Factors influencing pre-service science teachers' perception of computer self-efficacy[1]

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Received 30 Nov., 2006
Revised 26 Jun., 2007

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Abstract

This study examined the factors influencing pre-service teachers' perceptions of computers' self- efficacy. Participants in the study were 305 pre-service science teachers at a four-year public university in Turkey. Two instruments were used for this study: the Turkish version of the Microcomputer Utilization in Teaching Efficacy Beliefs Instrument in a Science Setting (MUTEBI) and a questionnaire for collecting demographic information. A multiple regression analysis was conducted to examine the degree of association between the outcome variables (perception of personal self-efficacy in teaching with computers; perceptions of outcome expectancy) and the

[1] This paper was presented at the 12th Symposium of the International Organization for Science and Technology Education (IOSTE) (30th July - 4th August 2006, Penang, Malaysia)

explanatory variables (personal use of computers, educational use of computers, level of computer use, grade level, school year, number of computer-related courses taken, age and gender). The findings of this study reveal that level of computer use and educational use of computers are closely related to the outcome measure of pre-service science teachers' personal self- efficacy in teaching with computers. Such findings can help researchers, teacher educators and education programs in assisting pre-service teachers to develop their personal efficacy and their outcome expectancies.

Introduction

The use of educational technology in teaching and learning has been a focus for many national organizations, major state curriculum development projects and educational policy reports. Various resources have been dedicated to the infusion of educational technology into science and other K through 12 curricula. Limited access to computers may no longer be a significant factor in teachers' computer use (Mitchell, 2000). Although teachers recognize the importance of integrating technology into their curricula, various kinds of barriers block their implementation efforts (Ertmer, 1999). A review of the literature pinpoints significant factors influencing teachers' use of computers, such as computer self-efficacy, computer experience, computer access, age and gender. This study investigates the computer self-efficacy of pre-service science teachers and factors influencing their perceptions of computer self-efficacy.

Self-efficacy in teaching with computers

Self-efficacy can be described as belief in one's ability to perform a particular behavior. The theory of self-efficacy was developed by Bandura (1977; 1986; 1997). Computer self-efficacy represents

> an individual's perceptions of his or her ability to use computers in the accomplishment of a task (e.g. using a software package for data analysis, writing a mail merge letter using a word processor), rather than reflecting simple component skills (e.g. formatting diskettes, booting up a computer, using specific software features such as 'bolding text' or 'changing margins') (Compeau & Higgins, 1995, p. 191).

Self-efficacy regarding computers refers therefore to a person's perceptions of and capabilities for applying computer technology (Compeau & Higgins, 1995). Bandura's theory of self-efficacy provides a basis for understanding the behavior of individuals with regard to their acceptance or rejection of technology (Olivier & Shapiro, 1993). An individual's feeling about a previous experience can affect beliefs about future performance. For this reason, individuals who perceive themselves as effective computer users predict positive computer experiences in the future. Individuals who perceive themselves as ineffective computer users, however, anticipate negative computer experiences in the future (Olivier & Shapiro, 1993).

The use of computer technology by teachers can be linked to teachers' self-efficacy beliefs. For instance, Compeau and Higgins (1995) examined the factors that affect an individual's use of technology. They found that participants with higher self-efficacy beliefs used computers more often and experienced less computer-related anxiety. According to Bandura (1977), an individual's sense of expectations based on personal mastery affects both initiation and persistence in performing that behavior, and plays an important role in completion of a task or behavior. For this reason, a person with high self-efficacy is more likely to persist in overcoming obstacles to reach his goal. Compeau and Higgins noted that individuals with higher self-efficacy beliefs with regard to computers see themselves as able to use computer technology, regardless of how difficult or challenging the task is. On the other hand, individuals who have lower self-efficacy beliefs about computers become more frustrated and more anxious working with computers and hesitate to use computers when they encounter obstacles.

Olivier and Shapiro (1993) remarked that it is crucial to study teachers' self-perceptions and behavior in studying the implementation and use of computer technology. Researchers found that self-efficacy is correlated to computer use (Compeau & Higgins, 1995; Compeau, Higgins, & Huff, 1999; Hasan, 2003; Marakas, Yi & Johnson, 1998; Potosky, 2002). Literature on factors influencing pre-service science teachers' perceptions of computer self-efficacy is, however, limited.

Computer Experience

Computer experience has also been associated with determining personal and educational use of computers. Hill, Smith and Mann (1987) found a significant positive correlation between previous computer experience and computer self-efficacy beliefs in a sample of 133 female undergraduates. They found that experience only

influenced behavioral intentions to use computers indirectly through self-efficacy. Thus, positive past experience with computers will increase self-efficacy beliefs. Ertmer et al (1994) found that although positive computer experience increased computer self-efficacy, the actual amount of experience (i.e. time on task) had no correlation to the self-efficacy beliefs of undergraduate students.

