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An investigation into effectiveness of different reflective learning strategies for learning operational software

Chorng-Shiuh Koong [a,*], Tzu-I Yang [b], Chao-Chin Wu [c], Han-Tai Li [c], Chien-Chao Tseng [b]

[a] Department of Computer Science, National Taichung University of Education, No.140, Min-Sheng Rd, Taichung 403, Taiwan, ROC
[b] Department of Computer Science, National Chiao Tung University, No.1001, University Rd., Hsinchu 300, Taiwan, ROC
[c] Department of Computer Science and Information Engineering, National Changhua University of Education, No. 2, Shi-Da Rd., Bao-Shan Campus, Changhua 500, Taiwan, ROC

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ABSTRACT

Skill certification promotion is one of the main policies facilitated by the technological and vocational education, where application software instruction is regarded as the core curriculum to foster skill certification. With its close connection with problem-solving learning, application software instruction relies heavily on hands-on operation incorporating information technology to adequately unravel the challenges where living or working application is simulated as problem situations. According to Dewey (1963) and Edwards (1996), the process of reflection is characterized by the inference course where learners attempt to analyze and solve the problems. However, more evidence is needed to decide what reflective learning strategies are effective for students' learning. Application software operation is categorized as procedural knowledge. Repeated drills are requisite to reach the ultimate goal of spontaneous reaction without thinking. Features of CAL system offer a well-rounded environment to meet the demands. The purposes of this study were 1) to investigate how different reflective learning strategies can affect learning effectiveness of operational application software acquisition, 2) to identify effective learning strategies and to incorporate the CAL approach with instructional practices to foster learning performance. Aiming at characteristics of operational software, this study proposed operational software learning strategy theory model based on reflective learning and Adaptive Character of Thought-Rational (ACT-R) model theories. The proposed model modified the reflective learning theory and added cyclical loop into CAL to fit for operational software instruction. The CAL system is developed and incorporated into learning activities of reflective learning theory strategy model by collecting frequent operation errors made in the first-year experiment as the source drill items. This study is conducted in a two-year sequence. A total of 172 second-grade students was recruited from a vocational high school. Different reflective learning strategies, individual and group reflective learning strategy, are implemented on two experimental groups in the first year. CAL strategy is later added into the experimental groups in the second year. The results suggest that group reflective learning strategy can enhance learning effectiveness of the holistic and medium-score group students. When reflective learning strategy is incorporated with CAL, in addition to maintaining the first-year learning effectiveness, learning effectiveness of the holistic and low-score group students can be benefited by individual reflective learning strategy. Furthermore, reflective learning incorporating with CAL has greater learning effectiveness than the learning without CAL.

1. Introduction

The process of reflection is usually characterized by the inference course where learners attempt to identify, analyze, and solve the problems (Dewey, 1963; Edwards, 1996; Park & Son, 2011). It is the mental and emotional activities that individual engages in searching and probing for prior experiences in the attempt to solve the problems (Boud, Keogh, & Walker, 1985). During the process, learners are allowed to

* Corresponding author. Tel.: +886 4 22183582 (Department office); fax: +886 4 22183580.
E-mail addresses: csko@mail.ntcu.edu.tw (C.-S. Koong), tiyang@cs.nctu.edu.tw (T.-I. Yang), ccwu@cc.ncue.edu.tw (C.-C. Wu), taiteacher@saihs.edu.tw (H.-T. Li), cctseng@cs.nctu.edu.tw (C.-C. Tseng).

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face a dilemma and consider what is needed to address the problem through the steps of reflection, which are vital to learn (Henderson, Napan, & Monteiro, 2004; Park & Son, 2011; Potting, Sniekers, Lamers, & Reverda, 2010). Jay (1999) suggested that reflection can be treated as problem-solving strategy. Reflecting on the process of an action is beneficial to untangle a challenge. Boud et al. (1985) have described reflection as intellectual activities in which individuals engage to explore their experiences in order to generate new understandings and appreciations. It may take place in individual or in-group settings. Many studies have recognized that reflection plays a (Gotoda, Sakurai, Matsuura, Nakagawa, & Miyaji, 2013, pp. 84–93) critical role in learning process in that it can foster learning effectiveness (Chi, DeLeeuw, Chiu, & Lavancher, 1994; Lee & Hutchison, 1998; McNamara, 2004), which include Motor learning (Gotoda et al., 2013), Professional education (Lyons, Halton, & Freidus, 2013), Medical education (Carek, Geiger, Oelklaus, James, & Karty, 2013; MacDermott, 2013), and Law education (Rué, Font, & Cebrián, 2013) for higher education. It can also be used in Mathematics Learning (Yu, 2013) and Language Learning (George, 2013, pp. 335–357) for young learners.

