Perceptions of Classroom Learning Environments and Computer Self-Efficacy Beliefs of Computer Science Students

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Abstract
Extensive studies have reported that students' computer self-efficacy beliefs are very important for students' academic achievement and outcomes. Students' levels of computer self-efficacy have been shaped by many factors such as perceptions of classroom learning environments, gender, and prior programming experience etc. which are consistent with these study findings. Our survey study collected from 549 undergraduate participants from 11 public and private universities in Thailand having computer science major. We discovered that there were relationships among perceptions of classroom learning environments, gender, high school programming experience, and computer self-efficacy beliefs (general computer and computer programming self-efficacy). In addition, hierarchical regression analysis demonstrated that perceptions of classroom environments were the best predictors to these beliefs and the other predicting factors were gender which males had higher in both beliefs than females, and previous programming experience which predicted to only computer programming self-efficacy. The results from this study suggested computer self-efficacy beliefs of computer science students were varied from perceptions of classroom environment dimensions, gender, and previous programming experience.

Keywords: computer self-efficacy beliefs; perceptions of classroom learning environment; computer science

Introduction

From many years, there are numerous research papers which have studied about self-efficacy in various domains of learning. The results from these studies have revealed that there are the number of factors that affects on self-efficacy beliefs; for instance, sources of self-efficacy beliefs, social supports (e.g. peers, teachers, and parents), gender, ethnics, perceptions of classroom learning environments etc. All of these factors play a vital role to encourage students to have high/low self-efficacy beliefs which are directly influent toward students' performance, effort, choices of persistence, academic achievement, and outcomes (Britner & Pajares, 2006; Larose et al., 2006; Thanita et a.l, 2012; Usher & Pajares, 2009; Zeldin & Pajares, 2000). However, the above mentioned research has given that the studies of the relationships between perceptions of classroom learning factors and self-efficacy beliefs are not much appearance with evidence especially focusing on five dimensions of classroom learning environments (cooperation, competition, involvement, autonomy, and meaningfulness) and specific with computer science students in Thai context which can be a gap for this paper to investigate in this area.

Student's self-efficacy is defined as the beliefs of judgments on his/her capabilities in order to produce the amount of effort and the levels of performance or behaviors (Bundura, 1977) and it is a part of social cognitive theory (Bandura, 1986). The changing individual's levels of self-efficacy are depended on student's perceptions from information that he/she obtains from any factors such perceptions of classroom environments, sources of self-efficacy (Pajares & Schunk, 2001) which are influential to high or low performance (Johnson, 2005). Four sources of self-efficacy are mastery experience - one's past performance, vicarious experience - observing others to perform tasks, social persuasions - social encouragement from others such as feedback from peers and teachers, and psychological states - emotional states such as anxiety, stress, fatigue, and mood (Bundura, 1977; Usher & Pajares, 2009; Zeldin & Pajares, 2000).

In computer science courses, computer self-efficacy beliefs point to individual's perceptions of abilities to deal with computer tasks (Compeau & Higgins,1995). There are some aspects of computer self-efficacy beliefs such as general computer, computer programming etc. (Galpin et al., 2003). General computer self-efficacy measured for non-specific computer use (Rosson et al., 2011) relates to students' judgment in their abilities to use computers, applications, internet etc. (Marsh, 2010; Johnson, 2005) but computer programming self-efficacy concerns with students' beliefs in their capabilities to perform computer programming tasks (Marsh, 2010). Much research has found these beliefs are very crucial factors on performing success in computer-related fields. For example, if students have higher computer self-efficacy beliefs, they will have more confidence in computer skills and information system, greater acceptance of new computer skills and technological changes, greater enrollment in computer and related courses, better learning performance (Hasan, 2003), higher persistence in computer science program (Sam et al., 2005), more accomplishment with computer assignments, and higher predicting of learning outcomes (Kinnunen & Simon, 2011; Hasan, 2003; Marsh, 2010).

As can be seen from the benefits of computer self-efficacy beliefs, it can assume that the higher computer self-efficacy beliefs students have, the more opportunities and

higher performance on achievement they will accomplish. Thus, the study of the influential factors (e.g. classroom learning environments, gender, and previous programming experience) is very important to explore because anticipated results can give evidence to support what are causing factors affecting students' levels of computer self-efficacy beliefs.