Researchers (Chen, 1986; Koohang, 1987; Simonson, Maurer, Montag-Toaradi & Whitaker, 1987) have found a positive correlation between computer knowledge, attitudes toward computers and length of computer experience. Rosen and Weil (1995) found that an individual's feelings about computers are influenced by the quality of his or her first experience with them. According to the researchers, if a teacher's first experience of introducing computers to his students causes computer anxiety and discomfort in the teaching assignment, such an experience might cause later discomfort with technology (Rosen and Weil, 1995).

Research findings revealed that teachers' feelings about computers were influenced by teachers' computer experiences. The quality of the first experience might cause computer anxiety and discomfort. Thus, there is a relationship between computer experience and pre-service teachers' attitudes toward computer and self-efficacy. In any attempt to measure pre-service science teachers' perceptions of personal self-efficacy in reaching with computers, it is necessary to consider their experiences with technology.

Research Questions:

1. Are pre-service science teachers' perceptions of personal self-efficacy in teaching with computers associated with the following explanatory variables: the outcome expectancy, personal use of computers, educational use of computers, level of computer use, grade level, number of computer-related courses taken, age and gender?

2. Are pre-service science teachers' perceptions of outcome expectancy associated with the following variables: personal self-efficacy in teaching with computers, personal use of computers, educational use of computers, level of computer use, grade level, number of computer-related courses taken, age and gender?

Participants:

Participants for this study were 305 pre-service science teachers at a four-year public university in Turkey. During a regular classroom session, participants completed a survey instrument relating to their demographic characteristics and the Microcomputer Utilization in Teaching Efficacy Beliefs Instrument in Science Setting (MUTEBİ).

Measures:

Computer self-efficacy beliefs were used as the dependent variable in this study. The MUTEBI contains two sub-scales: Personal Self-Efficacy (SE) and Outcome Expectancy (OE), which are consistent with the theoretical construct of self-efficacy (Bandura, 1986, 1997). The Personal Self-Efficacy scale evaluates "teachers' beliefs in their own ability to utilize the microcomputer for effective instruction" (p. 258).

The Outcome Expectancy items measure "teachers' beliefs with regard to teacher responsibility for students' ability or inability to utilize the microcomputer in the classroom" (p.258). The MUTEBI was derived from the Science Teaching Efficacy Beliefs Instrument, Form A (STEBI A) (Riggs & Enochs, 1990). The MUTEBI utilized a Likert scale format with response categories of: strongly agree, agree, uncertain, disagree and strongly disagree. Cronbach's alpha reliability coefficient for this study sample was 0.76 for the OE scale and 0.83 for the SE scale.

Methodology:

This study examines the following outcome variables regarding pre-service science teachers: pre-service science teachers' self-efficacy beliefs about teaching with computers and the outcome expectancy. The variables selected for analysis include pre-service science teachers' self-efficacy beliefs about teaching with computers, the outcome expectancy, personal use of computers, educational use of computers, level of computer use, grade level, number of computer-related courses taken, age and gender. Descriptive and inferential statistics were extracted from study responses. Descriptive statistics of frequency, central tendency, percentages and standard deviation were reported. Survey responses were analyzed by regression analysis procedures. Scores for outcome (dependent) variables were correlated with scores for each explanatory (independent) variable. For the statistically significant model, use of the regression coefficient and its statistical test assessed the strength of

the relationship between the outcome variables and the individual explanatory variables.

Teachers' beliefs affect their use of technology in the classroom (Ertmer, 1999; Marcinkiewicz & Grabowski, 1992). It is important to examine pre-service science teachers' beliefs to understand the reasons behind their practice of using computer technology for instructional practice. This study particularly examines pre-service science teachers' computer self-efficacy.

Sample Profile

Demographic Characteristics

The participants in this study were 305 pre-service science teachers at a four-year public institution. Table 1 provides the distribution of pre-service science teachers by gender. Females represented 66.6% (n= 203) and males represented 32.8% (n=100) of the participants. Two respondents did not report their gender. Two hundred and ninety-eight of the respondents gave information about their ages. The age of the respondents ranged from 17 to 25 years. Three hundred and two of the respondents reported information about their grade level. Table 1 provides the distribution of pre-service science teachers by grade level.

