Educational Software, Intelligent Conversational Agent, AIML, Personality, Emotions.

1 Introduction

Based on the latest assessment of education in Mexico [1], it was found an increase in the level of achievement of students between 3rd and 6th grade in the subject of Mathematics. However, the results show that 63% of the students of elementary school obtained an insufficient/elemental level of proficiency and only 37% of students obtained a Good/Excellent level of proficiency. At the secondary school level, these values become more critical, reaching percentages of 84.2% and 15.8% respectively. We thought that the use of funny educational games that reinforce the learning could be a new way to increase the interest on learning maths.

This paper presents educational software to reinforce the learning of mathematics, which incorporates an Emotional Embodied Conversational Agent (E-ECA) with the role of tutor. The virtual tutor's aim is to encourage, repress, correct and help the student during the different activities. The tutor has a cognitive module, implemented using a Bayesian network, for modeling a student's performance. Based on the performance of the student, the tutor can set the difficulty level of the arithmetic problems that the student must to solve. The tutor's aim is to create an immersion sense in the student and thus catch his attention on the game, incorporating personality traits and emotions in the tutor dialogues. For it, we adapted in the

dialogue module an architecture for incorporating personality traits and emotions in written dialogues in natural language [2]. This architecture is an Emotional Extension made to the AIML language (Artificial Intelligence Markup Language), which we here refer to as EE-AIML (Emotional Extension –AIML).

This paper is structured as follows: Section two presents related works and some definitions. Section three describes the overview of the EE-AIML architecture. Section four describes characteristics related to the implementation of immersion. Section five describes the adaptation of the EE-AIML architecture into the tutor dialog module, and finally section six presents the conclusions and future work.

2 Educational Software and emotional interaction

In the field of educational software math-oriented, there are works as *MatheMax* [3], *MatheMax Pro* [4] and *Matris* [5], which were designed for assisting students in basic math operations, starting with exercise like counting, simple addition, subtraction, multiplication and division as well as mixed modes for different skill levels. The feedback of these systems takes the form of a congratulatory graphic and sound. There are some educational software that integrate a character with the role of presenters, an example are the works *Mathematics with Pipo* [6] and *Mathematics with Mario 2* [7], which contains several different math games and exercises with different learning objectives ranging from counting, drawing with numbers, simple operations (logical sequences) to complex operations such as sorting, measuring, weighing, handling coins, etc..

Usually, the works that integrate virtual characters provide a feedback slight about student performance and can become static and repetitive, because are not adapted to the context of the situation. We think that the way to include a more realistic interaction is to have dialogues or phrases consistent to the context, for example, correcting to the student when a problem is really detected or congratulate him when he has performed well. Another problem, which we have identified, is that the traditional educational software does not integrate the affective aspect in the interaction with the student.

In this paper these problems are addressed by adapting the EE-AIML architecture to the dialog module of the virtual tutor. The EE-AIML architecture uses the AIML language as dialogue manager. This architecture incorporates personality traits and emotions in the dialogues of a virtual character. AIML language is an XML specification, which is a scripting language that defines a database of question-answer useful for programming chat robots [8].

Personality is an inherent people characteristic that largely influences the thoughts, feelings and human behavior. It is also the feature that makes a person different of another [9, 10]. Over time, several theories about personality that follow a psychological approach have been developed. [10] classifies them into: a) psychoanalytic theory, b) theories of traits, c) behavioral theories, d) biological theories, e) social learning theories and f) social cognitive theories.

The dialogues, besides exhibiting personality, also convey emotions. Some of the emotional theories that have influenced computer science researchers are *Appraisal*

theories, *Dimensional* theories, *Anatomical* theories and *Rational* Theories. Among the existing emotional theories, the *Appraisal* theory has had a major impact on the design of virtual agents. This theory is the most used in the implementation of computational models [11].

A work that integrates personalities and emotional models with the AIML Standard is the Huang et al work [14], in which they propose a framework called GECA, to facilitate communication between the different modules, such as sensor inputs from the human users, inference engine, emotion model, personality model, dialogue manager, face and body animation, etc. To control the agent's behavior, conversational markers were incorporated into standard AIML tags to specify parameters for nonverbal inputs and outputs.

Others works has made extensions to AIML language to incorporate emotional characteristics. Tee Conie [15], Sumedha Kshirsagar [16] and Baldassarri [17] have incorporated new tags in the AIML language in order to control aspects such as facial expression and response selection basing these processes on an emotional state.

In our research, the emotional aspect of virtual character is controlled by the EE-AIML architecture, which is based on the behavioral model of Morales-Rodríguez [12]. This behavioral model is a combination of appraisal and dimensional theories of emotions, integrated through the model of personality called Five Factor Model [13].

