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EMOTE: Embodied-perceptive tutors for empathy-based learning in a game environment

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Abstract: 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 EU-funded project EMOTE (EMbOdied-perceptive Tutors for Empathy-based learning) has recently started, and will continue until the end of 2015. The project aims to design, develop and evaluate a new generation of virtual and robotic embodied tutors that have perceptive capabilities to engage in empathic interactions with learners in a shared physical space.

In this paper we wish to discuss the approach we are taking in the project as well as how the project may contribute to knowledge relevant for the Games-Based Learning community.

Keywords: Geography, embodied tutors, empathy-based learning, embodied pedagogical agents, games-based learning, sustainable development.

1. Introduction

Animated pedagogical agents, embodied as a 2D or 3D character, with social cues integrated in learning environments may engage and motivate students and help them to achieve greater learning efforts (Chen et al. 2012, McQuiggan and Lester 2007). Recent research on comparing robots with their virtual representations has furthermore demonstrated that the robotic embodiment was preferred by users in terms of social presence (Kidd 2003), enjoyment (Pereira et al. 2008) and performance (Saerbeck et al. 2010). Moreover, embodied robotic tutors that are not only able to display social cues but also have the ability to perceive emotions experienced by learners, and to incorporate these into pedagogical strategies may be even more beneficial for learning (Burleson 2006).

In the EMOTE project, that will run from December 2012 to December 2015, the focus will be on embodied robotic tutors that are able to understand learners' affective and motivational states, adapt to the learners' needs and to display appropriate responses in order to engage and motivate children when learning geography in a game-like environment. Therefore, automatic recognition of the user's affective state is of primary importance for a virtual agent or robot to establish an affective loop with the user, through generation of an appropriate response (Castellano et al. 2010).

1.1 The set-up and geography games

The robotic tutor, an Aldebaran NAO torso, will interact with the students in a shared physical space with the support of maps and charts on a MultiTaction 55" multi-touch table. The target group will be children between the ages of 11 and 13 in geography or sustainable development classes. The tutor will shift between guided and discovery learning approaches depending on the topic that is taught and each student's needs. The multi-touch table will comprise two separate educational scenarios on geography-related topics, of which the first

will be a questlike virtual learning environment focusing on map exploration. A game developed by Brøderbund in 1985 titled 'Where in the world is Carmen Sandiego?', focusing on world geography, flags, currencies, etc. incorporates some similarities. However, EMOTE's set-up with a multi-touch table is more suitable for spatial activities, such as map reading. Another recent geography game relevant for EMOTE, designed to adapt "to individual learners, their prior knowledge, abilities, preferences, and learning progress" (Kickmeier-Rust and Albert 2009) is 80Days (www.eightydays.eu). Aside from adaptivity within the game, EMOTE will also explore the impact of adapting the robotic tutor's behaviour to the emotional state of the player.

The second scenario will focus on sustainability and will be based on an existing game EU-funded serious game called EnerCities, which deals with sustainable energy awareness. Both scenarios will be designed to gradually encourage students to apply self-directed learning strategies. After having experienced the interaction with the embodied tutor through the multi-touch table, the students will be able to work with a virtual version of the tutor in a different setting on a handheld device.

2. Work in progress

Currently, researchers in the participating countries are working alongside geography teachers through interviews, workshops and prototype studies, in order to develop the content and structure of the two scenarios, as well as the empathic behaviour of the tutor. First, several interviews were held to understand the teachers' needs for and feelings towards a robotic tutor in the classroom. Teachers were generally rather welcoming towards a robotic tutor if it could provide their pupils with an individualised learning approach that they cannot give themselves due to time constraints. However, they also wanted to have a clear picture of the activities the child and the tutor had gone through, meaning that the tutor/application should log interactions and provide teachers with an overview of students' progress. In addition, a concern was raised regarding the importance of ensuring that the amount of time spent with the tutor is evenly distributed among the students in order to avoid conflicts, while not placing additional administrative work load on the teacher.

Furthermore, teachers generally advocated for a multi-player mode where 2-4 students may participate. In such a setting, the game could be integrated into a thematic, collaborative, class project on sustainable development addressing different aspects of environmental, economic and social sustainability. While most of the teachers usually would place themselves outside the game as observers or moderators of discussion, they also recognized the possibilities for the tutor to function as an interactive learning partner or peer-learning agent actually playing the game on a student level, or even taking the role of a tutee in need of help from the other players, consequently providing the students with increased influence and responsibility in completing the game. We are planning to study the effects of these different tutoring approaches in the remainder of the project.

After the initial interviews, we gathered the official learning aims for geography and sustainable development education in each of the participating countries. Based on the interviews and the learning aims, a first learning scenario was defined. In this scenario the actions of the robotic tutor and the multi-touch table were described in detail as well as some envisioned reactions of the children on the tutors' instructions. The learning aims supported by this scenario as well as the scenario itself were then discussed once more with the teachers.

2.1 Next steps

A subsequent step will be to refine the scenario in collaboration with the teachers, especially focusing on how a real teacher would behave in similar situations. Our goals will be to design the teaching strategy (guided versus discovery learning) by asking teachers to design responses based on students' different levels of proficiency in the subjects; identify common errors (in order to detect them computationally) by asking teachers to pinpoint children's difficulties, to ensure that the system is easy to understand, and to design assessment activities that can evaluate learning outcome.

Thereafter, we will develop a visual layered paper prototype which the teachers will use with students in a mock-up study. At least two sessions comprising students in need of varying amounts of pedagogical support will then be videotaped and analysed. The goals of this mock-up study are to find out how the teaching strategy is expressed in reality, to verify and expand on the common errors made by the children through actual observation, to evaluate that the planned tasks are feasible and do not introduce unnecessary

confusion, and to get a corpus that will be annotated for empathy and teaching strategy in order to design the concrete behaviours of the robot.

3. Evaluation

Evaluation of the tutors and the application is no easy task; we will have to consider effects and affects, usability, user experience (UX) as well as game experience. Therefore we will start evaluating prototypes of the tutors and applications already during the first year of the project, especially concerning usability and UX. Towards the end of the project we will evaluate the tutors and the games in a small scale longitudinal study in which we explicitly intend to evaluate ecologically valid classroom use and the added value of the robots from a teacher perspective. The determination of proper evaluation methods for the longitudinal study based on relevant literature and research will begin in the second year of the project. It is believed, however, that an important basis for evaluating our set up will be to utilize teachers' existing experience and expertise in assessing teaching materials and learning outcome in general. Thus, we intend to explore methods of including teachers in the actual assessment of students' learning outcome. We hope that by paying special consideration to the users, both students and teachers, these findings may provide insights for future work on game-based learning materials aimed for authentic school settings.

4. Conclusions

This paper presented some initial steps in designing, developing and evaluating embodied empathic virtual and robotic tutors in a game-based virtual learning environment. Also, the EMOTE project aims to investigate whether the use of collaborative serious games can facilitate students' awareness and understanding of sustainable development. Most importantly, the project intends to contribute with knowledge about the role that an empathic tutor able to alter between different pedagogical strategies can play when children collaboratively or individually engage in game-based learning activities through a multi-touch table.

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