Chapter XVII
Collaborative Learning in a Mobile Technology Supported Classroom

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ABSTRACT

This chapter introduces the migration of a Web-based cognitive tool (CT) for the generation of procedural knowledge about mathematical fractions from a desktop version to a mobile version. It aims to provide insight into the potential of human-computer interaction in mobile learning environments to encourage reciprocal tutoring and foster collaborative learning. A collaborative mobile learning environment is designed using a design-based research approach. A Web-based CT for learning the concept of fraction equivalence is improved and modified to suit the environment as applied to a mobile technology supported classroom. This chapter first delineates the theoretical design approach and empirical design methodology that underlie the migration exercise, and then discusses the architectural design of artifacts and the pedagogical design of learning activities to shed light on the development and application of mobile technology in a classroom learning environment.

INTRODUCTION

Procedural knowledge is the knowledge that guides the performance of a task in the absence of access to the knowledge that underlies the procedure (Anderson, 1976). To acquire procedural knowledge about the operation of mathematical fractions, it is necessary to first have knowledge of fraction equivalence, which comprises the concept of fraction equivalence and knowledge of the computation of equivalent fractions, both of which are of equal importance (Kong & Kwok, 2005). Procedural knowledge of adding fractions with unlike denominators is more likely to be generated if a conceptual understanding of fraction equivalence is initially developed (Kong & Kwok, 2005).

Early research shows that learners seldom easily understand the procedural knowledge that is associated with fraction operations, such as
addition and subtraction (Huinker, 1998; Niemi, 1996; Pitkethly & Hunting, 1996). Traditional classroom instruction in this topic generally adopts the algorithmic approach, which suffers from the shortcoming of separating knowledge from meaning. To rectify this problem, a Web-based cognitive tool (CT) was developed to assist learners to generate procedural knowledge of adding fractions with unlike denominators (Kong, 2001) with the rationale that CTs are both mental and computational devices that can support, guide, and mediate the cognitive processes of learners (Derry & Lajoie, 1993; Kommers, Jonassen & Mayes, 1992).

Previous evaluation studies (Kong & Kwok, 2002, 2005) show that the adoption of reciprocal tutoring in a collaborative learning environment has the potential to increase learning effectiveness in this domain. As the portable nature of mobile devices offers the opportunity to promote reciprocal tutoring in a mobile technology supported classroom, the desktop version of the Web-based CT for comprehending procedural knowledge of mathematical fractions is adapted to create a mobile version for collaborative learning.

DESIGN FRAMEWORK

The goal of cognitive technology is to develop CTs that meet the needs of human users (Janney, 1999; Pea, 1985). The capability of the aforementioned Web-based CT to assist learners to generate procedural knowledge of adding fractions with unlike denominators has been validated, and experimental studies have revealed that it serves as a mediator that triggers discussion among learners. Slavin (1996) states that a collaborative learning context, such as discussion, is an important way of stimulating reflection among learners. From the perspective of cognitive science, peer discussion is a way of stimulating cognitive elaboration (Wittrock, 1979). In light of these views, the aim of the study presented in this chapter is to further improve the CT to meet the needs of learners who are learning naturally in a classroom setting by applying the tool to a collaborative learning environment in a mobile technology supported classroom. This section outlines the design framework of the new CT, which, when used in a mobile learning environment, promotes collaborative engagement and encourages the resolution of cognitive conflict by cognitive elaboration and reciprocal tutoring in the classroom.

Cognitive Elaboration

Cognitive elaboration is the process of forming associations between new information and prior knowledge. It is regarded as an essential process for facilitating comprehension and knowledge acquisition (Wittrock, 1986). In cognitive models, learners play an active, responsible, and accountable role in their generative learning. Newly learned materials are better retained and more easily recalled if learners undergo spontaneous cognitive elaboration to trace the relations between the new information and known information, because cognitive elaboration helps the transfer of new information from the short-term to the long-term memory (Doherty, Hilberg, Pinal et al., 2003; Wittrock, 1979).

An effective means of fostering the capability of learners to cognitively elaborate is to offer them opportunities to practice cognitive elaboration. Reciprocal tutoring is a good strategy for encouraging learners to practice cognitive elaboration in which learners take turns to tutor each other in a group learning context (Chan & Chou, 1997; Wong, Chan et al., 2003). The strategy enables students to learn from one another through the verbal elaboration of the new knowledge in a group learning context, thus allowing students who have gained insight into the new concept to reinforce their knowledge by providing explanations to others who need more opportunity to comprehend the knowledge. In this way, all group members benefit from engaging in the elaboration process.

Cognitive Conflict

Understanding mathematical ideas often involves the restructuring of the mathematical schema of learners. This restructuring process is intricately