3 Emotional Dialogue Manager in a Virtual Tutor

The virtual tutor proposed is an Emotional Embodied Conversational Agent (E-ECA). It is composed of two interconnected modules, a cognitive-emotional module and a dialogue manager.

The cognitive-emotional module performs cognitive evaluations based on the context of the conversation and it updates the emotional state according to the E-ECA personality. The dialogue manager is an Emotional Extension of AIML (EE-AIML), which has the function of selecting the response phrases of virtual tutor.

The dialogue manager contains a knowledge base that comprises the E-ECA dialogues, which are categorized in *conversational contexts*. This categorization is used to identify the conversational topic of the user inputs. The structure of the standard tags of AIML are <category>, <pattern> and <template>. The AIML interpreter seeks the user input that match with the terms defined by the <pattern> tag, thus, the output speech act (delimited by <template> tag) is consistent with the input [14] (see Fig. 1).

Fig. 1. Tags Structure in AIML Language.

The new extended structure of AIML allows the implementation of different personalities for the E-ECA. Each personality has a defined set of emotions and different ranges of emotional intensity. Different speech acts are associate to each range of emotional intensity, which respond to user input pattern. The new structure is presented in Fig. 2.

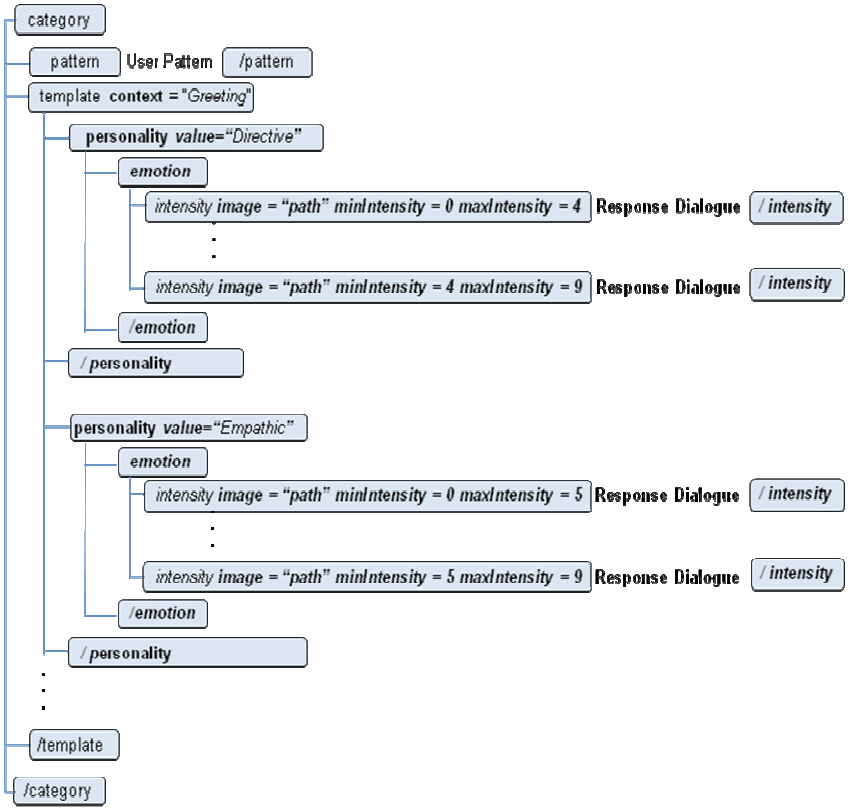


Fig. 2. Structure of the EE-AIML architecture

4 Implementation of Immersion

In order to increase the student interest in the game to get their attention and reinforce their knowledge, the software tries to develop a sense of immersion in the student, allowing the student to choose the character with whom the student identified himself the best for interact.

The software has two characters, a male and a female teacher with different personalities expressed by their interaction dialogues. The images of the tutors are presented in Fig 3.

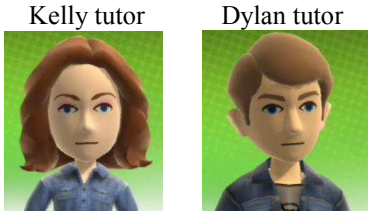


Fig. 3. Images of the virtual tutors

The exercises are presented dynamically, varying randomly the values of the responses and appearing in random positions on the screen. If after 20 seconds, the student has not chosen a correct answer, the answers options change of position on the screen. This is in order to induce to the student to respond using the shortest possible time. An example of the problems and response options are presented in Fig. 4:

