Using A Speech-Driven, Anthropomorphic Agent in the Interface of a WWW Educational Application

Maria Virvou, Nikitas Sgouros, Maria Moundridou, Dimitrios Manargias
Department of Informatics, University of Piraeus,
80, Karaoli and Dimitriou St., Piraeus 185 34, Greece
mvirvou@unipi.gr, sgouros@unipi.gr, mariam@unipi.gr

Introduction

Web-based education has the obvious benefit of allowing platform independent access to easily updated teaching material. Recently, a large number of educational applications have been delivered through the World Wide Web. Unfortunately, most of these systems are static, they do not maintain a student model and thus they are unable to provide individualised tutoring. Nonetheless, the future of web-based education seems promising since researchers in the field of Intelligent Tutoring Systems have made quite successful attempts to either move existing ITSs to the WWW or build from scratch web-based ITSs (Eliot et al., 1997; Stern et al., 1997). However, the development of an ITS requires the involvement of a large number of people, including experts of the specific domain, instructors and programmers. A way to overcome these problems may be the development of authoring tools, which will help construct cost-effective and reusable ITSs in various domains. One such authoring tool for ITSs is WEAR (WEb-based authoring tool for Algebra Related domains). WEAR incorporates knowledge about the construction of exercises and a mechanism for student error diagnosis that is applicable to many domains that can be "described" by algebraic equations (Virvou & Moundridou, 1999).

WEAR uses a talking head in its interface with the students. Animated characters have often been used in the interfaces of systems (Rist et al., 1997; Stone & Lester, 1996). Such an interface makes a system more appealing and attractive to the user and if talking about an educational application it may also promote the learning objectives. Walker et al. (1994) investigated subjects' responses to a synthesised talking head displayed on a computer screen in the context of a questionnaire study. Their findings showed that compared to subjects who answered questions presented via text display on a screen, subjects who answered the same questions spoken by a talking head spent more time, made fewer mistakes, and wrote more comments. In this paper we describe how the talking head is used in the whole educational application.

Description of the System and its Interface

WEAR aims to be useful to teachers and students of domains that make use of algebraic equations. Such domains could be chemistry, economics, physics etc. In particular the tool accepts input from a human instructor about a specific equation-related domain (e.g. physics). This input consists of knowledge about variables, units of measure, formulae and their relation. When the human instructor wishes to create exercises s/he is guided by the system through a step by step procedure. At each step of this procedure the instructor specifies values for some parameters needed to construct an exercise. Such parameters could be for example what is given and what is asked in the exercise to be constructed. After the completion of this procedure the tool constructs the full problem text and provides consistency checks that help the instructor verify its completeness and correctness.

WEAR assigns to each student a level of knowledge according to his/her past performance in solving problems with the tool. The tool suggests each student to try the problems corresponding to his/her level of knowledge. When a student attempts to solve an exercise the system provides an environment where the student gives the solution step by step. The system compares the student's solution to its own. The system's solution is generated by the domain knowledge about algebraic equations and about the specific domain in which the exercise belongs (e.g. economics). While the student is in the process of solving the exercise the system monitors his/her actions. If the student makes a mistake, the diagnostic component of the system will attempt to diagnose the cause of it.

When interacting with the students WEAR responds through a talking head, representing in some cases the instructor and in some others a co-student. The talking head component of the system uses speech synthesis to automatically produce speech output from text using MBROLA, a freely available speech synthesiser (http://tcts.fpms.ac.be/synthesis/mbrola.html). The talking head renders the interface quite attractive to students through the sound of speech. Moreover, since WEAR is an authoring tool for ITSs

there are a lot messages that are dynamically formed during the execution of the application. Therefore, the authoring tool could not use pre-stored material for the speech feature but rather a speech synthesiser.

In the case when the talking head represents the instructor it guides the student to the environment, recommends what problem to solve next and reads the problem text from the database of the authoring tool. Since WEAR is an authoring tool, new exercises are continuously added to its database. When the student begins to solve the problem, s/he may choose to solve it either with a simulated "co-student" or with the "instructor". These two different choices are only on the level of the user interface. This means that they use the same underlying reasoning abilities from the diagnostic component of WEAR.

