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The Relationships Between Student Computer Self-Efficacy and Cognitive Actions and Metacognitive Strategies While Engaged in Interactive Learning Modules

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Abstract: The current research aims to investigate the relationship between high school student's computer self-efficacy and their cognitive actions and metacognitive strategies while engaged in an interactive learning module. While the computer self-efficacy represents self-efficacy component, the cognitive actions represent the activities while using the modules. The metacognitive component was represented by planning, monitoring and regulating strategies. Students at two high schools in the state of Utah in the United States of America were the target research population. They enrolled in programming and math classes offered by school abc and a physics class offered by school xyz. One hundred students participated in this study. This study focuses on three ILM modules that represent some fundamental concepts in computer science. Three questionnaires were used: demographic questionnaire, computer self-efficacy questionnaire and self-regulated computer-based learning questionnaire. The results show that computer self-efficacy is positively correlated with cognitive actions. There is no significant correlation that exists between computer self-efficacy and components of metacognitive strategies.

Key words: Cognitive actions, computer self-efficacy, metacognition, strategies, ILM modules

INTRODUCTION

Transforming computer science education in this era can be done by improving its educational strategy and practice. Despite the increasing demand of computer science graduates, the student enrollment in this field has been decreasing (Vegso, 2005). Lack of introduction to computer science at the K-12 level and the difficulty in learning programming could be the factors that influence the situation (Ali and Shubra, 2010; Jepson and Perl, 2002).

Research has been done to improve learning instruction. The development of interactive learning modules can be utilized to deliver instruction in an interesting way (Teoh and Kian, 2007). Despite extensive research has been conducted in the use of computer supported instruction, limited study have investigated Self-Regulated Learning (SRL) skills while the students learn with an Interactive Learning Module (ILM) specifically in computer science education. According to Zimmerman (2002) self-regulated learners as those who are active in the metacognitive, motivational and behavioral aspects of learning (Zimmerman, 2002). The current research aims to investigate student's computer self-efficacy, cognitive actions and metacognitive strategies in a SRL framework while using the ILMs. The research question is twofold; what are the relationships between computer self-efficacy and cognitive actions and between computer self-efficacy and metacognitive strategies while engaged in ILMs and what is the relative importance of computer self-efficacy towards student's cognitive actions and metacognitive strategies while using ILMs?

Literature review

Computer self-efficacy, cognitive actions and metacognitive strategies viewed from a self-regulated learning framework: Self-regulted learning is an inherently constructive and self-directed process (Winne, 1995). Other researchers describe self-regulated learners as students who "learn by monitoring their performance-related feedback and by setting goals and forming expectancies regarding specific academic contexts" (Zimmerman and Schunk, 2001). From these definitions a self-regulation plays a significant role in learner's cognitive activities. Putting self-efficacy in the

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context of computer use, Compeau and Higgins (1995) define Computer Self-Efficacy (CSE) as "a judgment of one's capability to use a computer". While cognitive actions/strategies represent specific activities related to "internal processes by which learners select and modify their ways of attending, learning, remembering and thinking" (Gagne *et al*., 1992) metacognitive strategies specifically represent planning, monitoring and regulating strategies of any cognitive actions taken by the students.

Research on CSE has been conducted to investigate how individual's beliefs regarding their capability influence their performance while using computer (Celik and Yesilyurt, 2013; Karsten and Roth, 1998). A study reports that CSE was positively correlated with cognitive and engagement factors in online learning programs (Pellas, 2014). Similar results were reported by Paraskeva (2007). Furthermore, research reveals that it can be trained (Karsten and Roth, 1998).

Computer-based learning and self-regulation: The role of SRL in a classroom learning activity has been found in many studies. SRL studies within computer-based instruction context have also increased (Azevedo and Cromley, 2004; Moos and Azevedo, 2008; Narciss *et al*., 2007). The use of computer applications for learning requires effective strategies to achieve any expected outcomes. The skills help students in selecting the best approach while learning with the computer.

Computer-assisted instruction has been used for many years to facilitate learning in different areas; it is used not only in academic fields but also in industry. While previous studies have showed the development of learning application with advanced facilities (e.g., personalized learning facility, the use of avatars in learning management system) few studies focused on the way students learn with the tools including the ILMs.

MATERIALS AND METHODS

Participants: The participants are students at two high schools in the state of Utah in the USA. One hundred students participated in this study; 77 males and 23 females. About 66% participants consider majoring in engineering-related fields at university.

Interactive Learning Modules (ILM): The ILMs were developed to facilitate student learning of basic computer science concepts. This research utilizes boolean logic, minimum spanning tree and modeling using graphs modules. Those modules are appropriate for K-12 learners. The modules have the following features: guidelines, contents, exercises and levels of difficulty.

Instrumentation

CSE questionnaire: The researcher captured learner's CSE by modifying the previous work (Durndell *et al*., 2000). A content and face-validity tests have been conducted to select relevant items for the K-12 learners.

