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Developing an assessment-centered e-Learning system for improving student learning effectiveness

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ABSTRACT

This research used Web-based two-tier diagnostic assessment and Web-based dynamic assessment to develop an assessment-centered e-Learning system, named the 'GPAM-WATA e-Learning system.' This system consists of two major designs: (1) personalized dynamic assessment, meaning that the system automatically generates dynamic assessment for each learner based on the results of the pre-test of the two-tier diagnostic assessment; (2) personalized e-Learning material adaptive annotation, meaning that the system annotates the e-Learning materials each learner needs to enhance learning based on the results of the pre-test of the two-tier diagnostic assessment and dynamic assessment. This research adopts a quasi-experimental design, applying GPAM-WATA e-Learning system to remedial Mathematics teaching of the 'Speed' unit in an elementary school Mathematics course. 107 sixth-graders from four classes in an elementary school participated in this research (55 male and 52 female). With each class as a unit, they were divided into four different e-Learning models: (1) the personalized dynamic assessment and personalized e-Learning material adaptive annotation group ($n = 26$); (2) the personalized dynamic assessment and non-personalized e-Learning material adaptive annotation group ($n = 28$); (3) the non-personalized dynamic assessment and personalized e-Learning material adaptive annotation group ($n = 26$); and (4) the non-personalized dynamic assessment and non-personalized e-Learning material adaptive annotation group ($n = 27$). Before remedial teaching, all students took the prior knowledge assessment and the pre-test of the summative assessment and two-tier diagnostic assessment. Students then received remedial teaching and completed all teaching activities. After remedial teaching, all students took the post-test of the summative assessment and two-tier diagnostic assessment. It is found that compared to the e-Learning models without personalized dynamic assessment, e-Learning models with personalized dynamic assessment are significantly more effective in facilitating student learning achievement and improvement of misconceptions, especially for students with low-level prior knowledge. This research also finds that personalized e-Learning material adaptive annotation significantly affects the percentage of reading time students spend on the e-Learning materials they need to enhance learning. However, it does not appear to predict student learning achievement and improvement of misconceptions.

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1. Introduction

e-Learning has become an important trend in recent years. In addition to providing richer resources than the traditional classroom to facilitate learning, e-Learning also overcomes the limitations of time and space of traditional teaching. e-Learning allows learners to learn independently, meaning that it lacks the supervision and enforcement mechanisms of traditional teaching (Wang, 2011a). Given this, learners in an e-Learning environment must be highly self-regulated and independent, or their e-Learning effectiveness may be low (Kauffman, 2004; Wang, 2011a). Self-regulated learning plays an important role in both traditional and e-Learning environment. It is especially important in an e-Learning environment which lacks teacher's supervision and enforcement mechanisms (Jonassen, Davidson, Collins, Campbell, & Haag, 1995; King, Harner, & Brown, 2000; Puzziferro, 2008; Wang, 2011a).

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The major characteristic of self-regulated learning is that learners intentionally make an effort to manage and direct complicated learning activities (Gordon, Dembo, & Hocevar, 2007; Kauffman, 2004; Wang, 2011a). Puzziferro (2008) further pointed out that by providing proper learning strategies, an e-Learning environment could facilitate learners to perform self-regulated learning. Paris and Paris (2001) believed that self-assessment was an effective strategy to help learners perform self-regulated learning because learners were better able to evaluate their learning conditions if they could assess themselves during the learning process. They can also further monitor and correct their course of learning, and as a result, improve their learning effectiveness. Self-assessment is also the major feature of the assessment-centered learning environment (Bransford, Brown, & Cocking, 2000). Bradsford et al. contended that, in a successful assessment-centered learning environment, teachers incorporate assessment into teaching activities to facilitate students in performing self-assessment, and advance student learning effectiveness via interaction with the timely feedback from self-assessment. Since frontline teachers often teach many learners and are pressured into following a teaching schedule, it is difficult for learners to perform effective self-assessment and receive meaningful feedback. An assessment-centered learning environment is therefore difficult to be constructed in a traditional learning environment. However, with the help of information communication technology, when learners encounter difficulties during assessment, the system can help teachers provide learners with timely feedback. If the database of the Web-based assessment system is equipped with well-designed feedback data, it can provide learners with more effective feedback and facilitate e-Learning (Wang, 2007). In other words, learners can directly interact with a Web-based assessment system to perform effective self-assessment. Referring to the viewpoints of Bransford et al., Paris and Paris, Puzziferro and Wang, this research develops an assessment-centered e-Learning environment where learners can perform effective self-assessment by interacting with Web-based assessment system, expecting to improve learners' learning effectiveness.