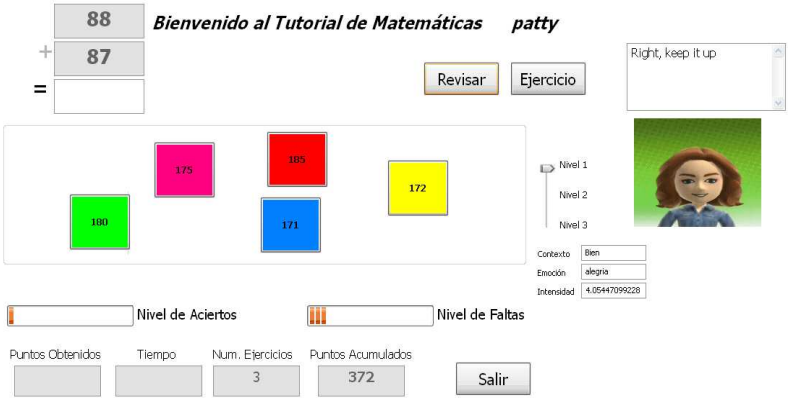


Fig. 4. Example of the exercises and their response options

The natural language dialogues used are characterized based on the personality and emotions defined for each tutor using the EE-AIML architecture. This allow different dialogues and the virtual tutors can exhibit a different personality and emotional behavior, endowing the interaction of greater dynamism and naturalness.

5 Integration of the EE-AIML architecture to the dialog module of the tutor

In this software the student interacts using the mouse for selecting their answer to the exercise problems shown by the tutor, there is no keyboard input available.

As described in [2], the EE-AIML architecture is designed to interact with users through dialogues written in natural language, which are formalized in a knowledge base of the AIML language. Therefore, in order to adapt EE-AIML architecture to the dialog module of the tutor, we identified phrases for representing possible actions

raised during the interaction by the student. For example, if a student chooses the correct answer to an addition problem, the pattern for knowledge base of AIML can be defined as "the sum is correct". This is necessary to retrieve from the knowledge base, the context and feedback (response phrases) appropriate to the action selected during interaction. The phrases recovered from the knowledge base are filtered according to the personality and emotional state of the tutor.

The following code shows an example of a knowledge base for modeling the input pattern "THE SUM IS CORRECT" to the personalities of the tutors called Dylan and Kelly, in particular, are presented the responses associated with the emotion of joy.

```
<category>
   <pattern> THE SUM IS CORRECT </pattern>
   <template context = "PROBLEM_OK">

      <personality value = "Kelly">
         <joy>
          <intensity image = "Kelly_Joy1.jpg" intensityMin = "0"
                                              intensityMax = "2.5">
            <Random>
                 <li>It was OK</li>
                 <li>Your answer was correct</li>
            </Random>
          </intensity>
          .
          .
          .
          <intensity image = "Kelly_Joy4.jpg" intensityMin = "7.5"
                                              intensityMax = "9">
            <Random>
                 <li>Excellent, Congratulation, continues well !!!</li>
                 <li> Very well, nobody does it better than you!!</li>
            </Random>
          </intensity>
         </joy>
         .
         .
         .
      </personality>


      <personality value = "Dylan">
         <joy>
          <intensity image = "Dylan_Joy1.jpg" intensityMin = "0"
                                              intensityMax = "2.5">
            <Random>
                 <li>Good!</li>
                 <li>Excellent</li>
            </Random>
          </intensity>
          .
          .
          .
          <intensity image = "Dylan_Joy4.jpg" intensityMin = "7.5"
                                              intensityMax = "9">
            <Random>
                 <li>Excellent, congrats you did great!!!</li>
                 <li>Cool, nobody does it better than you!!</li>
            </Random>
          </intensity>
         </joy>
         .
         .
         .
      </personality>

   </template>
</category>
```

The Fig. 5 presents examples of possible phrases and images that can be selected according to the intensity of joy emotion that the tutor Kelly could experience.

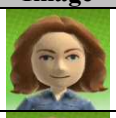
Intensity	Image	Phrases
0 ≤ Intensity < 2.5		It was OK Your answer was correct
2.5 ≤ Intensity < 5		You did very well Right, keep it up!
5 ≤ Intensity < 7.5		Excellent, continues well and learn a lot! Right, continues well and go for more!
7.5 ≤ Intensity < 10		Excellent, congratulations continues well! Very Well, nobody does it better than you!!

Fig. 5. Phrases and images that Kelly can select according to the intensity of emotion Joy

6 Conclusions and future work

In this paper we present the integration of emotional dialogue in a virtual tutor for educational software that reinforces learning of students in the area of math.

The virtual tutor expresses personality traits and emotion through their dialogues with the aim to develop a sense of immersion in the student in order to get his attention and thus enhance their knowledge through the different exercises.

The EE-AIML architecture [2] was adapted as a tutor dialogue module in order to feedback the student performance.