First, "Classroom is a social and learning environment" assists to form students' perceptions on their attitudes and feelings toward subject matter, adults and peers (Koul et al., 2012). There is much research studied for classroom learning environments in many subject areas such as mathematics, science, physics, and computer science etc. with some different dimensions of classroom learning environment measurement (e.g. student cohesiveness, teacher support, investigation, task orientation, equity, affiliation, teacher control, cooperation, involvement, competition, autonomy, meaningfulness etc.) (Aldridge & Fraser, 2000; Fisher & Fraser, 1985; Fraser, 1998; Ogbuehi & Fraser, 2007; Wolf & Fraser, 2008; Koul et al., 2012) but in this study focusing on only five factors according to Koul et al. (2012) recommended that classroom setting should be good with autonomy, meaningful learning, more cooperation, more involvement, and less competition (autonomy - chances to select and to control on learning (Lawless & Brown, 1997; Murray, 1999; Wang & Peverly, 1986), meaningfulness - assimilation with new knowledge into the existing one in memory (Fraser, 2002; Mayer, 1981; Mayer & Moreno, 2002), cooperation - fulfilling effort with group commitment rather than individual to accomplish tasks (Blumenfeld, 1992; Wolf & Fraser, 2008; Yerion & Rinehart, 1995), involvement - participation with classroom learning activities (Byer, 1999), competition - preference to compete with others (Regueras et al., 2011) or social comparison (Schunk & Pajares, 2001).

Therefore, to set classroom with positive environment can shape students' perceptions with higher satisfaction gained from better experience in class (Fraser, 2002; Hester, 2002, Kerr & Nelson, 2002 cited in Khalil & Saar, 2009; Zandvliet & Fraser, 2005) and higher self-efficacy beliefs (Schunk & Pajares, 2001) which lead them to reach their academic achievement (Dart et al., 1999; Hoyle, 1985; Khalil & Saar, 2009), and to enhance their learning outcomes (Wolf & Fraser, 2008). Perceptions are personal meaning that influence on personal behaviors which originate from the interaction between individual and environments (Byer, 1999; Wolf & Fraser, 2008). From related studies have given evidence that there are positive associations between students' perceptions of classroom learning environments and learning outcomes (e.g. cognitive, affective, behavior) (Byer, 1999; Fraser, 1998; Fraser, 2002; Wolf & Fraser, 2008), and perceptions of classroom environments and self-efficacy beliefs (Dorman, 2001; Lorsbach & Jinks, 1999; Schunk & Pajares, 2001). For instance, Giannakos et al. (2012) have emphasized that positive learning environment is important to increase students' self-efficacy levels and students' confidence in computer science learning including computer programming. In addition, Schunk & Pajares (2001) have reported that learning environment with competitive focusing on grading, social comparison, and teacher behaviors brings students to have lower in their self-efficacy but involvement of learning depending on how much students perceive from environment of autonomy has higher influence on self-efficacy leading to academic achievement of students. Moreover, Hodges & Murphy (2009) have shown that students' perceptions of classroom learning environments influence on

self-efficacy which are vital to students' achievement as same as Dorman (2001) and Lorsbach & Jinks (1999) have reported with the related theme.

Second, prior experience in computer programming is one of the factors which influences on computer self-efficacy beliefs (Johnson, 2005; Ramalingam et al., 2004; Venkatesh et al., 2000; Wilfong, 2006). Experience since high school can continue to affect student's abilities on their learning courses in university (Ramalingam et al., 2004) which means that unsuccessful experience may reduce personal beliefs of computer self-efficacy (Johnson, 2005).

Third, there are widely talking about gender differences and computer self-efficacy beliefs of students. Reports from previous research have demonstrated that in male-dominated subjects such computer science females have always rating themselves with lower computer self-efficacy than males (Schunk & Pajares, 2001; Sam et al., 2005; Volman, 2001) and they often feel intimidate into discussion and uncomfortable to have fun of work with others in class because of cultural image of this field (Wilson, 2003).

All of those factors are so crucial to clarify in order to in-depth understanding how many all of them have effect on computer self-efficacy beliefs and which one are the most effective factors. Data was collected from undergraduate students in public and private universities having computer science major. Research questions are following:
1. What is the relationship between students' perceptions of classroom learning environments and computer self-efficacy beliefs?
2. What is the relationship between gender and computer self-efficacy beliefs?
3. What is the relationship between prior computer programming experience and computer self-efficacy beliefs?
4. What are the influential factors as predictors of computer self-efficacy beliefs in general computer and computer programming self-efficacy?

Methodology

Participants

549 computer science undergraduate participants from first year to last year students (66.5% males, 33.5% females) in 8 public and 3 private universities having computer science major in Thailand were randomly selected. The percentage of participants in each year were 33% of first year, 21.3% of second year, 32.6% of third year, 12.8% of fourth year, and 0.4% more than fourth year.

