

Towards the Development of a Reading Comprehension Conversational Agent for Children applying User-Centered Design Techniques for Teachers and Students

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Abstract. Pedagogic Conversational Agents aim to support the learning process by providing a highly personalized environment with dialogues adapted to each student. We believe that a Reading Comprehension Conversational Agent able to talk to each student to find out up to which point they have understood the Maths problems could be useful to help them solving the problems. However, given the lack of such kind of agents, it should be studied how they can be designed and developed. In this paper, our focus is to present the procedure of development of a Reading Comprehension Agent according to the principles of User-Centered Design, i.e. taking into account the opinion and preferences of both teachers and students since the beginning of the project. A qualitative study with 2 teachers and 20 students is being carried out with preliminary satisfactory results.

Keywords: E-learning, Conversational Agent, User-Centered Design.

1 Introduction

Solving Maths problems is a difficult task for children all over the world [1-3]. There are several factors that can be identified to explain why the task is so complex, such as reading comprehension problems, ability to think and infer a solution, retention of concept and data, visual space problems, emotional stress and anxiety disorders of feeling unable to cope with the task.

In the last years, using technology-enhance learning has become very popular with many advantages, such as space and time flexibility (i.e. students can study from any computer connected to Internet at any time), interactivity (i.e. students get immediate feedback for each action in the system), and the possibility of adapting the learning procedure to the rhythm of each student [4,5].

In particular, in this paper, the focus is on the use Pedagogic Conversational Agents, which according to [6,7] can be defined as lifelike autonomous character that cohabite the learning environment creating a rich face-to-face interface with the student. Hundreds of different type of agents have been created for education, some of them based on the use of Artificial Intelligence techniques [8] to act as teachers able to focus on the concepts less known by the students, and other agents are based on the

use of different paradigms such as the “learning by teaching” one, according to which the agent acts as another student, or as an empathic companion agent to encourage students to keep working or to challenge them [9].

Pedagogic Conversational Agents have been applied to different domains, including Maths with Jake and Jane [10], but they have not been applied to assist students to solve the Maths problems by helping them to understand their meaning. It is our hypothesis that it is important to address that factor, because if students are unable to understand the meaning of the problem, although they know the formulae and procedure they might not be able to use them correctly.

Therefore, we started to think how to develop such Reading Comprehension Conversational Agent for children for the first time. We decided that the best approach was to follow a User-Centered Design Methodology [11] by taking into account the opinion of the teachers and students since the beginning of the project.

2 teachers participated in five meetings during the course to give us their ideas about the kind of agent they need, and to review the prototypes created incrementally. 20 students, 12-13 years old, participated in two meetings during the course to give us also their opinion, although in the case of the students as indicated in [12] it was more difficult to get feedback from them. So we chose a more direct approach in which the students started to use the agent since the first day to observe how they interacted with the agent, if they had some difficulty and how they enjoyed the personalization and natural language interaction provided.

The paper is organized in three sections: Section 2 describes the personalized design of the agent engaging both teachers and students; and, Section 3 ends with a discussion of the main ideas and some lines of future work.

2 User-Centered Design to personalize the agent

The agent will help students with the exercises assigned by their teachers. Therefore, it is necessary to think of possible designs for the author tool for teachers to create, modify and remove exercises in the agent. According to the User-Centered Design, in order to do that, it is necessary to allow teachers to take part in the development process since the beginning to the end, and not just at the beginning or at the end. This methodology allows us to find out the needs of the teachers, so that the interface is adequate and personalized for them. We also planned several meetings during the course to check whether the development of the tool meets the indicated requisites and whether the teachers have identified any new requisite.

Moreover, we also wanted teachers to define the features that the agent must have according to their knowledge of the students. Finally, there were established five meetings: November 7th, 2011; February 10th, 2012; March 22nd, 2012; April 24th, 2012 and May 3rd, 2012. These meetings will be described in the following paragraphs.