The EE-AIML architecture is an AIML core extension that integrates personalities and emotional tags incorporating the behavioral model of Morales-Rodríguez [12], which is a combination of Appraisal and Dimensional theories of emotions integrated through the model of personality Five Factor Model [13].

As future work we are interested on conduct an analysis to determine factors or elements that appeal to the students for improving the user interface, and to add activities associated with the student's learning style. Related to the virtual tutor, some future works are endow the tutor with the ability to handle written dialog entries to generate conversations and improve the non-verbal expression that it currently has.

References

[1] «Resultados de Prueba Enlace 2011 Básica y Media Superior». [Online]. Available: http://www.enlace.sep.gob.mx/content/gr/docs/2011/ENLACE2011_versionFinalSEP.pdf

[2] M. L. Morales-Rodríguez, J. J. González Barbosa, R. Florencia Juárez, H. J. Fraire Huacuja, y J. A. Martínez Flores, «Emotional Conversational Agents in Clinical Psychology and Psychiatry», presented at the International Conference on Artificial Intelligence 2010, Pachuca, Hgo, México, 2010, vol. Volume 6437, pp. Pages 458–466.
[3] J. Behling, «MatheMax - practice counting and arithmetics (ABC-Ware, Shareware and Freeware for Kids)». [Online]. Available: http://www.abc-ware.com/mathe.htm. [Accessed: 09-sep-2012].
[4] «edpr1011 - MatheMax Pro». [Online]. Available: http://edpr1011.wikispaces.com/MatheMax+Pro. [Accessed: 09-sep-2012].
[5] «MaTris - practice arithmetics with Tetris game (ABC-Ware, Shareware and Freeware for Kids)». [Online]. Available: http://www.abc-ware.com/matris.htm. [Accessed: 09-sep-2012].
[6] «Matemáticas con PIPO». [Online]. Available: http://www.pipoclub.com/espanol/pipo4/home.htm. [Accessed: 09-sep-2012].
[7] «Zona de Alumnos de la Junta de Castilla y León (zonaalumnos)». [Online]. Available: http://www.educa.jcyl.es/educacyl/cm/zonaalumnos. [Accessed: 09-sep-2012].
[8] R. S. Wallace, «The elements of AIML Style». ALICE A. I. Foundation, 2003.
[9] V. Vinayagamoorthy, M. Gillies, A. Steed, E. Tanguy, X. Pan, C. Loscos, y M. Slater, «Building expression into virtual characters», 2006. [Online]. Available: http://www.eg.org/EG/DL/Conf/EG2006/stars. [Accessed: 10-sep-2012].
[10] X. He, «An Affective Personality for an Embodied Conversational Agent», M. Sc., Curtin University of Technology, Department of Computer Engineering., 2006.
[11] S. Marsella, J. Gratch, y P. Petta, «Computational Models of Emotion». Scherer, K.R., Bänziger, T., Roesch, E. (eds.) A blueprint for an affectively competent agent: Crossfertilization between Emotion Psychology, Affective Neuroscience, and Affective Computing, Oxford University Press, Oxford (in press), 2010.
[12] M. L. Morales-Rodríguez, «Modèle d'interaction sociale pour des agents conversationnels animés Application à la rééducation de patients cérébro-lésés», PhD dissertation, Institut de Recherche en Informatique de Toulouse, Université Paul Sabatier, Toulouse, France, 2007.
[13] R. R. McCrae y O. P. John, «An Introduction to the Five-Factor Model and Its Applications», Journal of Personality, vol. vol. 60, pp. pp. 175–215, jun-1992.
[14] H.-H. Huang, A. Cerekovic, K. Tarasenko, V. Levacic, G. Zoric, I. S. Pandzic, Y. Nakano, y T. Nishida, «Integrating embodied conversational agent components with a generic framework», Multiagent Grid Syst., vol. 4, no. 4, pp. 371–386, dic. 2008.
[15] T. Connie, O. S. Goh, O. M. Goh Kah, y K. Lean Huat, «A Computational Approach to Emotion Recognition in Intelligent Agent», presented at the The Asian Technology Conference in Mathematics (ATCM 2002), Multimedia University, Malacca, 2002.
[16] S. Kshirsagar, «A multilayer personality model», in Proceedings of the 2nd international symposium on Smart graphics, New York, NY, USA, 2002, pp. 107–115.
[17] S. Baldassarri, E. Cerezo, y D. Anaya, «Interacción emocional con actores virtuales a través de lenguaje natural», presented at the VIII Congreso Internacional de Interacción Persona-Ordenador, Grupo de Informática Gráfica Avanzada (GIGA) Dept. Informática e Ingeniería de Sistemas Universidad de Zaragoza Instituto de Investigación en Ingeniería de Aragón (I3A) Zaragoza, 2007, pp. pp. 343–352.