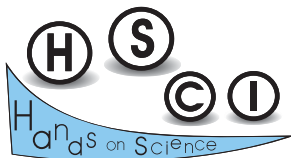


Hands-on Science

Advancing Science. Improving Education



Edited by:
Manuel Filipe P. C. Martins Costa
José Benito Vázquez Dorrío
Josep María Fernández Novell



The Hand-on Science Network

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Universidade do Minho

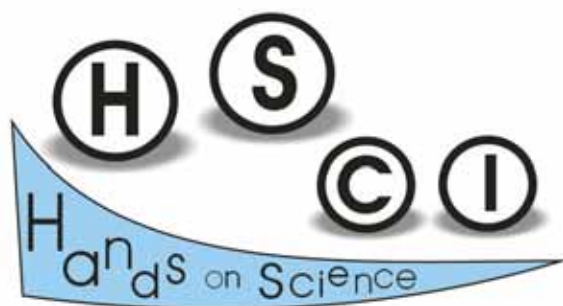
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Foreword

Advancing Science. Improving Education

Back in 2004 the first annual Hands-on Science international conference was successfully organized in Ljubljana. The main theme of the conference was "Teaching and Learning Science in the XXI Century". We intended to draw a picture of the current situation of science education in Europe and in the world and to point out ways of improvement in line with the Hands-on Science Network rational. Along the years a large number of excellent, pedagogically and scientifically, papers support materials and remarkable and inspiring examples of good practices were presented at our conferences and published in the sixteen proceedings and books we edited.

Sadly in this XXI century many of us are noticing an unexpected civilizational regression hard to accept and to understand on view of all remarkable progress achieved on previous decades. Fortunately Science keeps evolving and opening new and better development ways to a better future to humankind.

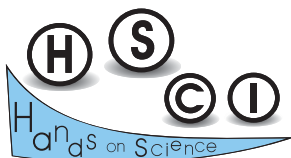
The book herein aims to contribute to the advancement of Science to the improvement of Science Education and to an effective implementation of a sound widespread scientific literacy at all levels of society. Its chapters reunite a variety of diverse and valuable works presented in this line of thought at the 15th International Conference on Hands-on Science "Advancing Science. Improving Education" held in Barcelona, July 16 to 20, 2018.

Vila Verde, Portugal, June 11, 2018.

Manuel Filipe Pereira da Cunha Martins Costa
Editor in-chief

Hands-on Science

Advancing Science. Improving Education



The Hand-on Science Network

FOREWORD

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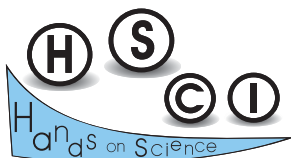
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Virtual Tutoring

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Abstract. The project VIRTUAL TUTORING – the virtual tutor as learning mediating artifact in online university education, is an ongoing project, with the main goal of analyzing the pedagogic impact of an anthropomorphic user interface on a typical distance learning environment targeted to support online higher education. This demands the creation of animated avatars for virtual tutors, able to display intelligent behaviour while interacting with the students. A Virtual Tutor should be analogous to a real human one, being able to proactively understand, solve and intervene in different student learning situations. This paper gives an overview of the project present development status.

Keywords. Virtual pedagogic models, online distance learning, virtual tutor, embodied conversational agents.

1. Introduction

Virtual people have been populating our reality for several years. In business terms, their significance as player and non-player characters in videogames is uncontested. Research is being carried on in the academic world on advances for virtual people and related novel uses for them.

The Virtual Tutoring project aims to find out and answer some challenging questions such as: how should a virtual avatar look and/or act to achieve effective engagement with the student, what aspects and information in the online learning environment should be taken into account to model the avatar's behaviour; or

what are the pedagogical implications that may arise.

At this moment, the project is entering into its first testing phase. Two different approaches were developed upon the Virtual Tutoring paradigm - one fully based on the desktop Moodle environment and another to work as a mobile Virtual Tutor companion.