Table 1. *Participant Characteristics – Gender and Grade Level (n=305)*

Characteristics	n	Percentage (%)
Gender (n=303)		
Male	100	32.8
Female	203	66.6
Grade level (n=302)		
1 st grade level	95	31.5
2 nd grade level	74	24.5
3 rd grade level	65	21.5
4 th grade level	68	22.5

Computer Experience

As an indication of relative familiarity with computers respondents were asked to answer two questions. Table 2 provides a summary of demographic characteristics that describe pre-service science teachers' computer experience. When asked how many years they had been using computers for personal purposes, 89% of respondents reported more than 1 year of computer use. The percentage of pre-service science teachers using computers for more than 10 years was 1.7 %. Only 13.1 % of the pre-service science teachers reported more than 5 years of educational computer use.

Table 2. *Participant Characteristics – Computer Experience (n=305)*

Characteristics	**n**	**Percentage (%)**
Personal use of computers (n=305)		
0 to 1 years	32	10.4
1.1 to 5 years	150	49.3
5.1 to 10 years	112	36.7
10.1 to 12 years	5	1.7
missing	6	2
Educational use of computers (n=305)		
0 to 1 years	65	21.3
1.1 to 5 years	196	59.2
5.1 to 10 years	40	13.1
missing	4	1.3

Pre-service science teachers' responses varied when asked how much time they spent using computers in a typical week. Responses ranged from 0 to 30 hours, with a mean of 9.2 hours. Pre-service science teachers also responded to the question: In your use of computers, do you consider your self a non-user, novice, user, good user or expert? Table 3 provides a distribution of pre-service science teachers by computer use.

Table 3. *Participant Characteristics – Computer Use (n=92)*

Characteristics	n	Percentage (%)
Computers use (n=90)		
non-user	4	1.3
novice	72	23.6
user	159	52.1
good user	59	19.3
expert	10	3.3

Computer access

The survey instrument asked for information about pre-service science teachers' access to a computer in their home, in the department, in the computer lab at school and in the library center/media center and dormitory. Out of all the respondents 89 (97.8%) had access to computers in their home/dormitory, and only 5% of them did not have computers. Those who did not have a computer answered a question about where they did use computers for educational or personal purposes.

Source of computer knowledge

Pre-service science teachers indicated that they had learned how to use computers through different development activities (see Table 4). 81% of the teachers reported that they had learned how to use computers by themselves ("learned on my own"). University coursework and private vendors also provided information on how to use technology (42% and 23%, respectively). 63% indicated that friends had helped them to learn how to use technology.

Table 4. *Percentage of Pre-service Teachers Reporting How They Learned Computer Use (n=92)*

Professional Development Activities	Frequency	Percentage (%)
High school coursework (for credit)	66	22.6
University coursework (for credit)	128	42.0
Private vendors	71	23.3
Friends	192	63
Learned on my own	249	81.6

Correlation

Correlations were computed between the pre-service science teachers' computer self-efficacy, outcome expectancy, personal use of computers, educational use of computers, level of computer use, grade level, age and number of computer-related courses (see Table 5).

Computer self-efficacy and age were negatively correlated (r = - .145, p= .012). Pre-service science teachers' computer self-efficacy was also negatively correlated with grade level (r = - .261, p= .000), level of computer use (r = - .622, p= .000), educational use of computers (r = - .329, p= .000) and personal computer use (r = - .280, p= .000). Pre-service science teachers' computer self-efficacy was not correlated with outcome expectancy or number of compute- related courses. Outcome expectancy was not correlated with any of the variables at 0. 05 level of significance.

Table 5. *Pearson Product-Moment Correlation between Outcome Variables and Explanatory Variables*

	1	2	3	4	5	6	7	8
1. Computer self-efficacy	1.000	-.031	**-.280****	**-.329****	**-.622****	**-.261****	**-.145 ***	-.054
2. Outcome expectancy		1.000	.008	.027	.065	-.005	-.030	-.008
3. Personal use of computers			1.000	**.441****	**.477****	**.144***	**.119***	.002
4. Educational use of computers				1.000	**.459****	**.254****	**.160****	.082
5. Level of computer use					1.000	**.305****	**.209****	.066
6. G rade level						1.000	**.616****	**.412****
7. Age							1.000	**-.225****
8. Number of computer-related courses								1.000

Note: p< .05, p<0.01** N= 305*

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At the 0.01 level of significance, pre-service science teachers' personal computer use was correlated with: educational computer use (r = .441, p= .000) and level of computer use (r = .477, p= .000). Educational use of computers was correlated with level of computer use (r = .459, p= .000) and grade level(r = .254, p= .000).

