Towards Empathic Artificial Tutors

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***Abstract*—In this paper we discuss how the EMOTE project will design, develop and evaluate a new generation of artificial embodied tutors that have perceptive capabilities to engage in empathic interactions with learners in a shared physical space.**

***Index Terms*—Robotic Tutors, Human-robot interaction, Empathy.**

I. Introduction

Significant work has been devoted to the design of artificial tutors with human capabilities with the aim of helping increase the efficiency achieved with a human instructor. Yet, these systems still lack the personal, empathic and human elements that characterise a traditional teacher and fail to engage and motivate students in the same way a human teacher does. The EMOTE (EMbOdied-perceptive Tutors for Empathy-based learning) project aims to design and evaluate a new generation of robotic tutors that have perceptive and expressive capabilities to engage in empathic interactions with learners in schools and home environments.

Overall, the EMOTE project aims to (1) research the role of pedagogical and empathic interventions in the process of engaging the learner and facilitating their learning progress and (2) explore if and how the exchange of socio-emotional cues with an embodied tutor in a shared physical space can create a sense of connection and social bonding and act as a facilitator of the learning experience. This will be done across different embodiments (both virtual and robotic), allowing for the effect that such embodiment will have on engagement and empathy to be explored. To ground the research in a concrete classroom scenario, the EMOTE project will develop a showcase in the area of geography, focusing on environmental issues. This will enable tutors to be tested in real world school environments in different European countries.

The EMOTE project will carry out interdisciplinary research on affect recognition, learner models, adaptive behaviour and embodiment for human-robot interaction in learning environments, grounded in psychological theories of emotion in social interaction and pedagogical models for learning facilitation.

II. MOTIVATION

Empathy and engagement, processes that are key to influence students' learning, are often forgotten when artificial learning systems are created. Empathy is often seen as being associated with the perception, understanding and experiencing another person's emotions. Such notion has been central in the study of human relations and is regarded as one of the major elements in social interactions between humans. According to Hoffman [1], empathy is associated with the psychological processes that make a person have "feelings that are more congruent with another's situation than with his own situation".

In order to embed empathy in learning environments one needs to perceive the learner's affective state, model it, reason about how the learners feel, and respond emotionally to the current situation. To address this issue, research on intelligent tutoring systems has recently shifted towards a more learner-centric approach to endow artificial tutors with the ability to perceive the emotions experienced by learners and incorporate these into pedagogical strategies to build more effective computer-based learning systems. Previous studies showed that students are engaged when school activities provide enjoyment and are challenging without making them lose confidence in their ability and control [2], that is, when they can keep the learners in a "zone of proximal development" [3].

Therefore it is desirable for an artificial tutor to keep the learners engaged for the whole duration of the learning process, which requires the ability to constantly capture their attention and provide enjoyment by allowing them to actively demonstrate their skills without involving them in a task that is too difficult. The findings by Lester and colleagues have shown that the presence of a tutor, embodied as a 2D or 3D character, has some positive learning effects, in particular in student engagement [4]. Saerbeck and colleagues [5] have also explored the effects of supportive behaviour of a robotic tutor in childrens learning performance and motivation.

Recent research on artificial companions showed the key role that embodiment plays in the perception of an artificial entity: experiments comparing robots with their virtual representations showed that the robotic embodiment was preferred by users in terms of social presence [6], enjoyment and performance [7]. This opens up opportunities for novel contributions in the field of artificial tutors. New findings on socially intelligent robots shows that robots are increasingly

being studied as partners that collaborate and do things with people [8], making the use of robotic platforms as tools for experimental learning more approachable [9]. Based on these recent findings, and aiming to achieve fruitful empathic interactions with learners, the EMOTE project will design, develop and evaluate a new generation of artificial embodied tutors that have perceptive capabilities to engage in empathic interactions with learners in a shared physical space.

