Exploring the Roles of Gender and Persistence on Self-Efficacy at Undergraduates in Computing

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Abstract. The aim of the study was to examine the effects of gender and persistence on learning self-efficacy, C programming self-efficacy, and computer self-efficacy. Survey data were collected from three groups of participants: (1) high persisters, (2) low persisters, and (3) non-persisters. High and low persisters have completed a minimum of two years of study in computing. High persisters would like to continue pursuing computing as their future career whereas low persisters considered not pursuing computing in their future. Non-persisters were those who have switched to another major from computing major. Findings showed that persistence had a significant effect on learning self-efficacy, C programming self-efficacy, and computer self-efficacy; however, gender exhibited no effect on self-efficacy believes.

Keywords: Self-Efficacy, Gender, Persistence, Computer Science Education

1. Introduction

Psychologists and computer science educators have concerned with gender inequality in computer science [1]. Camp used the term "Shinking Pipeline" to describe the phenomenon that the proportion of women has been declined from enrolling in computer science program, to completing computer science program, to aspiring to graduate degree in computer science, and even to pursue professional practice in the field of computer science [2]. Several researchers have found that the attrition rate of college women majoring in computer science has been higher than men [3, 4, 5, 6]. That is, women's persistence in computer science has been lower.

Researchers who examined gender differences on academic performance found no significant difference on academic performance between male and female students [7, 8]. Some studies have indicated that female students in computer science have performed better than male students [9]. However, female students have perceived lower ability and academic achievement than male students [8, 10, 11]. Hackett indicated women are unlikely to persist in the male dominated filed when they had lower self-efficacy [12]. Moreover, Galpin have suggested perceived self-efficacy of women may provide valuable insight for understanding the underrepresentation of women in computer science [13].

Self-efficacy is a component of Bandura's social cognitive theory. According to Bandura [14], perceived self-efficacy refers to "people's judgment of their capabilities to organize and execute courses of action required attaining designated types of performances" (p.391). Self-efficacy represents individuals' judgments about what they believe and expect that they can accomplish in a given situation rather than their actual ability or skills. Perceived self-efficacy can be influenced by four major sources of information: 1) mastery experiences, 2) vicarious experiences, 3) social persuasion, and 4) physiological states [15].

Perceived self-efficacy has been demonstrated to affect several aspects of human actions, such as choice of activities, effort, persistence, thought patterns, and emotional reactions [15, 16]. According to Schunk [17], self-efficacy influences behavior and motivation for academic achievement as well. For example, students with high self-efficacy to achieve a task are more likely to engage a task enthusiastically than those with low self-efficacy, who may try to avoid the task altogether. Individuals who perceive high self-efficacy put forth more effort and persist longer when they confront obstacles than those who perceive low self-efficacy. People who feel inefficacious might overestimate the degree of difficulty in tasks.

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Considerable research has focused on the influence of self-efficacy on academic behaviours in traditional academic settings, such as one's choices about what activities to engage [18], choices about what careers to pursue [19], persistence of the individual upon encountering difficulties [19], and performance [20, 21].

2. Purpose of Study

The study aims to investigate efficacy for learning, computer programming self-efficacy and computer self-efficacy of undergraduate women and men with high persistence, low persistence, and non persistence in computing.

3. Method

3.1. Participants

A total of 1132 undergraduates who majored in computer science in Taiwan were recruited across twenty second universities. These universities selected for the study taught C programming language in their computer science required courses. According to persistence level, participants further were classified as high presisters, low presisters and non- presisters. High and low presisters have completed a minimum of two years of study in computer science. High presisters would like to continue pursuing computing as their future career whereas low persisters have considered not pursuing computing in their future. Non-persisters were those who have changed their majors to other fields after entry. Individual instructors of computer science required courses for junior students in each participating university were contacted for granting permission for scheduling the dates and time to administer the questionnaire to those computer science majors during break time of courses. Relatively, major-change undergraduates were sought by using a snowball sampling technique and lists of acceptance of change of major announced by universities and later were personally invited to participate in the study via email, social networking sites, or phone. All participants received incentives in the form of cash for participating in the study.

3.2. Measures

Three scales were administered to measure self-efficacy for learning, computer self-efficacy and C programming self-efficacy. All items on the questionnaires are rated on 6 point Likert scales (1 = strongly disagree to 6 = strongly agree). The self-efficacy for learning scale consisting of eight items was modified from the Motivated Strategies for Learning Questionnaire (MSLQ) [22]. The Alpha coefficients for the self-efficacy scale of the MSLQ are 0.93 [23]. The computer self-efficacy scale consisting of ten items was developed by Compeau and Higgins [24]. The Alpha coefficients for the computer self-efficacy scale are 0.95. The

C programming self-efficacy scale with eighteen items was developed from the computer programming self-efficacy scale of Ramalingam and Weidenbeck and was asked participants to rate their self-efficacy in performing specified C programming related tasks [25]. The original scale overall reliability of the self-efficacy scores for their C++ scale was 0.98. In addition, persistence was measure by a survey item that asked those computer science majors to report whether they planned to pursue their career in computer science after their graduation. Based on the responses to the item, respondents were characterized as "high presisters" or "low presisters".