Instrument

There were three parts of questionnaire in this study. The first part of survey asked for students' general information such as GPA, year of study, prior computer programming experience, gender etc. The second part of questionnaire measured about students' perceptions in computer science classroom learning environments related to learner autonomy, competitive learning, involvement, and meaningfulness having 24 items. For example, "In CS class, most students are expected to compete with one other", "In CS class what you learn has relevance for you" (Koul et.al, 2012). The last part questioned about computer self-efficacy beliefs in general

computer and computer programming self-efficacy. 10 items to ask about general computer self-efficacy belief such as “I enjoy working with computers”, “I am very confident in my ability to use computers” (Papastergiou, 2008) and 6 items from Marsh (2010) for computer programming self-efficacy belief; for instance, “I learn to use different programming language easily”, “I find it easy to organize and manage my computer programs”. All items in second and third part of this questionnaire were rated by using a five-point Likert scale.

Analysis

This study would investigate the relationships among students' perceptions of classroom learning environments, gender, prior computer programming experience, and both computer self-efficacy beliefs by using Pearson’s correlation. Moreover, hierarchical regression analysis would be used to find the significant and influential predictors of the above mentioned factors toward general computer and computer programming self-efficacy beliefs.

Result

Results from this study showed in Table 1 and Table 2. Pearson’s correlation was given in Table 1 that there were significant relationships between all factors of classroom learning environments and both of computer self-efficacy beliefs. Meaningful learning was highly positive association to general computer self-efficacy (r = .37, ρ < 0.01) and learner autonomy was the highest correlation to computer programming self-efficacy (r = .30, ρ < 0.01). In addition, this study also found that gender and prior programming experience significantly associated with computer self-efficacy in general computer (r = - .20, ρ < 0.01; r = .09, ρ < 0.05) and computer programming (r = - .17, ρ < 0.01; r = .15, ρ < 0.01).

Hierarchical regression analysis revealed in Table 2. There were two separate analyses for both computer self-efficacy beliefs and we used two steps of following procedure to enter factors: gender and prior programming experience were entered into the first step and then all dimensions of classroom learning environments (cooperation, competition, involvement, autonomy, and meaningfulness) were input into the second step. The findings from this method were support our second research questions that factors of classroom learning environments were significant variations to predict computer self-efficacy beliefs; meaningfulness and learning involvement positively related to general computer self-efficacy, whereas meaningful learning, learner autonomy, and competitive learning positively associated to computer programming self-efficacy. Moreover, gender and prior programming experience were additional variance. Gender was found to be significant predictor of all beliefs but prior programming experience predicted only computer programming self-efficacy.

The analysis of general computer self-efficacy in Table 2 was showed in the third step that meaningful learning environment was the most significant predictor (β = .37, ρ < 0.001) along with gender and prior experience and it’s variance of outcome was 18%. After environment of learning involvement was loaded in the fourth step, the coefficient of meaningful learning dropped to .27(ρ < 0.001) and additional variance of learning involvement was 3% (R^2 = .21, ρ < 0.001, ΔR^2 = .03, ρ < 0.001). Another significant predictor of general self-efficacy was gender (β = - .20, ρ< 0.001).

In addition, computer programming self-efficacy analysis was resulted in the same table. In the third step, learner autonomy was found to be the most significant predictor (β = .28, ρ = 0.001) along with gender and prior experience and it’s

variance in outcome was 13%. When meaningfulness and competition environments were added in the fifth step, the coefficient of autonomous dropped .16 ($\rho < 0.001$). Meaningful learning was 3% and competitive learning was 2% of additional variances ($R^2 = .18$, $\rho < 0.001$, $\Delta R^2 = .02$, $\rho < 0.001$). Other significant predictors of computer programming self-efficacy were gender ($\beta = -.14$, $\rho < 0.01$) and prior programming experience ($\beta = .10$, $\rho < 0.05$).

Table 1: *Interrelationships among perceptions of classroom learning environments, prior programming experience, gender, and computer self-efficacy beliefs* (*n*=549)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	***M***	***SD***
1. Gender		-.02	.01	-.14**	.01	-.02	-.01	-.20**	-.17**	1.34	.47
2. Prior programming experience			.04	.08	.04	.11*	.11**	.09*	.15**	2.33	1.01
3. Cooperative learning				.11*	.53**	.37**	.40**	.22**	.10*	3.91	.59
4. Competitive learning					.07	.25**	.03	.12**	.20**	3.05	.75
5.Learning involvement						.45**	.48**	.33**	.19**	3.88	.55
6. Learner autonomy							.40**	.25**	.30**	2.95	.51
7. Meaningful learning								.37**	.29**	3.99	.64
8. General computer self-efficacy									.42**	3.88	.72
9. Computer programming self-efficacy										3.17	.74

* $\rho < 0.05$, ** $\rho < 0.01$.