The following sections give an overview on the present state-of-the art in the field of virtual tutoring, besides the present state of development and implementation of the project.

2. Background

Online learning (OL) has grown in importance as a direct consequence of the rapid development taking place in information and communication technology (ICT). This development has pushed OL agents into finding new methods of teaching and learning that could explore the technological media to the limits that ICT could actually offer. Due to the evolution of OL, it is difficult to find a precise and current definition. Nichols [1] describes OL as "education that occurs only through the Web", that is, it does not involve any physical learning materials issued to the students or an actual face to face contact. Pure online learning is essentially the use of eLearning tools in a distance education mode using the Web as the sole medium for all student learning and contact." Even though this statement is still valid, recent OL has evolved to include between others, aspects such as collaborative learning [2], connectivist learning [3], online participation, massive open online learning or serious games, virtual reality or digital storytelling [4-6].

To Universidade Aberta's pedagogical model this form of teaching and learning is based on several principles [7]: student-centered learning; learning flexibility (both spatial and temporal); and online interaction, in particular, asynchronous interaction, which blurs the temporal barriers imposed by communicational synchronism, and is consistent with the flexibility principle and digital inclusion. Interaction is absolutely fundamental for the teaching learning process so that students can effectively acquire the corresponding knowledge and skills. It occurs when students are actively participating in

learning activities involving peer-to-peer and teacher communication, be it contributing in a discussion, solving an exercise, analyzing a result, simply exchanging views with their colleagues, or clarifying questions with the teacher [6-8]. In this pedagogical model some learning activities are moderated by a Virtual Tutor (Human).

One of the main research goals in online learning environments, according to Oncu & Cakir [9] is enhancing learner engagement and collaboration. In distance education, online interaction is one of the most important practices that influence engagement and collaboration in the learner community. Anderson [10] classifies interaction in 6 categories involving the teacher, student and content. Of these, the learner-learner and learner-teacher as well as the learner-content categories are essential to modern learner centered educational environments, being crucial to promote them in distance education, where the agents tend to become more centered educational environments, being crucial to promote them in distance education, where the agents tend to become more isolated and these types of interaction not commonplace or natural.

In distance OL, one of the most relevant roles the teacher/tutor is called to play, is that of "helping students develop as learners capable of managing their learning process" [7]. However, they also have tasks as motivators, clarifying ideas, defining learning paths, instruction, training, support, feedback, moderation and facilitation of interactions, among others. Supporting the student goes beyond cognitive support, to include a more organizational aspect, that is concerned with counselling and time management, which is critical to the students' success. Thus, the online teachers/tutors must master a set of competencies such as: the capacity to develop an adequate curriculum and to organize learning processes; competencies that relates to the various teaching/tutoring roles (giving feedback, motivating, training); and competencies that relates to reflection and evaluation. Within student support, they stress guiding the student, setting deadlines, and monitoring the students' progress, contacting them in cases of prolonged absence. All the contributions underline the relevance of the role played by the teacher/tutor in online distance

learning, as well as its complexity. The challenge posed to this project is to investigate the potential of Virtual Tutors (digital tutors) as valuable teaching-learning tools in helping the human teacher/tutor fulfil his/her duties in OL.

On the other hand, ECAs are known to have important positive effects in the user interaction with technological devices; for instance visual speech can increase the intelligibility of audio speech; lessen the efforts required for understanding and; increase the satisfaction of user experience. However, the idea of synthetic companions capable of establishing meaningful relationships with humans remains far from being accomplished. To achieve this, synthetic companions must interact with people in natural ways, employing social mechanisms that people use while interacting with each other. One such mechanism is empathy, often seen as the basis of social cooperation and pro-social behaviour. Artificial companions capable of behaving in an empathic manner, which involves the capacity to recognise another's affect and respond appropriately, are more successful at establishing and maintaining a positive relationship with users [11-13].

