Fiction Design of a 3D Tutor for and with School Children

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***Abstract*—In this paper, we describe the fiction design approach we are using in collaboration with school children and teachers in order to produce a 3D Tutor. We introduce the actors and procedure we are following with particular emphasis on the activities devised to engage children in the various stages of design and produce the necessary output for each of the facets of the 3D Tutor. Our assumption is that making learning more fun will increase the overall level of children's engagement and their motivation towards it. Thus, we describe how children are helping us to design a 3D Tutor able to cater for individual learning styles as well as being fun to work with. Finally, we discuss how this ongoing experience with collaborative fiction design is providing us with directions towards the first prototype of our 3D Tutor.**

Keyword-E-learning Interaction; 3D Tutor; Collaborative Design; User Requirements; Fiction Design.

I. INTRODUCTION

Technology is used to support teaching and learning in many ways. Here, we are exploring the design of a 3D Tutor to act as a teachable agent to engage primary school children. Teachable agents are defined by Biswas et al. [1] as a "…computer agents that students teach, and in the process, learn themselves". Children asked to teach them are forced to structure their knowledge, take responsibility for its delivery and reflect upon it. All essential steps in the learning process. Both the social and emotional dimensions of teachable tutors are still under study, and our work contributes to this research by exploring the impact of one of its possible manifestations, that in the shape of 3D holographic tutor.

Our assumption is that, by involving children in the definition of the look and feel of their teaching tutor-agent, they could help us design one that better satisfies their needs. Besides, given that our tutor will learn from children, we would start our exploration by revisiting the list of qualities proposed by Buskin et al. [2] and focusing on few of the most highly ranked in that study. Thus, we wanted to find out whether for our pupils, as for the older students in that study, it is important that their 3D Tutor *should be enthusiastic about learning, promotes crucial thinking, approachable, respectful, creative, has realistic expectations*. By engaging children and teachers as co-designers, we came up with the first set of user requirements for a prototype of a 3D Tutor together with a list of desirable qualities for making it an ideal teaching agent. We start by providing a very brief account of previous works on co-design with children and explorations of the social and emotional dimensions of teachable agents. We then provide a description of our study, and finally draw some initial conclusions based on the evidence gathered.

II. RELATED WORK

In the literature describing how co-design can help the design of effective digital tutors for children, we found inspiration from the work by Herberg et al. [3] involving children in the identification of qualities for an ideal robot tutor. Among the many approaches to collaborative design, particularly suitable for young children is fiction design, where "something that creates a story world… has something being prototyped within that story world, … does so in order to create a discursive space." [4].

Moving on to consider research on the design of teachable tutors [1], Ogan et al. [5] go on to explore the social dimension of teachable agents and report on how having a friendly, equal approach, where the tutor and the child align themselves to be peers, together with being able to use informal interactions, including mutual teasing, is conducive to successful learning experiences. On the contrary, keeping a formal distance has a negative effect on the overall experience. While most of the available literature reports on pro and cons of having robots to play the role of the tutor, we set out to explore an alternative, that of a 3D holographic entity.

The 3D Tutor is a 3D character animated in real-time, able to interact through different senses (touch, voice, vision) and to convey dialog, emotions and lessons. It is responsive and adaptive: it can diagnose end users' conditions (e.g., he/she may be tired), preferences, needs and peculiarities/ environment conditions (e.g., preferred language, currently available bandwidth, etc.) in real time. In this way, we separate the content of the lesson to be taught (Knowledge) from the means used to convey this content (Teaching methodology) and interact with students. Using Artificial Intelligence, the 3D Tutor can choose the right question/topic;

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using Artificial Empathy, the 3D Tutor has the ability to recognise users' emotional state and engagement to react in the proper way. Thus, the content is adapted to both the conditions of the student and the particular device used (mobile device, web, classroom). With the 3D Tutors, teachers can explore new ways to present subjects to students, as well as encourage students to find the learning style that suits them including the adoption of the teaching agent paradigm. The concept of a 3D Tutor is based on that of Human-like Interaction (HLI) [3]. HLI implies the use of all dimensions of human language, not only written or verbal communication but also gestures, postures and expressions. Starting from the concept that transmitted messages between humans contain both an informative (rational) value and an emotional value, the human form is the best way to synthesize them.