Table 2: *Hierarchical regression analysis for perceptions of classroom learning environments, prior programming experience, and gender predicting students' computer self-efficacy beliefs (n=549)*

Dependent Variables	**Independent Variables**	**β Step 1**	**β Step 2**	**β Step 3**	**β Step 4**	**β Step 5**
General computer self-efficacy	Gender	-.20***	-.20***	-.19***	-.20***	
	Prior programming experience		.09*	.05	.05	
	Meaningful learning			.37***	.27***	
	Learning involvement				.20***	
	R^2	.04***	.05*	.18***	.21***	
	Change in R^2		.01*	.13***	.03***	
Computer programming self-efficacy	Gender	-.17***	-.16***	-.16***	-.16***	-.14**
	Prior programming experience		.15***	.12**	.11**	.10*
	Learner autonomy			.28***	.20***	.16***
	Meaningful learning				.20***	.21***
	Competitive learning					.14**
	R^2	.03***	.05***	.13***	.16***	.18**
	Change in R^2		.02***	.08***	.03***	.02**

* $\rho < 0.05$, ** $\rho < 0.01$, *** $\rho < 0.001$.

Discussion

The results of this study contributed to understanding of the factors that affected to students' beliefs of computer self-efficacy from differential perceptions of classroom environment dimensions, gender, and prior programming experience. For computer self-efficacy beliefs, general computer self-efficacy was predicted by meaningfulness and learning involvement and computer programming self-efficacy was predicted by autonomy, meaningfulness, and competition. These findings can suggest how to arrange the proper classroom environments of each computer science course (e.g. general computer or computer programming). Moreover, these results were also supported by the findings from Schunk & Pajares (2001) that involvement and autonomy of classroom environments influence on students' level of self-efficacy and classroom with meaningful learning also helps students to maintain positive efficacy (Pajares & Urdan, 2006). Although, this study found that competitive environment predicted computer programming self-efficacy. In non-social science classrooms have had higher in competition and lower affiliation than social science classrooms (Koul et al., 2012). According to some previous studies, there were certain aspects of competitive advantages. For example, competitive with peer pressure was beneficial to develop programming skills by more practicing and peer interaction (e.g. promoting students' effort from programming contest, programming showcase). As a result, students well performed in computer programming such as deeper understanding in programming logic course (Ribeiro et al., 2009), more motivation of active learners (Regueras et al., 2011) leading to students' higher levels of self-efficacy beliefs (Law et al., 2010).

Moreover, the current study also found that there are gender differences in both of computer self-efficacy beliefs. Male students had higher levels of general computer self-efficacy (x=3.98) and computer programming self-efficacy beliefs (x=3.25) than females. These findings were consistent with prior studies that males have had higher in computer self-efficacy beliefs than females (Durndell et al., 2000; Durndell & Haag, 2002; Galpin et al., 2003; Lopez et al., 2006; Rosson et al., 2011) because females have still believed and rated themselves lower self-efficacy than males especially for male domains such a computer science (Schunk & Pajares, 2001; Volman, 2001). Although, females always completed their studies before males had done (Ilias & Kordaki, 2006). Some studies have suggested that computer science classroom environments are very difficult for females to success in this major than males (Howell, 1993). Therefore, setting computer science classroom environments with balance in gender are very importance for undergraduate students to success in this major (Marsh, 2010) and to lead students to have more class interaction, more opportunities for practice, more performance feedback (Fensham et al., 1986; Schunk & Lilly, 1984; Schunk & Pajares, 2001).

Furthermore, prior programming experience influenced on computer programming self-efficacy consistent with previous studies findings (Johnson, 2005; Ramalingam et al., 2004; Venkatesh et al., 2000). Programming experience helps students to have more opportunities to success in computer science program and do well in class; for instance, better in design and problem analysis, good practice and feedback, and problems solving and project management abilities etc. (Beaubouef & McDowell, 2008). Thus, encouraging students to have programming experience since high school

is beneficial to push students to have higher beliefs in their programming abilities. As a result, students have more confident to solve complex programming tasks which benefits for students to persist in computer science, to have higher in computer self-efficacy beliefs (Hasan, 2003; Ramalingam et al., 2004), and to reach for academic achievement and outcomes (Barbeite & Weiss, 2004; Durndell et al., 2000; Durndell & Haag, 2002; Kinnunen & Simon, 2011; Sam et al., 2005; Wilson & Shrock, 2001; Zingaro, 2014).

Conclusion and limitations

In conclusion, this study support previous research studies that classroom learning environments are crucial factors to determine students' self-efficacy beliefs (Koul et al., 2012) along with gender and prior programming experience (Durndell et al., 2000; Johnson, 2005). However, there are some limitations of this study. First, the sample only focused on undergraduate students in Thailand such that for future research should include high school students and cross-culture study. Second, career aspirations of computer science major did not mention in this paper. Third, qualitative research with interviewing method should be applied in order to get deeper understanding of students.

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