Chapter 3

Revolution by Evolution:
How Intelligent Tutoring Systems Are Changing Education

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ABSTRACT

This chapter will discuss the development of intelligent tutoring systems (ITSs) for education in the last decade and will trace the challenges they meet. The author will examine the social and cultural impacts of several types of ITSs, from data-driven ITSs, which became the backbone of educational data mining approaches, to model-based adaptive systems. The latter utilizes artificial-intelligence-based tools that can provide dialogue to engage students in the learning process, to provide open learning models in order to promote self-awareness, to adopt meta-cognitive scaffolding, to use social simulation models, and to use cultural models. The layout of the chapter is as follows: the author will describe the technology of various ITSs with a focus on implementation of different techniques and algorithms in ITS modules (e.g., student modeling module, pedagogical module, and interface), followed by a discussion of how these ITSs begin to change the whole spectra of educational paradigms toward open everyone-is-a student models.

INTRODUCTION

Artificial Intelligence (AI) has a long history as a driving force behind many technologies – cars are using AI to adapt vehicle behavior to drivers' style, intelligent communications have become a common, and voice commands have already replaced keyboards in many interfaces. AI moved into the education field in the late 1970s, with the development of the pioneering intelligent tutoring systems (ITSs) SCHOLAR (Carbonell, 1970a) and BIP (Barr, Beard, & Atkinson, 1976). ITSs are a broad category encompassing any computer program that contains intelligence and can be used for the purpose of learning (Freedman, Ali, & McRoy, 2000). ITSs are an interdisciplinary field that investigates how to devise educational platforms providing instruction that fits the learning needs of each individual. In order to fulfil this mission, ITSs are designed to support various models of learning, such as one-to-one learning, collaborative learning, and learning with examples. Undoubtedly, one-to-one tutoring is the most desirable and effective form of teaching (Bloom, 1984). However, it is often out of the reach for many students, not only because of the lack of so many tutors, but also because of the financial, social, cultural, and linguistic limitations. In this sense, ITSs have huge social and cultural impact over society by providing a simulated one-to-one tutoring, which best matches the cognitive needs of the student without an actual tutor present. Collaborative learning is a valuable form of learning where the students participate in a common learning activity (e.g., online course or group project). Collaborative learning across diverse groups may be impacted by lack of social interaction skills, language or cultural differences. Many modern ITSs use AI technologies to facilitate the learner group formation and the discussions within the group. One of the most commonly used approaches in group formation is to explore student models according to some pre-defined criteria (i.e., adaptive group creation). The latter could be a group of students with the same or similar skills level or a group of students with complementary skills. Other approaches in group formation utilize internal models of collaborative patterns, which ITSs use to recognize the level of understanding of a concept across the group or use of intelligent agents to simulate a particular type of participant into a group–from the tutor to a member of a group and to a virtual test student.

The learning process has cultural and social dimensions. In this sense, ITSs may be designed as culture-neutral or culture-specific. However, transferring knowledge across multinational and multicultural groups requires consideration of culture (Chung & Miller, 2011). Simply put, the design of an effective ITS requires an understanding of the social and cultural background of the students, in order to provide individual instruction and adequate feedback to the user. The culturally aware ITSs are very specific and explore specific frameworks that guide the design of intercultural virtual humans and software (Raybourn & Waern, 2004). The U.S.

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