Approaches to reflection may involve reflective journals, logs, portfolios, and self-writing (Barney & Mackinlay, 2010; Carrington & Selva, 2010; Moon, 2004). They proffers a elaborate list of information that are intended to help learners understand how to learn reflectively. However, it is relatively hard to check if the students do actively reflect (Ryan & Ryan, 2013). Collaborative reflections, on the other hand, can help students actively reflect though different reflective skills. Through information sharing, helping each other, discussion, and evaluating one another's ideas can help students to improve the reflection efficiently. For the past decade, many researches had only reveal part of the information on effectiveness of using individual reflection (Gotoda et al., 2013; Rué et al., 2013) or only focus on self-report which may not be precise enough. It is relatively unclear that different reflective learning strategies will affect the performance of learning. Besides, how to apply reflective learning with appropriate strategies on different ability students is still not clear. Therefore, more evidence is needed to decide what reflective learning strategies are more useful for students' learning.

The prominent position which application software instruction holds within the technological and vocational education is widely recognized in terms of computer science curriculum, skill certification, and promoting quality workforce. Acquisition of application software relates closely to problem-solving learning, because it may involve many problem-solving strategies which include lateral thinking and trial and error. Trial and error is a fundamental method of solving problems (Helman, 1989). It is characterized by repeated, varied attempts which are continued until success, or until the agent stops trying. Lateral thinking (Bono, 1967) is solving problems through an indirect and creative approach, using reasoning that is not immediately obvious and involving ideas that may not be obtainable by using only traditional step-by-step logic. Where living or working application is simulated as problem situations, learners are expected to adopt information technology integrating pertinent knowledge of computer science, goal-identification, and strategic steps to adequately unravel the challenges (Browning, 2010; Léger et al., 2011). Grounded on prior knowledge or experience, problem-solving demands the coordination with reflection to surmount a dilemma, process of which is a learning experience (Jeppesen & Lakhani, 2010; Wang & Chiew, 2010). Chi and Glaser (1985) have suggested that problem-solving is the process during which individuals strive to find solutions to attain a specific goal.

In addition, application software operation is categorized as procedural knowledge, such as open the file, insert picture from file, and create a new table. Procedural knowledge refers to having the understanding of the procedure of an action. In other words, it is the knowledge acquired by learning the sequence of an operation (Anderson, 1983). The function of procedural knowledge is that it can equip learners with rapid and mastery performance, which when adopting on specific knowledge domain can help cultivating specialized personnel (Lin, 2007; Luechtefeld & Watkins, 2011). The ultimate goal of procedural knowledge acquisition is automation, that is, spontaneous reaction without thinking. Once the level is reached, instead of being constantly attentive to certain messages, individuals can engage fast operation without thinking and thereby reducing working memory load (Chang, 1996). However, repeated drills on procedural knowledge are necessary before automation and learning transfer can be attained (Gagne & Briggs, 1992; Simpson, 1972). Accordingly to Adaptive Character of Thought-Rational (ACT-R) theory of knowledge representation, procedural knowledge operation is often accompanied by declarative knowledge. With their close interaction, procedural knowledge cannot be fully acquired without stressing the learning of declarative knowledge (Lin, 2007). Although reflection is widely recognized as beneficial to problem-solving related courses, incorporating procedural knowledge into the learning of operational software needs further empirical evidence to prove its validity on learning effectiveness.

Computer-Assisted Learning (CAL) is operated in the way that question items are put forward by computer for learners to engage repeated drills for the proficiency of the learning content (Hartley, 2010; Huang, Liu, & Chang, 2012; Yalcin & Celikler, 2011). Since opportunity provided by CAL on the same concept or question is unlimited and feedback offered is instant, learners can be benefited and consequently enhance their learning effectiveness (Nirmalakhandan, 2007). For skill learning, adopting CAL on the underachievers have shown significant result on the enhancement of their learning effectiveness (Seo & Bryant, 2012). The abovementioned suggested that integrating CAL system is effective in the learning of operational software.

The purposes of this study were 1) to investigate how different reflective learning strategies can affect learning effectiveness of operational application software acquisition, 2) to identify effective learning strategies and to incorporate the CAL approach with instructional practices to foster learning performance.

This study designed an operational software learning strategy theory model (shortened as OSLST-model) based on characteristics of operational software, Adaptive Character of Thought-Rational (ACT-R) model theory, and reflective learning strategies. Students' frequent operation errors made in the process of learning Microsoft Word from the first-year experiment are identified and collected as the source drill items for the design of CAL system. Later, results from the two-year experiment are used to scrutinize how individual and group reflective learning strategy instructions, and how CAL system can affect students' learning effectiveness in the acquisition of operational software.

1.1. Research questions

To underpin the hypothesis, we investigate the following questions:

1. Does different learning effectiveness exist between different reflective learning strategies without CAL for holistic and different level students?
2. Does different learning effectiveness exist between different reflective learning strategies with CAL for holistic and different level students?