A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course

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A B S T R A C T

The flipped classroom is a well-recognized learning mode that enables effective practice and interactions among teachers and students in the class by switching the in-class instructional time and out-of-class practicing time. However, owing to their lack of self-regulated competence, most students might fail to browse and comprehend the instructional materials out of class by themselves. In this paper, a self-regulated flipped classroom approach is proposed to help students schedule their out-of-class time to effectively read and comprehend the learning content before class, such that they are capable of interacting with their peers and teachers in class for in-depth discussions. In order to evaluate the effectiveness of the proposed approach, a quasi-experimental design was employed in an elementary school Mathematics course. The experimental group students learned with the self-regulated flipped classroom approach, while the control group students learned with the conventional flipped classroom approach. The study was conducted using a quantitative approach. The instruments used were a performance test, and questionnaires of self-efficacy and self-regulation. The experimental results indicated that the post-test score of the experimental group was significantly higher than that of the control group. It was also found that the higher self-regulation students showed significantly different learning achievements when learning with different approaches, while there was no significant difference between lower self-regulation students with the different learning approaches. Moreover, the experimental group showed significantly higher self-efficacy than the control group. In addition, the learning log analysis results further showed that, conforming to the objective of the self-regulated strategy, the students would determine the goals for the next learning phase based on their current performance. To sum up, the findings of this study indicate that integrating the self-regulated strategy into flipped learning can improve students' self-efficacy as well as their strategies of planning and using study time, and hence they can learn effectively and have better learning achievements.

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1. Introduction

Scholars have emphasized the importance of conducting student-centered learning activities in school settings (Agbatogun, 2014; Piirto, 2011). In student-centered learning activities, fostering students' active learning and solving their individual learning problems have been identified as the keys to improving their learning performance (Chang, Hsiao, & Barufaldi, 2006; Kamarainen et al., 2013). Among various learning modes, flipped classrooms are considered as an effective mode for engaging students in active learning as well as in meaningful peer-to-peer and peer-to-teacher interactions during the in-class learning process (Forsey, Low, & Glance, 2013; Pluta, Richards, & Mutnick, 2013; Teo, Tan, Yan, Teo, & Yeo, 2014). Moreover, Bergmann and Sams (2012) indicated that flipped classrooms enable teachers to take individual students' needs into account as well as to facilitate more interactions among peers and teachers in the classroom.

The learning context of flipped classrooms consists of two kinds of activities: computer-assisted out-of-class personal instruction and interactive in-class group learning activities (Bishop & Verleger, 2013). That is, students obtain learning content before class, and then spend time in class deepening their understanding of the content (Baker, 2000; Lage, Platt, & Treglia, 2000). This learning mode emphasizes self-paced learning, and supports students in solving problems through the guidance (Rahman, Aris, Mohamed, & Zaid, 2014).

However, scholars have pointed out the challenges of conducting the flipped classroom approach, such as the preparation of instructional videos with effective learning guidance (Rahman et al., 2015; Schultz, Duffield, Rasmussen, & Wageman, 2014). Without proper guidance or assistance, most students might show low self-regulated behaviors and little responsibility during the learning process (McLaughlin et al., 2013; Sun, Wu, & Lee, 2016). For example, in the out-of-class learning activities, students may fail to schedule their time to watch the videos and comprehend the learning content owing to their lack of self-regulation. In this circumstance, they are likely to fail to effectively learn in the following in-class activities (Mason, Shuman, & Cook, 2013).

Therefore, to enhance the effectiveness of the flipped classroom, it is important to provide students with a self-regulating mechanism. In this study, a self-regulated flipped classroom approach is proposed. A learning system has been implemented based on the proposed approach to enable students to determine the learning goals, engage in learning based on their own plans, monitor and evaluate their own learning performance, and make reflections accordingly. Moreover, an experiment was conducted to evaluate the performance of the approach in terms of improving students' learning achievement, self-efficacy, and self-regulation.

2. Literature review

2.1. The flipped classroom

In recent years, the educational paradigm has shifted from teacher instruction mode to student-centered learning. Based on this kind of innovation, more technologies have been integrated into the educational scene, and multiple learning modes have provided students with various ways of learning (Li et al., 2014). Among the various learning modes, the "flipped classroom" is regarded as a potential and extraordinary learning method that engages students in applying their learning knowledge and conducting higher order thinking, rather than receiving direct teaching instruction (Davies, Dean, & Ball, 2013; Flumerfelt & Green, 2013).

The term "flipped classroom" represents the learning approach that exchanges the time used to deliver basic knowledge in class and the out-of-class time for applying the knowledge or doing homework (Bergmann & Sams, 2012); that is, teachers are able to engage students in more learning activities for applying the knowledge they have learned through practicing, doing projects, discussion, and solving problems in class (Missildine, Fountain, Summers, & Gosselin, 2013), as shown in Fig. 1. The
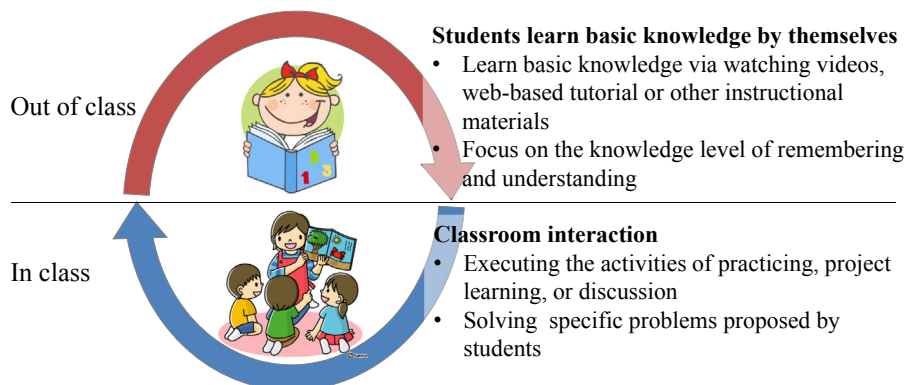

Students learn basic knowledge by themselves
- Learn basic knowledge via watching videos, web-based tutorial or other instructional materials
- Focus on the knowledge level of remembering and understanding

Classroom interaction
- Executing the activities of practicing, project learning, or discussion
- Solving specific problems proposed by students

Out of class

In class

Fig. 1. The learning mode of the flipped classroom.