The use of ECA as Virtual Tutors in real online teaching-learning scenarios is still a ground-breaking challenge since OL itself is still in its infancy. In spite of the achievements registered in the area of ECAs there is still a lack of virtual entities that can effectively give support to online teaching-learning. Very few experiments are referred in the literature. They have remained at a stage of limited demonstration and basic proof-of-concept, or expressive talking-heads where no actual pedagogic impact analysis has been carried on [14-15]. Most of the developments remain at a demonstration stage, with ECAs holding insufficient capabilities at level of natural language communication, artificial intelligence or emotional/affective interface. This leads to low levels of ECA's believability which implies their limited acceptance from users interested in more than playing with a nice demonstration. In this project we aim to advance one step further in the research of ECA integration support virtual tutoring in OL.

3. Methodology

The methodology chosen consisted in a multidisciplinary research team involved

covering the distance education (e-learning), pedagogy and technology expertise needed for its implementation.

This is a multidisciplinary project. It is both about devising a new teaching-learning (pedagogy) tool and strategies as well as the application of novel technologies on ECAs. Its main aim is to evaluate the pedagogic impact and potentiality of ECAs for online teaching-learning. The research methodology is divided in four parts. The first has to do with the analysis and technological adaptation of current up to-date ECA technology, including written natural language communication, anthropomorphic interfaces regarding the special facial animation of avatars, knowledge modeling based on ontologies and emotion-based agent architecture and interfaces. A model and implementation of a virtual tutor will be realized and integrated in a LMS. The adopted LMS will be the e-learning platform of Universidade Aberta (Portuguese Open University) - UAb, the Portuguese leading public online university with more than 12.000 students from all over the world. In the second part of the project three trial scenarios will be prepared and implemented. These scenarios will be used to test the virtual tutor in three virtual classrooms in the context of three learning units taken from formal online courses (one graduation course and; two post-graduation courses). In the third part of the project we want to analyze the pedagogic impact of virtual tutoring in the context of three concrete trial scenarios (which are designed according to the virtual pedagogic model adopted in UAb) while devising how virtual tutors can be, or not, valuable artifacts to mediate between teachers, students and learning materials. The pedagogic impact analysis on the student side will be realized by means of online inquiries/questionnaires on student's satisfaction, virtual tutor usability, interaction and collaboration verified, among others, as well as monitoring observation focused in the incidence and quality of the teaching-learning results and student's behaviour. On the teacher side there will be additional ethnographic observations focused on the teacher's actions when configuring and using the virtual tutor as an extra and complementary teaching tool. Finally, we would like to design and propose a revised virtual pedagogic model (based on the virtual pedagogic model adopted in Universidade

Aberta) that embraces virtual tutoring as a pedagogic strategy for online teaching-learning processes that are based on user-centred and collaborative learning.

4. Virtual Tutor Prototypes

4.1. Desktop Moodle environment

The virtual tutor window is superimposed over the Moodle's webpage of a discipline; it occupies a fixed position on the bottom right corner of the webpage, allowing students to scroll up and down over this page. The virtual tutor is an avatar (just head and shoulders) that was created based on photographs of real people.

The avatar delivers speech (text, lips' movements, but no sound yet) and exhibits facial expressions. Both speech and expressions are variable and depend on two factors: (i) the results of the student in the continuous evaluation components and also (ii) on his/her level of attendance in that Moodle's page.

Besides the avatar and the balloon with its speech, the window contains an area that lists the items with new information and also a set of buttons that guide the student in the navigation. The interface uses colour to highlight the novelties that appeared in the page since the last login of the student.

4.2. Mobile Virtual Coaches

To demonstrate empathic competence, a digital tutor should be able to: recognize, through the use theory of mind [16], the user's affective state within a particular context; possess a computational model allowing the simulation of the empathic process, and; being able to exhibit empathic behaviour [17]. In this work, we researched how two virtual tutors, Maria and João, working as coaches and inhabiting an Android application could provide empathic support to the student while interacting with a Learning Management System and going through an online course curriculum.