4. Results

38 cases that could not make a decision for their future career plan and 57 cases with missing values were excluded from the analysis. The rest of data were screened for univariate outliers defined as standardized scores in excess of 3.29. 45 cases with univaraite outlier were found and were deleted. As a result, the dataset comprised 994 cases for the final data analysis. Among 994 students, 190 (19.1%) were female and 804(80.9%) were male. Moreover, 864 (86.9%) were high presisters, 107 (10.8%) were low presissters and 23 (2.3%) were non-presisters.

The internal consistency of the three scales varied from 0.87 to 0.97. The reliability coefficients satisfied the criteria of reliability, where Cronbach's alpha values were either close to or over .70, and thus indicated

good internal consistency. Descriptive statistics for the persistence and gender on self-efficacy for learning C programming self-efficacy, and computer self-efficacy are presented in Table 1.

Table 1: Mean and Deviation for all the variables and reliability

	Female			Male		
Variables	High Presisters (n=157)	Low Presisters (n=27)	Non Presisters (n=6)	High Presisters (n=707)	Low Presisters (n=80)	Non Presisters (n=17)
Self-efficacy for learning						
M	3.76	3.41	3.25	3.82	3.51	3.67
SD	0.72	0.79	0.83	0.67	0.74	0.99
Reliability	0.94	0.95	0.97	0.95	0.95	0.87
C programming self-efficacy						
M	4.44	4.18	3.67	4.50	4.06	4.08
SD	0.65	0.74	0.88	0.70	0.79	0.61
Reliability	0.93	0.94	0.96	0.93	0.91	0.91
Computer self-efficacy						
M	4.53	4.37	4.47	4.58	4.30	4.95
SD	0.69	0.80	0.86	0.70	0.65	0.68
Reliability	092	0.88	0.93	0.88	0.89	0.91

Separate two-way ANOVAs were performed to compare groups on self-efficacy for learning, C programming self-efficacy, and computer self-efficacy and the Tukey test was used for post hoc comparisons. The analyses show that the main effects for persistence on self-efficacy for learning, C programming self-efficacy and computer self-efficacy are all significant, $F(2, 988) = 9.43$, $p < 0.00$, $F(2, 988) = 4.02$, $p < 0.05$, and $F(2, 988) = 14.22$, $p < 0.00$, respectively.

Pairwise comparisons, adjusted for multiple comparisons using the Tukey test, showed that the mean score of learning self-efficacy for high persistence group (*M = 3.81, SD = 0.68*) were significantly higher than that for low persistence group (*M = 3.48, SD = 0.75*), but not for non-persistence group (*M = 3.55, SD = 0.95*).

Moreover, the mean score of C programming self-efficacy for high persistence group (*M = 4.50, SD = 0.69*) were significantly higher than that for low persistence group (*M = 4.09, SD = 0.78*) and that for non-persistence group (*M = 3.97, SD = 0.70*).

In addition, the mean score of computer self-efficacy for non-persistence group (*M = 4.83, SD = 0.74*) was significantly higher than that for high persistence group (*M = 4.57, SD = 0.70*) and that for low persistence group (*M = 4.32, SD = 0.69*). The mean score of computer self-efficacy for high persistence group was significantly higher than that for low persistence group.

However, the analysis revealed that the results of the main effects for gender variable failed to achieve statistically significant differences on self-efficacy for learning [$F(1, 988) = 2.42$, $p = 0.12$], C programming self-efficacy[$F(1, 988) = 0.90$, $p = 0.34$], and computer self-efficacy [$F(1, 988) = 1.547$, $p = 0.214$]. Moreover, there are no significant interact effects between gender and persistence on three outcome variables.

5. Discussions

The study aimed to investigate self-efficacy for learning, C programming and computer among female and male undergraduate students with high-, low, non- level of persistence in computing. Findings suggested that students persisting in computer science perceived self-efficacy for leaning and C programming self-efficacy higher than those who had planned to drop out of the computer science pipeline and had switched out of the majors. Moreover, students who had switched out of the majors perceived higher computer self-efficacy than those persisting in computer science and those who had planned to drop out of the computer science pipeline. However, the study did not find any gender difference on self-efficacy believes.

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