III. OUR STUDY

Here, we describe our experience in involving children in the design of a 3D Tutor to assist them in their learning as teaching agent. We included in our study 154 children in primary 2, aged 7 to 8, from two schools, one in Italy and one in the Italian speaking part of Switzerland, and 9 teachers. One of them, playing the role of digital creative, worked very closely with the researchers when proposing procedures and protocols for engaging the children. We applied a make-believe approach, where we created a fictional world supported by narrative and acting. This helped to generate intrinsic motivation in pupils to take part in the various activities necessary to inform our design process, and provide us with the necessary insights to define the look and feel of our 3D Tutor. While the design process is still ongoing, by having completed the first two phases: the *meeting the Alien* and the *Looking and Feeling like a Human Being,* both described below, we have gathered a wealth of data and experience to share with our community.

The use of an alien in anthropomorphic form has made it easier to encode a series of messages that, otherwise would have been very complex to transmit to our co-designers. For example, the message of non-aggression was conveyed to the children in an intuitive way by having the alien assume the posture of a timid person: it often looked down at its feet, rocking slightly on its heels.

IV. FICTION DESIGN WITH CHILDREN

Our design scenario includes an unusually large number of children, more than 150. Teachers behaved as co-designers and proposed, adapted and conducted the various design related activities. Researchers acted as facilitators and made sure teachers had all the technological support for the make-believe approach. Head-teachers and parents in both schools were informed and asked to keep up with the fictional setting, without revealing what was really happening. Our main assumption was that children as young as 7 to 8 had the necessary flexibility towards reality, yet still had the ability to embrace mystery and magic.

V. MEETING THE ALIEN

The first meeting was staged in a theatre (Fig. 1) and resulted in a memorable event for children, as reflected in the quality and quantity of their comments. Children had received an email via their school head-teacher, wherein a group of scientists was asking for their help to make sense of a mysterious message from space. On reading it, children immediately accepted to take part in the adventure. They had also been invited by their teachers to prepare questions beforehand to ask the alien, in the assumption the children could understand the answers. This was the beginning of the make-believe narrative adopted in the study.

Figure 1. Meeting the Alien

The second step was the encounter with Olo-Disk, as the name of the alien was finally revealed ("discolo" is an Italian old fashioned term for naughty child).

The event was carefully staged, with a couple of researchers playing the role of lab scientists, wearing white coats in a dark room. Finally, in a surreal silence, Olo-Disk appeared, remote, and different but intentionally never dangerous, (see Fig. 2). Looking often down to his/her feet, with a subdued attitude and using a never heard concoction of Italian, Finnish and Cantonese with a prevalence of "ɑ:" sounds, s/he had clearly a non-threatening appearance.

Figure 2. Our friendly Alien

S/he started to explain that, while travelling in space s/he was attracted by a blue planet (Earth), but s/he was aware that his/her physical features were not adequate to come and visit

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it. That was why s/he was trying to communicate with scientists: s/he needed their help to know how to transform her/himself to be like humans. Immediately after the meeting, children were asked to engage with some simple exercises, individually and in groups, in order to explore how they felt and reflect on their experience. They were invited to select one single word that, summarised the experience of meeting Olo-Disk and then, as group, to put forward some more words linked with the event. These were then copied on a poster size paper, to be shared with others.

Pupils were asked to make a drawing, to represent the most important element of the day (Fig. 3). The purpose of these exercises was to make children reflect and fix their memories of the day.

Their artifacts were then analysed by teachers and researchers, looking for signs of engagement and participation. We searched for expressions of surprise, curiosity, fear and excitement, between those used in the two word based exercises.

Figure 3: The experience in one drawing – English for "In un disegno"

For drawings as in Fig. 3 we adopted and adapted a coding scheme from Xu at al [2], see Table 1.

TABLE 1: CODING SCHEME FOR DRAWINGS

Element	Evidence	Score
Participation	Children, self portraits	Score: Absent (0) or Present (1)
Visual Magic	Portrait of the Alien: size, color, appearance, lights	Not evident (0), Possibly Evident (1) Evident (2) Highly Evident (3)
Interactive Magic	Questions and answers, communication, sound, gestures	Not Evident (0) Possibly Evident (1) Evident(2) Highly Evident (3)

VI. ACTIVITIES

It is worth noticing how all activities were designed to be in line with existing curriculum. Even if the stimulus was coming from a request issued by Olo-Disk, it was up to the teachers to interpret it and guide the children in a process of problematisation of the request to result in a stronger form of engagement with the new learning activity. After the first meeting, a new message came directly to the children. Olo-Disk needed their help to look and behave like a human being.

A. *Looking and Feeling like a Human Being*

In order to answer this new request, a series of activities were elaborated by the different teachers and proposed to the children.