The virtual tutors perception is based on: (1) subjective factors such as the evolution of the perception of challenge by the student (i.e. how easy it has been to complete the course assignments over time), endogenous motivation (i.e. how much the student is

enjoying the course over time) and exogenous motivation (i.e. the importance of the course for the student over time), as well as; (2) objective factors such as performance (i.e. grades obtained over time), effort (i.e. amount of time spent on the course over time) and engagement (i.e. amount of interaction with course materials over time). The evolution of these variables allows for the computation of an affective state using the "emovector" model [18] that is associated with the student situation at this point in time (e.g. the student grades dropping more than expected).

This affective state is then used to select an empathic strategy based on all the objective and subjective context variables as well as the affective state itself. Empathic strategies are created based on the affective improvement strategies defined by Niven et al. in their interpersonal affect regulation strategies classification [19] and implemented as dialog trees. A dialog tree editor supports the development of strategies adequate in the context of a specific course and learning culture. To modulate the affective expression of the tutors while the dialogue occurs, the synthetic emotions "felt" by each one of the two tutors is computed by modulating the student's perceived emotion through a personality layer that allows for the tutors to express distinct and complementary personalities (e.g. in our case Maria is more understanding and caring, while João is stricter while encouraging).

The interaction with the tutors happens in real time through an interface inspired by the videogame "Oxenfree" (Night School Studio, 2016) using unlocked speech balloons to convey verbal information as well as providing non-verbal and back-channelling information through gaze, nods and animated speech balloons. The animation system controlling the agents, 3Motion [20] is inspired in 3-stages affective expression from principles of traditional animation [21].

We believe our approach is able capture the important elements of empathic behaviour creation: recognizing the student's affect through the objective and subjective dimensions of the learning experience, integrating a computational model that supports perspective taking and the ability to express emotions and exhibit empathic verbal and non-verbal behaviour, through the interaction and

dialog with the two virtual tutors: Maria and João.

5. Future

Customizing and attending individually are two of the essential elements of the elearning pedagogical perspective [22]. The Virtual Tutoring project prioritizes in one of its axes the service to the individualities with information and interaction intervening proactively in different situations of student learning. In this perspective, the artificial intelligence approach is established with its own elements and characteristics insofar as the interaction is valued and intensified. The trend is to facilitate more informative interaction processes that drive learning in virtual environments. It is significant to affirm this convergence of technological elements, artificial intelligence and pedagogical strategies for the contexts of elearning to break down the possible barriers of learning.

The pedagogical model of the Open University [7], permanent in its innovation and creation of solutions, especially in the new learning formats, prioritizes this innovation always thinking about the evolution of the quality of the educative process in elearning for the formation of people. The continuation of the development of projects that prioritize the quality of the interaction and attendance to the individualities of the elearning student is a growing line in the investigations of the area.

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7. References

- [1] Nichols M. A theory for eLearning. *Educational Technology & Society* 2003, 6, 1-10.
- [2] Garrison R. Implications of Online and Blended Learning for the Conceptual Development and Practice of Distance Education. *The Journal Of Distance Education* 2009, 23, 93-104.
- [3] Anderson T, Dron J. Three generations of distance education pedagogy. *The*

