Longitudinal effect of a computer-based graduated prompting assessment on students' academic performance

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ABSTRACT

The dynamic assessment (DA) approach has been shown to be a useful evaluation tool for understanding students' learning potential. In the present learning context via technology-mediated learning (TML), the DA approach has a significant effect on learning. The aim of this study was to understand two gaps in the research on the effect of DA (in our case, computer-based graduated prompting assessment) on students' academic performance. First, the extant research has focused on DA that is based on pre- and post-test evaluation. The influence of time is an important predictor of information technology use, and understanding the effect of computer-based DA on students' academic performance across time is thus necessary. Second, the TML-based assessment has been designed because the assessment system has students who receive help directly in isolated TML environments. As such, we developed a TML-based, computer-based graduated prompting assessment and conducted a longitudinal examination of computer-based graduated prompting assessments in graphing courses. Quasi-experiments involving 60 students in an experimental group and 60 students in a control group were conducted to test the growth model of hierarchical linear modeling. The results showed that this assessment statistically significantly influenced students' academic performance, as might be expected. However, the use of this assessment over time did not lead to a change in the growth rate. Recommendations for using computer-based graduated prompting assessments across a long timeframe to prompt students' academic performance are also discussed.

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1. Introduction

Assessment procedures have been recognized as an important stage in understanding students' learning achievement by providing feedback to teachers and students (Boud, 2007). However, static and simple standardized tests are insufficient to represent learning outcomes (Marzano, 2000; Tzuriel, 2000), as this type of assessment focuses too much on learners' overall performance. The results of such tests show the learners' present achievement (Marriott, 2009; Wang, 2010); lack feedback (Resing, Tunteler, de Jong, & Bosma, 2009) or adequate information for remedial instruction (Shih, Ku, & Hung, 2013); make

no attempt to change, guide, or improve students' learning performance (Tzuriel, 2000), and fail to reflect the learning potential of students and learning processes (Resing et al., 2009; Wang, 2010).

To overcome the criticisms of static assessment, researchers have proposed dynamic assessment (DA), emphasizing that the DA procedure is closely related to learning processes (Tzuriel, 2000). Instead of focusing on a specific moment, DA integrates an overall plan to enhance students' learning potential and change their cognitive functions and structures, resulting in more flexibility and applicability in problem-solving situations (Davidovitch, Parush, & Shtub, 2006). DA has been found to be more effective than standard web-based tests or traditional paper-and-pencil tests in facilitating students' learning and performing remedial teaching (Wang, 2011). Moreover, web-based DA can also collect data on students' learning effectiveness through specific web characteristics (Wang, 2010, 2011).

The technology-mediated learning (TML) perspective seeks to motivate researchers to learn about how technology enhances learning (Alavi & Leidner, 2001). The effectiveness of web-based DA in facilitating learning has been previously demonstrated (Wang, 2010, 2014). The conditions of the DA system do not allow interaction with other learners or instructors; the system is designed to encourage learners to acquire prompts and instruct them on how to apply the prompts in their learning processes to enhance their learning performance. Thus, based on the TML perspective, we focused on developing and using the graduated prompting assessment in an effective TML environment.

Additionally, despite computer-based assessment's increasing acceptance in engineering graphing courses to train students in graphing skills, empirical research that sheds light on the efficacy of the assessment in engineering graphing courses is still being undertaken. Engineering graphing is an important part of the process of manufacturing industrial products. Poor product designs have a direct influence on the quality of the products (Selvaraj, Radhakrishnan, & Adithan, 2009). Nirmalakhandan, Daniel, and White (2004) noted that the application of computer-based DA improved problem-solving skills and enhanced academic performance in basic engineering.

Thus, the aim of the present study was to contribute to our understanding of how the computer-based graduated prompting assessment system is designed through feedback to support 2D graphing; other aims were to examine the effectiveness of the computer-based graduated prompting assessment system—one type of DA—and to understand students' learning processes in a computer-aided 2D graphing course. In particular, the major research question was, "How does computer-based graduated prompting assessment influence students' academic performance in a computer-aided 2D graphing course over time?" Two approaches are suitable for analyzing the growth of individual learning processes: the growth model of hierarchical linear modeling (HLM; Strenio, Weisberg, & Bryk, 1983) and the latent growth model in structural equation modeling (SEM; Meredith & Tisak, 1990). Both approaches appear to offer similar advantages, although SEM is generally considered to be more flexible and is widely used. However, HLM is widely regarded as more suitable for cross-level data (Hox & Stoel, 2005). Thus, this study drew from the TML perspective to design the graduated prompting assessment in an effective TML environment and used the growth model of HLM to explore the longitudinal effect of computer-based graduated prompting assessment.

2. Theoretical background

2.1. Dynamic assessment and graduated prompting assessment

Prompts are questions or hints designed to guide the regulation of students' problem-solving processes (Ifenthaler, 2012; Renkl, Skuballa, Schwonke, Harr, & Leber, 2015). Prompts have many different typologies. Davis (2003) differentiated prompts into generic and directed prompts: Generic prompts ask students to stop and think, while directed prompts provide hints to encourage students to process additional information.

Graduated prompting assessment, proposed by Campione and Brown (1987), is based on Vygotsky's (1980) sociocultural theory of cognitive development and integrated zone of proximal development (ZPD), social mediation, and internalization. Graduated prompting assessment is a type of DA (King, Binger, & Kent-Walsh, 2015). DA incorporates active teaching within the assessment procedures to observe students' learning process (King et al., 2015). Lantolf and Poehner (2008, p. 274) noted that there are two general approaches to DA: interventionist and interactionist. Interactionist DA is more sensitive to the ZPD, and the mediation is attuned to the responsiveness of the learner (or group), whereas interventionist DA quantifies performance as an index of the speed of learning in terms of the amount of help required for a learner to quickly and efficiently reach a prespecified end point, and the mediation is standardized.

Graduated prompting assessment is a type of DA and may have the following advantages over static approaches. First, graduated prompting assessment emphasizes standardized step-by-step prompts to understand learners' "best performance" (Poehner & Lantolf, 2005). In contrast, traditional static tests overemphasize students' performance at a single stage, while overlooking richer information that explains changes throughout the learning process. Thus, DA supplements the shortcomings of static assessment (Murphy & Maree, 2006); DA can be transferred across test contexts and is flexible and sensitive to students' learning (Peltenburg, van den Heuvel-Panhuizen, & Doig, 2009). Second, graduated prompting assessment is effective in facilitating learning (Wang, 2010), provides students with a prearranged order of prompts, and enables them to obtain instructional prompts in a graduated way (Wang, 2014).

In recent years, the Internet's contributions to improving instructional effectiveness in higher education have been affirmed (Kay, 2011). Graduated prompting assessment can be developed as a web-based assessment system (Wang, 2010, 2011). To achieve the expected instructional objectives, the present study used two-dimensional (2D) graphing courses as