If the student selects the mode of the "co-student" then the talking head provides very friendly messages as a peer to the student. This simulated student is responsible for providing positive feedback when the student's actions are correct and for pointing out the student's underlying misconception in case of an erroneous action. The information concerning which actions are considered correct or not and also the messages that the simulated student should say are provided by the diagnostic component of WEAR. The talking head as a simulated student is aimed at increasing the student's attention and possibly collaboration attitude (although in a limited form). Indeed as VanLehn et al. (1994) have pointed out peer learning even in a setting where the other peer is a simulated student may increase students' collaboration skills.

If the student selects the mode of the "instructor" then the talking head provides messages similar to the "co-student" but they are more formal and the diagnosis of misconceptions goes one step further to resolve ambiguities using the long term student model. Indeed, there may be cases where a student's erroneous action may be attributed to more than one misconception. In such cases, the diagnostic component first consults the long term student model and then through the talking face asks the student a question to determine his/her underlying misconception and resolve the ambiguity. The benefit of directly asking the student is twofold: firstly, the system may find out the real reason for the erroneous action and provide appropriate feedback and secondly, the student through explaining why s/he acted in that way gains more knowledge and understanding. It is a common finding in many researches that explaining things either to oneself or to another student helps one's understanding (Webb, 1989; Pressley et al., 1992).

Conclusions

In this paper we described the work in progress of the development of a web-based authoring tool for Intelligent Tutoring Systems. The tool, called WEAR, aims to be used by teachers and students working in domains that make use of algebraic equations. In this paper we focussed on the interface of the ITSs that are generated by WEAR: animated talking heads are used to simulate both the instructor and a co-learner of the student solving a problem. In that way, instruction and feedback are more "human-like" resulting in friendlier and more appealing ITSs. Furthermore, the students interacting with WEAR, may gain better understanding of the domain being taught and also improve their ability to collaborate with others; benefits that arise from the peer learning situation in which the students are involved.

References

Eliot, C., Neiman, D. & Lamar, M. (1997). Medtec: A Web-based intelligent tutor for basic anatomy. *Proceedings of WebNet '97, World Conference of the WWW, Internet and Intranet*, AACE, 161-165.

Pressley, M., Wood, E., Woloshyn, V.E., Martin, V., King, A. & Menke, D. (1992). Encouraging mindful use of prior knowledge: Attempting to construct explanatory answers facilitates learning. *Educational Psychologist*, 27, 91-109.

Rist, T., André, E. & Müller, J. (1997). Adding Animated Presentation Agents to the Interface. *Proceedings of the 1997 International Conference on Intelligent User Interfaces*, Orlando, Florida. 79-86.

Stern, M., Woolf, B.P. & Kurose, J.F. (1997). Intelligence on the Web? *Proceedings of the 8th World Conference on Artificial Intelligence in Education*. Kobe, Japan.

Stone, B.A. & Lester, J.C. (1996). Dynamically sequencing an animated pedagogical agent. *Proceedings of AAAI-96*. Portland, Oregon. Vol 1, 424-431.

VanLehn, K., Ohlsson, S., & Nason, R. (1994). Applications of simulated students: An exploration. *Journal of Artificial Intelligence and Education*, 5(2), 135-175.

Virvou, M. & Moundridou, M. (1999). An authoring tool for Algebra-related domains. *Human-Computer Interaction: Communication, Cooperation, and Application Design, Proceedings of the 8th International Conference on Human-Computer Interaction - HCI International '99*, Mahwah, NJ: Lawrence Erlbaum Associates, Vol. 2, 647-651.

Walker, J.H., Sproull, L. & Subramani, R. (1994). Using a Human Face in an Interface. *Proceedings of Conference on Human Factors in Computing Systems (CHI'94)*, 85-91.

Webb, N. (1989). Peer interaction and learning in small groups. *International Journal of Educational Research*, 13, 21-40.