III. SCENARIO EXAMPLE

Two students, Alice and Brian, are beginning to learn about ecology models. They want to create a model of how acid rain impacts the level of fish in a local stream both in the winter, when it contains a lot of cold water, and in the summer, when its water level is low and much warmer. They find grasping how the various processes affect each other quite difficult and, when completing structured learning activities individually at their computers, they get quickly tired and frustrated. Another option is to work on the activity together at the multi-touch table with the robot tutor Emys (Figure 1). Emys calls up a graphical representation of the different processes on the table and asks the children to link them together in order to create their model. During this activity, Emys is tracking their choices

Fig. 1. EMYS at the multi-touch table

and is able to ask questions that set them on the right track while physically pointing at items on the table that scaffold their learning. The students ask Emys questions using buttons on the table and related gestures. Emys encourages them when they seem uncertain and praises them when they succeed. Through their non-verbal responses, and their progress in the task, Emys is able to confirm that they now understand much more clearly how to construct this model.

IV. METHODOLOGY

The design and development of embodied tutors in EMOTE is structured around three main components: (1) the tutor's perception and modelling of the learner, (2) the tutor's empathic behaviour and dialogue generation engine, and (3) the learning platform and tutor embodiment. Interaction between these components follows a learner-centric approach, where the user's socio-emotional cues and actions on the multi-touch table provide the input to build a model of the learner and the learner's affect (component 1), which is used to plan personalised empathic (adaptive dialogue and non-verbal triggers) and pedagogical interventions (adaptive teaching strategies and learning content) (component 2). A generic architecture (Figure 2) for the learning platform (component 3) will support the hardware (multitouch table and robotic tutor) and the interaction modalities, and integrate component 1 and 2.

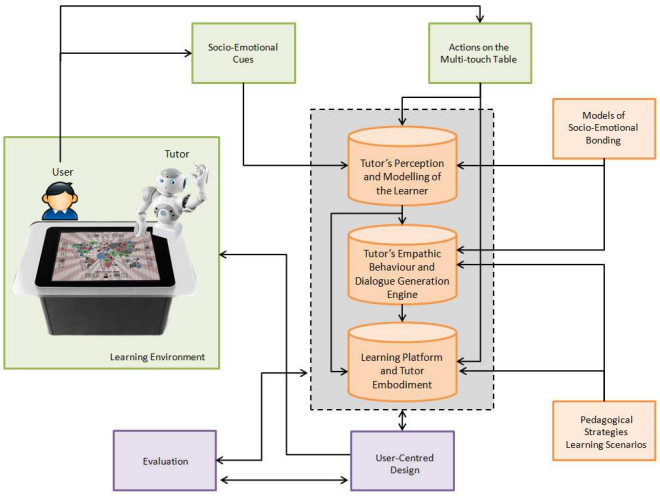

Fig. 2. Functional architecture with EMOTE components

V. CONCLUSION

The EMOTE project will research the design of artificial tutoring systems with empathic responses and pedagogical interventions that we believe will advance the state-of-the art in artificial tutoring systems and enhance the overall learning experience.

REFERENCES

[1] M. Hoffman, *Empathy and moral development: Implications for caring and justice*: Cambridge University Press, 2001.

[2] D. J. Shernoff, M. Csikszentmihalyi, B. Schneider, and E. S. Shernoff, *Student engagement in high school classrooms from the perspective of flow theory*, School Psychology Quarterly, pp. 18, 158-76, 2003.

[3] A. L. Brown, S. Ellery, and J. C. Campione, *Creating zones of proximal development electronically*, in Thinking practices in mathematics and science learning. Mahway, NJ: Lawrence Erlbaum, 1998, pp. 341-367.

[4] S. W. McQuiggan and J. C. Lester, *Modeling and evaluating empathy in embodied companion agents*, International Journal of Human-Computer Studies, 65, pp. 348-360, 2007.

[5] M. Saerbeck, T. Schut, C. Bartneck, and M. D. Janse, *Expressive robots in education: varying the degree of social supportive behavior of a robotic tutor*, in Proceedings of the International Conference on Human Factors in Computing Systems, 2010, pp. 1613- 1622.

[6] C. Kidd, *Sociable Robots: The Role of Presence and Task in Human-Robot Interaction*, 2003.

[7] C. Bartneck, *eMuu - an embodied emotional character for the ambient intelligent home*, 2002.

[8] C. Breazeal, *Role of expressive behaviour for robots that learn from people*, Philosophical Transactions of the Royal Society B, vol. 364, pp. 3527-3538, 2009.

[9] F. Tanaka and S. Matsuzoe, *Children teach a care-receiving robot to promote their learning: Field experiments in a classroom for vocabulary learning*, Journal of Human-Robot Interaction, vol. 1, no. 1, pp. 7895, 2012