The teachers and children from the Italian Swiss school devised a variety of multidisciplinary exercises. As there was only one class engaged in the process, all children were involved in all activities that spanned across disciplines. Children worked on emotions and prepared drawings portraying those they felt stronger, as in Fig. 4 ("I am Leone, and I am happy"; "I am Valeria and I am happy" is written in Italian in the picture). These drawings were analysed in terms of dominant emotions, and assisted in the definition of the look and feel of the interface for our 3D Tutor. During their art class, they also prepared outfits for Olo-Disk to look like a human being, different ones in case Olo-Disk were a female or a male being. These artifacts contributed to define the appearance of our 3D Tutor.

Figure 4: Emotions

The English teachers wanted to contribute to the project, by discussing with children what kind of information would be useful to Olo-Disk. They decided to share with Olo-Disk their knowledge of the solar system in English, given that they had to use the universal translator to communicate anyway. In order to make it more fun and engaging for Olo-Disk, children and teachers decided to organize a play where each pair of pupils would act as one planet and describe it to Olo-Disk, by using a mixture of words and gestures. Teachers reported on how committed children were, as they felt this task would help Olo-Disk in his/her quest. In particular, knowing that their play was being recorded and sent to Olo-Disk, made them learn their lines faster and each put as much effort as possible in order to share their newly acquired knowledge with their friend.

In Italy, the six classes were teamed in pairs. In order to answer the main question, about what makes us human, each pair fully explored one of the three facets of our 3D Tutor: *corpus* (physical facet), *indoles* (emotional facet) and *societas* (social facet). Children in every class worked first in small groups, each focusing on a specific sub-facet. All contributions were then combined. To give Olo-Disk enough information for becoming similar to a human being. The indoles team worked to sort out which emotions Olo-Disk had to learn, detailing in which conditions they are generated. Finally, the classes who worked on societas, identified

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conventional relationships and related behaviours among people.

During the activities, the teachers let children free and encouraged them to consider every possible solution. Thus, few members of the "corpus" team- wrote an email to Olo-Disk asking if he/she really wanted agree to transform him/herself, explaining that they didn't mind if he/she was so peculiar, adding also that they were available to help her/him to travel the world without transforming him/herself.

All the 154 children, across the two schools, were invited to work using the same tools: drawings, content tables and text, to organize and summarize in writing the conclusions reached and their achievements for each activity. Desktop computers and interactive whiteboard where part of the resources available to them, when helping their friend Olo-Disk.

VII. NEXT STEPS

In the immediate future, we will complete the analyses of all data gathered and use that output to inform the production of the first prototype of our 3D Tutor. This will be presented to the children by the end of the current school year, 2017-2018, when they will meet Olo-Disk with his/her new look and behavior. Children will also be sent a message from the scientists, thanking them for all the work done and showing them how, this was used to help Olo-disk to answer his/her quest on how to become human. In the new autumn semester, 2018-2019, we will then involve the same children as assessors in its evaluation and proceed toward the production of incremental prototypes. These will expand the 3D Tutor in three directions:

- by providing an authoring tool for teachers and children to add educational material;
- by expanding on the sensorial experience with Olo-disk, acquiring the ability to see and touch.
- by enhancing Olo-disk's ability to master the use of language and rhetoric.

VIII. CONCLUSIONS

The introduction of artificial tutors in education is still under debate and presents many open issues. We believe that by following an appropriate design approach, we can deliver a 3D Tutor to enhance the learning experience, starting from primary school. We tested our hypothesis by involving seven classes of primary school 2nd grade children and their teachers across two countries, in a collaborative fiction driven design process. Even if the process is still ongoing, its outlook is encouraging. Usually, the introduction of new technology in educational activities brings high levels of engagement. Thus, it was not a surprise that children reacted with vibrant enthusiasm from the very beginning of the project. Guided by an effective make-believe narrative, the children immediately adopted the tutor as one of them. By analyzing the discourse in class and interviewing the teachers, it was clear that Olo-Disk was never perceived as a "teacher" but a companion or a friend, a truly *approachable* teachable agent. One of the teachers commented on the fact that Olo-Disk had become such an important member of the class, so much so that children were asking her to find more time during the day for activities linked to him/her, as these stimulated their *creativity*. Children felt Olo-Disk was *enthusiastic about learning* as s/he valued and *respected* them. They never felt under pressure for his/her requests, as these responded to *realistic expectations,* while at the same time, *promoted crucial thinking*, as when children pondered whether the transformation was really necessary.

Besides, the combination of the HLI approach with fiction design, in a collaborative setting involving children, has proved successful in keeping a high level of motivation and producing a large number of artifacts. These will serve as input for the user requirement phase of our project. The analysis and interpretation of all the heterogeneous data gathered from drawings to acting, from word chains to discussions in focus groups and teachers' interviews is proving to be a stimulating activity too. Our 2nd grade children have fully engaged with all the proposed activities and we are looking forward to them moving on to next step, and acting as evaluators for our project.

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