Regression analysis

A multiple regression analysis was conducted to examine the degree of association between the outcome variables (perception of personal self-efficacy in teaching with computers; perceptions of outcome expectancy) and the explanatory variables (personal use of computers, educational use of computers, level of computer use, grade level, school year, number of computer-related courses taken, age and gender). Two regression models were tested to investigate the influence of explanatory variables on each of the outcome variables. Analyses were performed by use of SPSS REGRESSION. Results of the evaluation of the assumption for linear regression analysis led to deletion of the variable "school year" to reduce the multicollinearity. Twenty-seven cases with missing data were deleted from the regression analysis, n=278 for each analysis.

The first regression model consisted of eight explanatory variables and the outcome variable "perceptions of outcome expectancy". Results showed that R^2 was not statistically significant at the 0.05 level. The second regression model consisted of eight explanatory variables and the outcome variable "perception of personal self-efficacy in teaching with computers". Results showed that R^2 was statistically significant, F (8, 278) =23,844, p = .000. This model indicates that the explanatory variables are jointly associated with 41% of the pre-service science teachers' perception of personal self-efficacy in teaching with computers.

The regression formula for the second research question is as follows:

$$Y = \alpha + ß_1X_1 + ß_2X_2 + ß_3X_3 + ß_4X_4 + ß_5X_5 + ß_6X_6 + ß_7X_7 + ß_8X_8 + ß_9X_9 + \varepsilon$$

When the eight explanatory variables are placed in the regression model, the following formula results:

> Perception of personal self-efficacy in teaching with computers = α (constant) + $ß_1$*(outcome expectancy) + $ß_2$*(personal use of computers) + $ß_3$*(educational use of computers) + $ß_4$*(level of computer use) + $ß_5$*(grade level) + $ß_6$*(number of computer- related courses taken) + $ß_7$*(age) + $ß_8$*(gender) + ε (error).

Table 6 shows the unstandardized regression coefficient (b), the standardized regression coefficient (ß), and the observed t-values (t). Two of the eight variables

were statistically significant at 0.05 levels: educational use of computers and the level of computer use.

Table 6 indicates that level of computer use and educational use of computers are highly related to the outcome measure of pre-service science teachers' personal self-efficacy in teaching with computers ($p < .000$, and $p < .006$ respectively). In this regression equation, no other variable was significant at the $p < .05$ level. This observation is interpreted to mean that as the perception of pre-service science teachers' level of computer use decreased, it is likely that personal self-efficacy in teaching with computers increased.

The final regression equation, built from information in the Table 6, is as below:

Perception of personal self-efficacy in teaching with computers = 49.797 + (1.561E-03)*(outcome expectancy) + 0.416*(personal use of computers) + (-0.856)*(educational use of computers) + (-6.539)*(level of computer use) + (-1.034)*(grade level) + 0.605*(number of computer-related courses taken) + 0.402*(age) + (-0.427)*(gender) + ε (error).

Table 6. *Regression Analysis Summary for Pre-service Science Teachers' Personal Self-efficacy in Teaching with Computers*

Variable	*b*	*β*	*t* values	*p* -values
(Constant)	49.797		6.497	.000*
Outcome Expectancy	1.561E-03	.001	.016	.987
Personal use of computers	.416	.122	1.961	.051
Educational use of computers	-.856	-.179	-2.777	.006*
Level of computer use	-6.539	-.573	-10.172	.000*
Grade level	-1.034	-.133	-1.487	.138
Age	.402	.088	1.058	.291
Gender	-.427	-.027	-.473	.637
Numbers of computer- related courses	.605	.096	1.366	.173

Note: $R^2 = .407$ ($n = 278$, $p = .000$)
*$p < .05$.

Educational significance of the study

With the support of educational funding from the European Union, most of the high schools provide computers for their students. This study revealed that younger students have higher computer self-efficacy. This difference could be the result of their experience during high school study.

In an effort to inform teachers' education practice in Turkey, this study provides insight into pre-service elementary science teachers' efficacy beliefs. Research findings can help researchers, teacher educators and education programs in assisting pre-service teachers to build their personal efficacy and their outcome expectancies. Programs in education faculties should be restructured to give enough opportunities to their pre-service teachers to improve their personal efficacy and outcome expectation in the use of technology. Education programs should provide a learning environment for pre-service science teachers in how to use new technologies as part of their instruction. It is obvious that some of the pre-service science teachers are frightened to use technology for their own purposes. If they have problems in using technology for themselves, how can we expect them to use new technologies in the classroom? Learning new technologies with other pre-service science teachers might create a learning environment in which they can support and encourage each other. With the encouragement of other new learners, they may feel comfortable in using technologies in their teaching practice in the future.

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