- International Review Of Research In Open And Distance Learning 2011, 12, 80-97.
- [4] Leitão R, Rodrigues J, Marcos A. Game-Based Learning: Augmented Reality in the Teaching of Geometric Solids. *International Journal of Art, Culture and Design Technologies* 2014, 4, 63-75.
- [5] Rodrigues P, Bidarra J. Transmedia Storytelling and the Creation of a Converging Space of Educational Practices. *International Journal of Emerging Technologies in Learning* 2014, 9, 42-48.
- [6] Urbano P, Balsa J, Ferreira P, Antunes L. How much should agents remember? The role of memory size on convention emergence efficiency. Lopes LS, Lau N, Mariano P, Rocha LM (Eds.). *Progress in Artificial Intelligence. EPIA 2009. Lecture Notes in Computer Science*, 5816. Berlin: Springer, 2009, 508-519.
- [7] Pereira A, Mendes A, Morgado L, Amante L, Bidarra J. *Modelo Pedagógico Virtual da Universidade Aberta: para uma universidade do futuro*. Lisboa: Universidade Aberta, 2007.
- [8] Graham Ch. Blended Learning Systems: Definition, Current Trends, and Future Directions. Bonk C, Graham C (Eds.). *The Handbook of Blended Learning: Global Perspectives, Local Designs*. San Francisco: John Wiley & Sons, 2005.
- [9] Oncu S, Cakir H. Research in Online Learning Environments: Priorities and Methodologies, *Computers & Education* 2011, 57, 1098-1108.
- [10] Anderson T. Modes of interaction in distance education: recent developments and research questions. Moore MG, Anderson WG (Eds.). *Handbook of distance education*. New Jersey: Lawrence Erlbaum Associates Inc., 2003, 129-144.
- [11] Castellano G, Leite I, Pereira A, Martinho C, Paiva A, Mc Owan P. Context-Sensitive Affect Recognition for a Robotic Game Companion. *ACM Transactions on Intelligent Interactive Systems* 2014, 4, Article 10.
- [12] Castellano G, Leite I, Pereira A, Martinho C, Paiva A, Mc Owan P: Multimodal Affect Modelling and Recognition for Empathic Robot Companions. *International Journal of Humanoid Robotics* 2013, 10, 1350010.
- [13] Leite I, Pereira A, Mascarenhas S, Martinho C, Prada R, Paiva A. The influence of empathy in human-robot relations. *International Journal Human-Computer Studies* 2013, 71, 250-260.
- [14] Mahmood A, Ferneley E. Embodied agents in e-learning environments: An exploratory case study. *Journal of Interactive Learning Research* 2006, 17, 143-162.
- [15] dos Santos C, Osório F. An intelligent and adaptive virtual environment and its application in distance learning. *Proceedings of the Working conference on Advanced Visual Interfaces. ACM*, 2004, 362-365.
- [16] Premack D, Woodruff G. Does the chimpanzee have a theory of mind? *Behavioural and Brain Sciences* 1978, 4, 515-526.
- [17] Leite I, Castellano G, Pereira A, Martinho C, Paiva A. Modelling empathic behaviour in a robotic game companion for children: an ethnographic study in real-world settings. *Proceedings of the 7th Annual ACM/IEEE International Conference on Human-Robot Interaction, ACM*, 2012, 367-374.
- [18] Martinho C. Using Anticipation to Create Believable Behaviour. *Proceedings of the 21st AAAI Conference on Artificial Intelligence (AAAI'16)*, 2006, 175-180.
- [19] Niven K, Totterdell P, Holman D. A classification of controlled interpersonal affect regulation strategies, *Emotion* 2009, 9, 498-509.
- [20] Rodrigues R and Martinho C. Towards Believable Interactions Between Synthetic Characters. *Proceeding of the International Conference on Intelligent Virtual Agents (IVA 2017)*. Berlin:

Springer, 2017, 385-388.

- [21] Thomas F, Johnston O. *The Illusion of Life: Disney Animation*. New York: Hyperion, 1995.

- [22] Hollingshead A. *Designing Engaging Online Environments: Universal Design for Learning Principles*. Milheim KL (Ed.). *Cultivating Diverse Online Classrooms Through Effective Instructional Design*. Pennsylvania: IGI Global, 2018.

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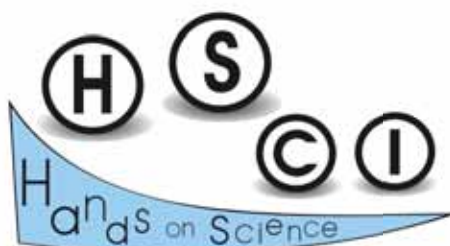
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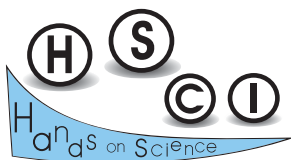
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