Dynamic Student Modelling of Learning Styles for Advanced Adaptivity in Learning Management Systems

Sabine Graf, School of Computing and Information Systems, Athabasca University, Edmonton, AB, Canada

Kinshuk, School of Computing and Information Systems, Athabasca University, Edmonton, AB, Canada

ABSTRACT

Learning management systems (LMSs) are commonly used in e-learning; however, they typically do not consider the individual differences of students, including their different background knowledge, cognitive abilities, motivation, and learning styles. A basic requirement for enabling such systems to consider students’ individual characteristics is to know these characteristics first. This paper focuses on the consideration of learning styles and introduces a dynamic student modelling approach that monitors students’ behaviour over time and uses this data to build an accurate student model by frequently refining the information in the student model as well as by responding to changes in students’ learning styles over time. The proposed approach is especially useful for LMSs, which are commonly used by educational institutions for whole programs of study and therefore can monitor students’ behaviour over time, in different courses. The paper demonstrates how this approach can be integrated in an adaptive mechanism that enables LMSs to automatically generate courses that fit students’ learning styles and discusses how dynamic student modelling can help in identifying students’ learning styles more accurately, which enables the LMS to provide more accurate adaptivity and therefore support students’ learning processes more effectively.

Keywords: Adaptivity, Dynamic Student Modelling, Felder-Silverman Learning Style Model, Learning Management Systems, Learning Styles, Technology Enhanced Learning

INTRODUCTION

Nowadays, many educational institutions, such as universities, use learning management systems (LMSs) for offering either blended or fully online courses. LMSs, such as Moodle (http://www.moodle.org), Blackboard (http://www.blackboard.com) and Sakai (http://www.sakaiproject.org/portal) aim at supporting teachers in creating, administering, and holding online courses by providing them with a variety of features. Such features assist them in admin-
istrative issues, such as enrollment, allow them to create courses with many different activities and resources, support communication between teachers and students as well as among students, and much more. However, LMSs typically do not consider individual differences of learners and treat all learners equally regardless of their needs and characteristics.

In this paper, we focus on the consideration of students' learning styles. Research about considering learning styles in technology enhanced learning is motivated by educational and psychological theories, which argue that learners have different ways in which they prefer to learn. Furthermore, literature suggests, for example, that learners with a strong preference for a specific learning style may have difficulties in learning if the teaching style does not match with learners' learning style (Felder & Silverman, 1988; Felder & Soloman, 1997). From a theoretical point of view, conclusion can be drawn that incorporating learners' learning styles in the learning environment makes learning easier for the learners and increases their learning efficiency. On the other hand, learners whose learning styles are not supported by the learning environment may experience problems in the learning process.

Based on these theoretical arguments, several adaptive learning systems have been developed over the last years. Examples of such systems include CS383 (Carver, Howard, & Lane, 1999), IDEAL (Shang, Shi, & Chen, 2001), and LSAS (Bajraktarevic, Hall, & Fullick, 2003), TSAL (Tseng, Chu, Hwang, & Tsai, 2008), and WELSA (Popescu, 2009). Evaluations of these systems demonstrated the possible benefits of considering learning styles in educational systems, showing that learners' effort can be decreased in terms of time required for learning and the overall learner satisfaction can be increased. Although these adaptive systems seem to support learners very well and therefore demonstrate that considering learning styles can help learners in learning, the systems which are currently used by most educational institutions, namely LMSs, typically do not consider individual differences and in particular do not consider learning styles.

A crucial issue for considering individual differences and providing adaptivity is to know the respective characteristics of students first. With respect to learning styles, a lot of adaptive systems use a collaborative student modelling approach, where students are explicitly asked about their learning style preference, for example, by using a questionnaire which students need to fill out before they start to learn in the course. Recently, more and more research has been done on developing automatic student modelling approaches where information about students' learning styles is identified based on their behaviour and actions in an online course (Cha, Kim, Park, Yoon, Jung, & Lee, 2006; García, Amandi, Schiaffino, & Campo, 2007; Graf, Kinshuk, & Liu, 2009). Such automatic approaches have several advantages over the learning style questionnaires. Since they gather information automatically from students' behaviour and actions, no additional effort from students is required, such as answering questions of the questionnaire. Furthermore, through using data about students' behaviour and actions, these approaches are based on data reflecting what students are really doing in an online course rather than on information about what students think they do in a course. Another advantage of automatic approaches is that they use data from a time span rather than from a specific point of time as in questionnaires. This makes automatic approaches more accurate and less error-prone.

Most of the automatic student modelling approaches developed for identifying learning styles are static, meaning that learning styles are calculated only once from a certain amount of data (Cha et al., 2006; García et al., 2007; Graf et al., 2009). Since LMSs are typically used for teaching whole programs of study and therefore students learn within such systems for several years, the incorporation of dynamic aspects in student modelling has high potential to develop more accurate student models and therefore make adaptivity more accurate as well. On one hand, dynamic student modelling allows for considering changes in students' learning styles over years and therefore enables an adaptive LMS to provide students with more accurate adaptivity, leading to courses that reflect the
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