In the **first meeting (November 7th, 2011)** we explained the teachers the idea of Pedagogic Conversational Agents to assist students in reading comprehension. They told us that the idea was quite interesting, in fact, they were satisfied with the previous use of agents to encourage students to work and in general, the use of the computer as

a tool to assist in education. However, they also told us that this time they would like to focus the design of the agent in a more specific problem, in particular, they have detected that many students failed Maths problem because they do not understand the statement. Therefore, they asked us if it is possible to design an agent to help students in reading comprehension of Maths problems. We told them that it has not been done before, but that from the technical side we believe it possible.

We asked the teachers which aspects they consider that are more relevant to help students to understand the problems. They told us that students are not able to identify the key clause in which it is indicated what the problem is really asking, as well as verbs, pronouns and some specific keywords.

It would help them to manage their time more efficiently, but in case that some mistake were to be found in the automatic identification, they would like to be able to modify it from the authoring tool in a easy way. Figure 1 shows a paper prototype agreed during the meeting for the interface of the system.

Given the complexity of the requirements, it took us some months until those requisites were implemented and we asked the teachers for a second meeting in February to show them our advances.

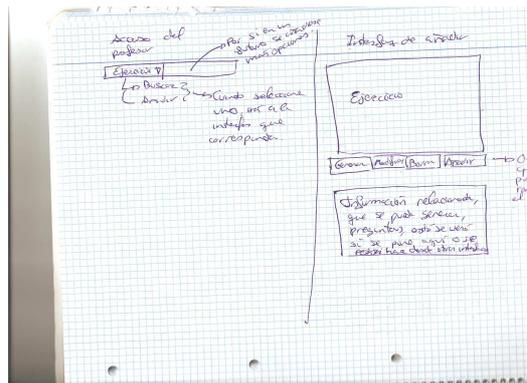


Figure 1. Paper prototype of the agreed interface for the teacher

In the **second meeting (February 10th, 2012)**, teachers were shown the prototype of the author tool in the computer for the first time (see Figure 2). They were allowed to interact with it under our observation to detect whether they were able to correctly use it. So they could give us any comment or proposal for any change or new functionality. Teachers were glad to be able to give their opinion, and to have the opportunity of getting exactly the tool that they need. They approved the general design, but they would also like to add the possibility of looking for problems according to criteria such as information of the problem, type, level of difficulty or creator. They were also concerned about showing the level of difficulty in the agent because they believe that when students read that a problem is too difficult, it can prevent them even from trying, so we took note of not showing that information in the student interface.

Regarding the student interface, we asked teachers how they think that children would like it better: with an animated agent or a static one, with a human, animal or

robotic shape, etc. Teachers told us that given that children have to complete the exercises by hand without voice, they think that the agent should be static and without voice. Regarding the question of the shape of the agent, teachers think that children would enjoy something formal (i.e. not a cartoon) but not too formal (i.e. not the image of a teacher), then we agreed on using either children of the same age or a graduate so that it encourages them to study, and to ask children in the first meeting whether they like it or not.

Figure 3 shows the paper prototype of the agreed interface for the agent between the researchers and the teachers. As can be seen, it is an interface pretty similar to the Messenger interface that is a program that children are used to interact with, and the dialogue will be according to the information extracted from the problem (key clause, pronouns, verbs, keywords) according to an algorithm that will be explained elsewhere as it is not the focus of this paper.

Bienvenido Dr. Roland

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Ejercicio

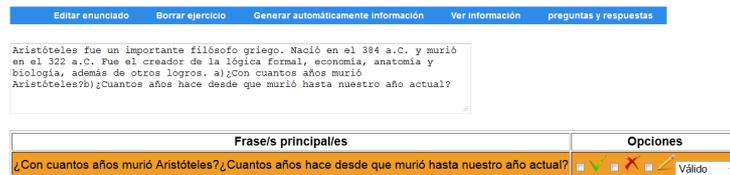


Figure 2. Interface for the teacher. The sample Math exercise translated to English is “Aristóteles was an important Greek philosopher. He was born in 384 BC and died in 322 BC. How many years was Aristóteles when he died?”

