Chapter 73
Pedagogical Agent Gestures to Improve Learner Comprehension of Abstract Concepts in Hints

Igor Martins
Universidade do Vale do Rio dos Sinos (UNISINOS), Brazil

Felipe de Morais
Universidade do Vale do Rio dos Sinos (UNISINOS), Brazil

Bruno Schaab
Universidade do Vale do Rio dos Sinos (UNISINOS), Brazil

Patricia Jaques
Universidade do Vale do Rio dos Sinos (UNISINOS), Brazil

ABSTRACT

In most Intelligent Tutoring Systems, the help messages (hints) are not very clear for students as they are only presented textually and have little connection with the task elements. This can lead to students' undesired behaviors, like gaming the system, associated with low performance. In this paper, the authors aim at evaluating if the gestures of an animated pedagogical agent to explain hints related to equation solving improves the students' understanding of these help messages. With this goal, they developed an animated pedagogical agent that uses gestures coupled with messages to explain hints in an algebra tutor. The authors performed a qualitative pilot study with four students to verify the impact of using gestures by the animated pedagogical agent on the comprehension of the hints, using two different versions of the system. The difference between these versions was the availability of gestures by the agent. The results showed that students understood the hints provided by the agent more correctly when they were coupled with agent's gesture. Furthermore, they also preferred using the tutor version with gestures.

DOI: 10.4018/978-1-5225-5643-5.ch073

INTRODUCTION

One-to-one tutoring is well documented as the best way to learn (Bloom, 1984). Cognitive research has shown that the learning process is influenced by individual differences and preference in learning style (Woolf, 2008). Educators at all levels need to consider the various forms of learning, different skill levels and different socioeconomic and social backgrounds of their students. Teachers must adapt their educational activities to an increasingly heterogeneous population of students (Koedinger, Anderson, Hadley, & Mark, 1997; Woolf, 2008).

Intelligent Tutoring Systems (ITSs) have achieved the same learning levels as one-on-one tutoring, helping to increase students grades almost one sigma (Vanlehn, 2011; Ma, Adesope, Nesbit, & Liu, 2014). ITSs are tools that assist the learner when solving tasks, providing immediate feedback and help messages when students are stuck. The success of ITSs is in great part due to the use of AI algorithms to analyze student activities, modelling their knowledge, skills, affective and cognitive states to provide customized feedback.

A step-based ITS is able to provide personal assistance for the learner when solving a step-by-step task (Vanlehn, 2006). For each step, the tutor helps students through feedback and hints. The feedback is usually a visual indication of whether the step is correct (minimal feedback) and also an explanation when the answer is incorrect (explanatory feedback). Besides, an ITS also provides hints when the learner is stuck. Otherwise, students can guess the answer repeatedly, then get frustrated and give up.

There are important issues of design in the implementation of a hint mechanism. The designer must determine whether hints are displayed when requested or when the ITS detects guess. It should also establish in what steps it will offer hints and how the hints can maximize the student's experience and allow him or her to solve the problem (Vanlehn, 2006). Therefore, to develop a feedback mechanism, it is more necessary than technical expertise on handling messages. The tutor must decide how and when to present each hint based on the student model (Vanlehn, 2006).

Hints in ITSs have not been completely effective and are associated with students strategies that leads to low performance (Baker et al., 2006; Baker et al., 2008). Students usually exhibit behaviors such as help refuse and help abuse, which impair learning (Baker et al., 2006). The possible explanations for this ineffective use are: lack of motivation, aversion to the software content, poor understanding of the hint content and even the belief that the tutor is not useful for learning (Baker et al., 2008).

Studies show that human teachers employ gestures to illustrate and highlight the most important aspects of an explanation, and it has a major positive impact on the students' understanding (Cook, Duffy, & Fenn, 2013). Thus, we hypothesize that in an ITS the gestures of an animated pedagogical agent (APA) can also be used to illustrate the hints and thus improve learners' comprehension. APAs are lifelike characters that offer more anthropomorphic modes of interaction using gestures and facial expressions. Unlike simple cartoon characters, APAs have their own educational goals and make decisions about what actions to take to achieve these goals. They integrate AI techniques to reason through their actions.

In this article we propose the use of APAs' gestures to improve the students' understanding of abstract concepts in hints. As human teachers usually do, our APA uses redundant gestures to illustrate and highlight important aspects of an explanation. Our agent was integrated into a step-based algebra ITS that assists students in solving equations step-by-step, providing minimal feedback for each step and showing hints when requested by the students or when they solve a step incorrectly. It indicates the errors made by students during the problem solving, pointing out which parts of the equation are incor-