Self-regulated computer-based learning questionnaire: There is a need to contextualize the SRCBL instrument to the modules. In this study the researcher modified an instrument developed by Lawanto (2011) to capture student's cognitive actions and metacognitive strategies. The SRCBL consists of 7 planning strategies, 12 cognitive actions, 9 monitoring strategies and 11 regulating strategies. The scales of the SRCBL: 1 = almost never, 2 = sometimes, 3 = often and 4 = almost always. Several statements are negatively worded and the scores were reversed before being analyzed.

Data collection and analysis: The researcher informed the goal and guideline of the research to the students. Participants completed a short demographic survey and an online CSE questionnaire on the first phase of the data collection and then they used the ILMs. The researcher provides rewards for student's participation.

The data gathered were analyzed as follows: first, the mean values of CSE and SRCBL items were measured using descriptive statistics. Scores are interpreted as low-to-moderate if they fell between 1.00 and 2.75 on the 4-point scale and moderate-to-high if they fell between 2.76 and 4.00. Second, Spearman rho correlation coefficients were calculated to measure the relationships between CSE and cognitive actions and between CSE and metacognitive strategies. Moreover, to investigate whether CSE predicted student's cognitive actions and metacognitive strategies, a multiple regression tests were carried out.

RESULTS AND DISCUSSION

The descriptive statistics: The descriptive statistics of CSE components are as follows: beginning skills on using a computer (Mean = 4.54; SD = 0.52), advanced skills (Mean = 4.12; SD = 0.73) and file and software skills (Mean = 4.34; SD = 0.64).

Examples of CSE statements

Beginning skills: I feel confident:

- Working on a personal computer
- Entering and saving data (numbers or words) into a file

Advanced skills: I feel confident:

- Using the user's guide when help is needed
- Understanding terms/words relating to computer hardware, for example computer processing unit hard-drive, memory

File and software skills: I feel confident:

- Getting the software up and running
- Copying a flash drive

The results revealed that students had a moderate-to-high awareness of planning (Mean = 2.95, SD = 0.61) monitoring (Mean = 2.91, SD = 0.62) and regulating (Mean = 2.89, SD = 0.54) their actions. On the other hand, the students demonstrated a low-to-moderate awareness of executing their plans into actions (Mean = 2.72, SD = 0.59).

Examples of cognitive actions statements: When I am engaging in a learning activity using the ILM, I:

- Think about the best way to finish the activity as quickly as possible (REVERSED)
- Relate my activity to the objectives I want to achieve
- Follow the step-by-step guidance to complete the activity

According to the findings, the students reported a low-to-moderate awareness of their planning on: "work on the activity right away" (Mean = 1.93, SD = 0.76) and "consider available time to complete the activity (Mean = 2.70, SD = 1.04)". Furthermore, the students also reported difficulty in dealing with time management.

Examples of metacognitive strategies statements Statement

Planning strategies: As I start engaging in a learning activity using the ILM, I:

- Work on the activity right away (REVERSED)
- Identify the objectives that I need to attain

Monitoring strategies: While I engage in a learning activity using the ILM, I:

- Evaluate my progress to see if my work is going well
- Evaluate whether I attain the objectives

Regulating strategies: While I engage in a learning activity using the ILM, I:

- Check whether my responses make sense to me
- Reread the instructions

Relationships between CSE, cognitive actions and metacognitive strategies: A significant positive correlation revealed between CSE and cognitive actions, $r(100) = 0.195$, $p<0.05$. The analysis also shows that there are significant positive correlations between; advanced skills component and cognitive actions, $r(100) = 0.209$, $p<0.05$ and file and software skills component and cognitive actions, $r(100) = 0.190$, $p<0.05$. In addition, there was no significant correlation between CSE and overall metacognitive strategies, $r(100) = 0.147$, $p = 0.072$. A further analysis also revealed that no significant correlation existed between CSE and the metacognitive strategies.

The relative importance of cse towards cognitive actions and metacognitive strategies: The multiple linear regression analysis shows that CSE components were not significant predictors of cognitive actions. The findings reveal that the three CSE components explain only 3.40% of the variance. Advanced skills had the highest Beta value compared to beginning and file and software skills. Moreover, an investigation of the relative importance of student's CSE towards metacognitive strategies reveals that CSE is not a significant predictor of metacognitive strategies. These findings suggest that there are other factors that might contribute more to student's cognitive actions and metacognitive strategies.

CONCLUSION

The descriptive statistics shows that learners reported high CSE. Moreover, analyses of SRCBL find that students had moderate-to-high awareness of metacognitive strategies however, learners had low-to-moderate awareness of cognitive actions. These findings might have been caused by some statements that are not directly related to navigation on the modules such as note taking and student perception of strategies to finish the activity as quickly as possible.

Moreover, significant relationships exist between CSE and cognitive actions. Analyses of multiple linear regressions show that advanced skills have the highest Beta (β) value compared to beginning and file and software skills. The regression tests between CSE components and planning strategies also find that beginning skills have the highest Beta value compared to advanced and file and software skills. The findings confirm a previous study regarding the relationship between CSE and learning strategies (Paraskeva, 2007). The absence of any significant relationship may be due to two factors. First in general, there is no difference on the way of thinking and acting in responding to feedback from modules regardless of their CSE level. Second, learners may have difficulties in findings any features that encourage them to reflect on their activities.

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