The interactive model of learners and assessment can be constructed by adopting dynamic assessment. The theoretical basis of dynamic assessment is the 'Zone of Proximal Development (ZPD)' proposed by L. S. Vygotsky (Elliott, 2003; Haywood, Brown, & Wingenfeld, 1990). ZPD refers to the difference between the cognition level learners can achieve with and without the assistance of others such as teachers and outstanding peers (Elliott, 2003; Vygotsky, 1978; Wang, 2010, 2011b). According to Elliott, early dynamic assessment was mainly used to evaluate examinees' real ability and categorize them for specific training and education. In recent years, dynamic assessment has been more commonly applied to education. It is used to develop individualized educational interventions and in turn assist teaching (Elliott, 2003; Wang, 2011b). In most cases, dynamic assessment is performed in the form of test-teach-retest (Moore-Brown, Huerta, Uranga-Hernandez, & Peña, 2006; Wang, 2010). Campione and Brown (1985, 1987, pp. 92–95) proposed the 'graduated prompt approach' to develop and perform dynamic assessment. The key of 'graduated prompt approach' is to deliver instructional interventions with personalized prompts. When answering dynamic assessment items incorrectly, they can get personalized prompts to assist their learning. These personalized prompts are displayed in a pre-set sequence based on their levels of explicitness (Bransford, Delclos, Vye, Burns, & Hasselbring, 1987). They start with 'general hints' and gradually become 'specific hints'. General hints offer relatively little specific information about the solution, while a specific hint offers a detailed blueprint from which learners can generate the correct answer (Campione & Brown, 1985, 1987, pp. 92–95). Wang (2010, 2011b) followed the 'graduated prompt approach' in developing a Web-based dynamic assessment system, the 'Graduated Prompting Assessment Module of the WATA system (GPAM-WATA),' on the architecture of the 'Web-based Assessment and Test Analysis system (WATA system) (Wang, Wang, & Huang, 2008; Wang, Wang, Wang, Huang, & Chen, 2004).' GPAM-WATA can assist teachers in incorporating important learning concepts into the design of the instructional item and the instructional prompt, allowing learners to acquire substantial learning through online self-assessment by answering the item and receiving the prompt (for a detailed introduction of GPAM-WATA, see Section 2.1). Wang (2010) integrated GPAM-WATA into an e-Learning environment for a elementary school nature science course. Learners can log into the system for self-assessment after reading the e-Learning materials. Wang (2011b) also employed GPAM-WATA in remedial teaching for a junior high school Mathematics course. Learners log into the system for self-assessment after completion of traditional Mathematics instruction. Both studies showed that GPAM-WATA can help improve learning effectiveness.

GPAM-WATA in Wang (2010, 2011b) is a Web-based dynamic assessment system that allows teachers to create items and prompts, and administer online dynamic assessments, but does not allow teachers to compose e-Learning materials online, nor does it provide learners with the personalized assessment scenario. This means all learners logging in must answer the same set of items. This research further enhances the design of the teaching and learning strategies in GPAM-WATA to construct an assessment-centered e-Learning system, named the 'GPAM-WATA e-Learning system (GPAM-WATA_EL).' This e-Learning system allows teachers to construct items and prompts and compose e-Learning materials online and allows learners engaging in e-Learning to perform assessment-centered e-Learning. GPAM-WATA_EL is centered on assessment for all learning and teaching activities. For learning, the system provides personalized dynamic assessment, which relies on a two-tier diagnostic assessment. It automatically constructs a personalized dynamic assessment based on the results of the pre-test of the two-tier diagnostic assessment. In personalized dynamic assessment, examinees only need to answer the items related to the concepts they answered incorrectly in the pre-test of the two-tier diagnostic assessment. When they answer dynamic assessment items incorrectly, they can obtain progressive prompts in sequence and therefore achieve learning. For teaching, the system provides personalized e-Learning material adaptive annotation. Based on how each examinee answers items in the pre-test of the two-tier diagnostic assessment and dynamic assessment, personalized e-Learning material adaptive annotation reminds examinees by marking 'recommended reading' for the e-Learning materials requiring enhanced learning. These two designs are discussed in greater detail in Section 3.3.1.

In a traditional learning environment, as required by a teaching schedule, teachers often need to teach more than one student at a time. Therefore, it is not possible to provide effective teaching feedback based on students' personal needs. This research expects to apply GPAM-WATA_EL to assisting teachers' teaching, especially the remedial teaching. After conventional teaching process, teachers can leverage this e-Learning system to perform remedial teaching. Learners are allowed to compensate the deficiencies of their learning with personalized learning. This research applies GPAM-WATA_EL to the remedial teaching of the 'Speed' unit of an elementary school Mathematics course and investigates how the two designs of GPAM-WATA_EL, personalized dynamic assessment and personalized e-Learning material adaptive annotation, help improve student learning effectiveness. This research investigates student learning effectiveness from the perspectives of learning achievement and improvement of misconceptions. This research develops four e-Learning models (see Section 3.4) based on the two designs and investigates the effectiveness of the four models. This research also explores how the four e-Learning models assist learners with different levels of prior knowledge. This research answers three questions:

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