

Chapter I

Adaptive Support for Inductive Reasoning Ability

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Abstract

Inductive reasoning ability is one of most important mental abilities that give rise to human intelligence and is regarded as the best predictor for academic performance. However, most adaptive virtual learning environments tailor the learning material adaptively according to the learner's domain performance only, thus leaving the learner's cognitive capacity, such as inductive reasoning ability, unsupported. This chapter presents a framework of adaptive support for inductive reasoning ability in a virtual learning environment based on researches in cognitive science. The use of the adaptive theory, Exploration Space Control, and adaptive techniques to achieve the adaptivity required is discussed in detail. A summarising discussion points out future research possibilities and concludes the chapter.

Introduction

Adaptive virtual learning environments, such as adaptive hypermedia systems (e.g., AST by Specht, Weber, Heitmeyer, & Schoch, 1997; and InterSim by Kinshuk, Oppermann, Patel, & Kashiara, 1999) and intelligent tutoring systems (e.g., WBITS by Yang, Kinshuk, and Patel, 2002; and ISIS-Tutor by Brusilovsky and Pesin, 1998), tailor the learning material adaptively according to learners' needs and characteristics. Most of the research on adaptivity emphasises only the issue of how adaptivity should be provided according to the domain performance of the learner. A learner's cognitive skills, such as inductive reasoning ability and working memory capacity, are of great importance to the learning process but are often overlooked and unsupported in most learning systems (Lin, Kinshuk, & Patel, 2003).

In student-centred learning environments, learners are expected to take the initiatives in learning and construct their own knowledge with facilitation from teachers, peers, and/or with the help of computer-based learning systems. In these environments, the learner's inductive reasoning ability acts as a cognitive tool used for the construction of knowledge, thus bearing great influence on the learning experience and the outcomes. Adaptive support for inductive reasoning ability is therefore a very important facility for the learners. Research on cognitive trait model (Lin, Kinshuk, & Patel, 2003) has attempted to profile the learner's cognitive attributes, such as inductive reasoning ability and working memory capacity, in order to allow virtual learning environments to provide learning materials adapted to an individual learner's cognitive capacity.

Inductive reasoning is one of the important characteristics of human intelligence. Researchers have regarded inductive reasoning as one of the seven primary mental abilities that account for intelligent behaviours (Selst, 2003). Pallegirino and Glaster noted that the inductive reasoning ability can be extracted in most aptitude and intelligent tests and is the best predictor for academic performance (Harverty, Koedinger, Klahr, & Alibali, 2000). Harverty et al. (2000) cited several other research works that viewed inductive reasoning as a significant factor for problem solving, concept learning, mathematics learning, and development of expertise. Heller, Heller, Henderson, Kuo, and Yerushalmi's (2001) research showed that inductive reasoning is a necessary ability for extracting the knowledge of problem solving in physics.

Despite the recognised importance of inductive reasoning underlying the learning process of human beings, there is very little research available on how to support the inductive reasoning process in virtual learning environments (Lin, Kinshuk, & Patel, 2003). Existing methods for providing adaptivity in learning systems do not consider the individual differences in learners' inductive reasoning ability. This chapter aims to address this issue and attempts to fill the gap between research on advanced adaptive techniques and research of human induction in cognitive psychology. The chapter will: (1) examine closely the characteristics of inductive reasoning ability, (2) enumerate a list of patterns of activities that could be used to find out a student's inductive reasoning ability, and (3) propose a framework of adaptivity to support inductive reasoning ability.

In order to find out the characteristics of inductive reasoning ability, research in many fields, including cognitive science, psychometrics, and machine learning, is examined. Working memory capacity (Holland, Holyoak, Nisbett, & Thagard, 1987; Lin, Kinshuk,

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