An Innovative Approach for Assisting Teachers in Improving Instructional Strategies via Analyzing Historical Assessment Data of Students

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ABSTRACT

Identifying learning problems of students has been recognized as an important issue for assisting teachers in improving their instructional skills or learning design strategies. The accumulated assessment data provide an excellent resource for achieving this objective. However, most of conventional testing systems only record students’ test results, which are not helpful to teachers in realizing students’ learning problems without further assistance. To cope with this problem, in this study, an innovative approach that combines a student concept model and the change mining mechanism is proposed to analyze the learning problems of students from their historical assessment data. The teachers received the analysis results and then used those suggestions to improve their instructional strategies. To evaluate the performance of the proposed approach, a web-based learning assessment system has been developed and an experiment has been conducted on an “Introduction to Computers” course in a university. The experimental results showed that, those analysis results provided by the innovative approach were helpful to the teachers in providing appropriate instructional assistance and remedial learning materials for improving the learning achievements of the students.

Keywords: Concept-Effect Model, Educational Data Mining, Remedial Instruction, Teaching/Learning Strategies

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1. INTRODUCTION

Researchers have indicated that most teachers are facing major challenges about effectively tracking the progress of their many students, and requiring more assistance to manage their classes, enhancing their teaching skills, and preparing suitable curriculum content (Coates, 2005; Hwang et al., 2008b, Macfadyen & Dawson, 2010). To provide well suggestions of instructional designs with appropriate learning content, it is important to analyse students’ learning status as well as review the teachers’ instructional methods. In the past decade, several methods or systems have been proposed to diagnose the learning problems of students for specified learning content, such as a small extent of concepts or subject units (Hwang, 2003a, Hwang et al., 2012; Panjaburees et al., 2013).

To maintain the teaching quality, uniform material or curriculum is generally applied to school education or professional skills education. The design of the commonly compulsory curriculum aims to have students with different background establish a common basic concept through the instruction with same material. It is expected that students achieve certain level on basic knowledge. However, the knowledge background of students is different, such that students will have different views, ideas and interpretations of the same material. Therefore, how to provide diagnostic mechanisms and effectively detect the learning weakness of students for assisting teachers in planning their teaching strategies has become an important issue.

Among the existing methods for analysing students’ learning status, educational data mining has emerged as a focal research area in recent years (Merceron & Yacef, 2011; Baker & Yacef, 2010; Lin et al., 2013; Romero & Ventura, 2010). The main objective of educational data mining is to analyse the various types of educational data and to generate useful information to solve educational research issues. The successful applications of educational data mining include the adaptive learning system (Hsieh & Wang, 2010), diagnosing system (Chang et al., 2005; Hwang et al., 2008a; Merceron & Yacef, 2011; Chen & Chen, 2009; Tseng et al., 2010), recommendation and remedial learning system (Chu et al., 2010; Khribi et al., 2009; Romero et al., 2009; Hsu et al., 2010; Milicevic et al., 2011; Martínez-Maldonado et al., 2013), and learning management system (Graf, Kinshuk, & Liu, 2009; Liu et al., 2010; Macfadyen & Dawson, 2010). Martínez-Maldonado et al. (2013) aimed to explore the potential of an enriched tabletop to automatically and unobtrusively capture data from collaborative interactions. They applied many data mining techniques to assist collaborative learning, e.g., clustering (Martínez-Maldonado et al., 2013) and sequential pattern mining (Perera et al., 2009). Moreover, Merceron and Yacef (2011) have successfully conducted association rule mining on Learning Management System (LMS). In our survey, it can be seen that there were less reference has applied change mining and association classification mining for teacher’s educational purpose.

The summative assessment measures the learning performance of students and typically provides minimal insight into the learning status of students (Novak & Gowin, 1984; Nuhfer, 1996; Smith et al., 2004; Hargreaves, 2008). Several studies have applied new techniques to extract useful information from assessment results because the accumulation of assessment results is an excellent information resource (Ma, Liu et al., 2000; Hwang et al., 2008a; Panjaburee et al., 2010; Su & Wang, 2010). The analysis information not only helps teachers improve the quality of teaching material, but also helps students diagnose their personal learning status. Prior research focused on new strategies to diagnose personal learning. However, knowledge is limited on the application of data mining techniques on assessment results to help teachers provide suitable remedial material for students and to understand the learning situation of students. To identify the various learning weaknesses of the students in different achievement groups,
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