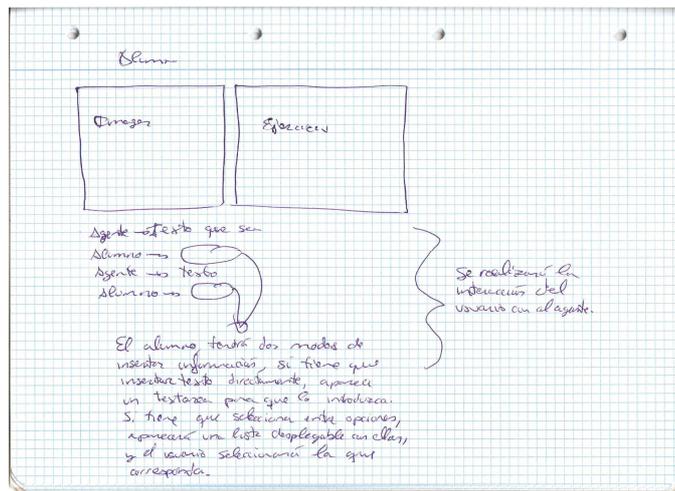


Figure 3. Paper prototype of the agreed interface for the students

In the **third meeting (March 22nd, 2012)**, once a first prototype of the agent for the students was finished, it was shown first to the teachers so that they validate it before going to class. Teachers told us that the agent was OK, although they would like to add a new help button in case that a student or a teacher has any doubt about how to answer the agent or the meaning of some sentence uttered by the agent. We agreed on adding the help option, and it took us a pair of months until the algorithm was implemented in the agent.

In the **fourth meeting (April 24th, 2012)**, the agent was used in class by 20 children, for the first time, during 10 minutes. Our focus then was on the reaction of the students, which will be described in the next section. Figure 4 shows the students' interface as it was shown that day. As can be seen, the picture of the agent is on the left, with the problem on the right, and below the questions regarding the key clause, pronouns, verbs and keywords as indicated by the teachers. These questions change depending on the answers of the students and their level of knowledge and difficulty.



Figure 4. Interface for the student. The English translation of the questions are: “Do you know the result?”, “Do you understand what you have to do?”, “Do you need help?”, “Which sentence do you think that is the key one?”

Children did not find any difficulty in using the agent, they were highly tolerant to any fault as it was still a prototype: they would just say that they could not continue with the next question, and tried again. They told us that they would not change anything of the interface. We proposed the children a quiz in which if they sent to us images for the agent by mail, they could choose a different image. No children sent us any mail. Thus, we asked their teachers to keep using the agent in class, to measure the efficiency of the approach to improve the ability of solving Maths problems. This analysis is still in progress, so in this meeting we focused on solving any technical problem for the next interaction with the agent, that will last one hour and without any novelty effect as it would be the second time they used the application.

In the **fifth meeting (May 3rd, 2012)**, the agent was used in class by the same 20 children, for the second time, during 60 minutes, in this case the agent had been tested

to avoid any technical failure and the students did not provide any comment. However, we could observe that they had problems with decimal numbers, and in general, they would always answer that they understood the statement of the exercise, even when they did not. The agent would identify that case when the solution given to the problem was erroneous and thus, it would suggest to ask a teacher for help.

3 Discussion and future work

User-Centered Design has been key to produce an agent that has successfully been used both by teachers and students. The personalization of the interface to their needs has allowed them an efficient use of the tool, according to their expectations. Given the lack of Pedagogic Conversational Agents applied to the reading comprehension domain, we believe that this work in progress can help other researchers and developers that would like to create a similar agent. Moreover, we would like to keep working on the agent to find out whether it is possible to help children to solve Maths problems by understanding what they have to do in each case, and with problems adapted to their level of difficulty and questions ordered according to their preferences and individual feedback to the system.

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