Chapter 19
Web-Based Two-Tier Diagnostic Test and Remedial Learning Experiment

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ABSTRACT

Offering a series of diagnosis and individual remedial learning activities for a general class by means of web and multimedia technology can overcome the dilemma of conventional diagnosis and remedial instruction. The study proposes a three-layer conceptual framework and adopts a two-tier diagnostic test theory to develop a web-based two-tier diagnostic test and remedial learning management system called "the Dr. System." The study also designs the two-tier diagnostic test items of electro-magnetic concepts and the related multimedia remedial learning materials based on the theory of modular course for the purpose of investigating the remedial learning effects. In addition, the study helps the participants eliminate their misconception through a quasi-experiment at an elementary school in a metropolitan area of northern Taiwan. The results show that the learners of the experimental group who received the treatment under the Dr. System performed significantly better than those who took the traditional remedial class. The study also indicates that the web-based two-tier diagnostic test helps us understand learners' misconceptions. As a result, it also provides learners useful remedial multimedia materials, which are necessary for them to eliminate their individual misconceptions in the remedial learning process.

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1 INTRODUCTION

In science and technology learning, abstract concepts are difficult to understand; so many misconceptions or alternative concepts are held in the students' mental models and affect their learning performances and attitudes. How to diagnose the students' misconception is an important and complex task in a traditional classroom or e-learning environment. There are many conventional methodologies for science misconception diagnosis, including concept mapping, interviewing, paper and pencil testing, and two-tier diagnostic testing. Under the method of concept mapping, the students are required to accept the concept-map drawing training, and the concept maps drawn by the learners can be used for probing the learners' misconception, but it is hard to analyze and score (Snow & Lohman, 1989). The method of interviewing can investigate the learners' internal ideas deeply similar to the concept mapping method, but it is time-consuming and the interviewers must possess excellent questioning skills and master the professional domain knowledge about interview topics. Both concept mapping and interviewing are difficult to use for surveying a large quantity of samples. By contrast, the method of paper and pencil testing is suitable for administering tests to a large number of students and for evaluating the test-takers' response patterns and performance, especially for the multiple choice items. But the paper and pencil test is difficult to use for assessing and analyzing the test-takers' internal ideas and often encounters measurement errors due to the students' examination behaviors, such as guessing (Griffard & Wandersee, 2001). So as to avoid the shortcomings of the paper and pencil test, the two-tier diagnostic test was proposed by Treagust in 1985 (Treagust, 1985, 1986, 1988; Treagust & Haslam, 1987). Most of the two-tier diagnostic test is administered by means of traditional paper-and-pencil-based method. After the learners' misconceptions are detected, in the traditional instructional context, the learners will be provided with a remedial instruction opportunity after class by their teachers or learning guidance mentors. But in the traditional large classroom, it is impossible for teachers to provide individual remedial instruction to the learners based on their individual learning problems.

Offering a series of diagnosis and individual remedial learning activities for general class by means of web and multimedia technology is one of the best and most feasible alternatives. By means of the web-based two-tier diagnostic test, the student's misconception can be probed more easily and accurately. Computer-based multimedia materials can attract the learners' attention and promote their learning motivation. If the multimedia materials are designed based on modular curricula, they can be easily composed into a compensatory or tutorial course to meet underachiever individual need and competency using a computerized system. A web-based system can combine diagnosis task and remedy materials into a series of structured remedy learning activities. This is similar to medical doctors' clinic behaviors which include diagnosing patient's symptoms and then offering prescriptive medicine. As a whole, combining testing, diagnosis and remedy instruction together makes e-learning valuable and meaningful. Nevertheless, there is minimal research in this area. This study proposed a three-layer conceptual framework and employed web technology to integrate the two-tier diagnostic test and remedial learning tasks to develop an e-remedial learning system called Dr. System (which name reflects that Dr. System can diagnose the learners' weaknesses on-line and offer the web-based prescriptive materials just as human doctors diagnose a patient's disease and prescribe the appropriate medicine). In other words, Dr. System offers the learners diagnostic testing online, analyzes the test result, generates the diagnostic report and selects suitable or personalized digital materials for remedying or eliminating the students' individual misconceptions. In addition, to investigate the diagnosis and remedy learning