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PHYSICS ANXIETY OF PRE-SERVICE TEACHERS AND THEIR SELF-EFFICACY BELIEFS: DIFFERENCES ACCORDING TO GENDER AND PHYSICS ACHIEVEMENT

Serap Çalışkan

Abstract. *The aim of this research is to determine the predictive level of physics self-efficacy with regard to physics anxiety and the correlations between the physics anxiety and self-efficacy of pre-service teachers, also to examine whether physics anxiety and self-efficacy beliefs differ depending on pre-service teachers' achievement in physics and their gender. The research was conducted with 344 pre-service teachers enrolled at a state university in Turkey. The data obtained were analyzed using means (M), standard deviation (SD), simple regression analysis, the one-way multivariate analysis of variance (one-way MANOVA) and as a follow-up test, the univariate analysis of variance (univariate ANOVA). The outcome of the research indicating the physics anxiety of the pre-service teachers was a significant predictor of their physics self-efficacy, significant differences between physics anxiety and self-efficacy depending upon the level of achievement in the physics course, also showing that in general, female pre-service teachers had significantly higher levels of anxiety compared to males and that with respect to self-efficacy, differences were in favor of male pre-service teachers only in the dimension of problem-solving in physics.*

Keywords: *physics anxiety, physics self-efficacy, pre-service teachers' gender, physics achievement.*

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Introduction

Importance of affective dimension in teaching and learning process is obvious. In this case, while learning can be affected by emotions and feelings, emotions and feelings are also impacted by learning (Alsop &Watts, 2000). It is often said that learning and performance are associated with positive feelings (Jerusalem & Pekrun, 1999). In this context, emotional factors and success are inseparably dependent upon each other and ultimately, those who are interested in the cognitive achievement of their students must also take emotional factors into consideration (Güngör, Eryılmaz & Fakıoğlu, 2007). Although cognitive skills are important determinants of student achievement, in recent years affective variables have earned recognition as being striking factors that have an impact on perseverance and achievement in the areas of mathematics and science (Singh, Granville & Dika, 2002). Among the prominent affective variables defined in the literature can be cited students' academic self-concepts, attitudes, confidence, anxiety, motivation, self-esteem and locus of control (Higbee & Thomas, 1999). Similarly, in a study conducted by Güngör, Eryılmaz and Fakıoğlu (2007), the researchers relate that the affective variables that are suggested in studies on science and mathematics education as being the factors that are commonly employed and may have a correlation with physics learning and physics achievement are attitudes toward physics (the interest in and importance placed on physics), student motivation in the physics class (student motivation), achievement motivation in physics class (achievement motivation), physics anxiety (anxiety about the physics course and physics exams), physics self-efficacy, physics self-concept (self-concept) and the locus of control in physics (locus of control). At the same time, it is possible to find literature on affective factors in the areas of science and mathematics but this type of study relating to physics education is very few (Güngör et al., 2007). This is despite the fact that there are many powerful stories of how many students find physics to be tasteless, boring

and stuffy (Alsop & Watts, 2000). In this sense, the importance of conducting research on examining the relationship between learning physics and principal affective variables such as interest, love, placing importance, self-efficacy, motivation and anxiety is very clear. Also, such research conducted with pre-service teachers may have a separate significance for the teachers of tomorrow. This is because emotional growth is a developmental requirement for teachers and is one of the key characteristics of effective teaching (Senler, 2016). In the light of this, physics anxiety and physics self-efficacy affective variables were chosen in this research.

Anxiety and Physics Education

The term "anxiety" has existed for more than a century. Furthermore, the concept of "science anxiety" was invented by Mallow in 1977 at Loyola University Chicago. The first Science Anxiety Clinic was founded at Loyola University Chicago. Science anxiety has been defined as a widespread or indeterminate phobia in the science learning setting (Mallow, 1978). The choices students make about the courses they take at the university or in their future careers is generally related to how comfortable they feel in dealing with certain topics. Because of the phenomenon that is well-known today as science anxiety, it is not rare for students to shy away from science courses or perform poorly in their science studies (Udo, Ramsey & Mallow, 2004). Chiarelott and Czerniak (1987) conducted a study with schoolchildren of the ages 9-14 in which they reported that science anxiety is associated with science achievement, a high level of anxiety leads to low achievement in science, and girls have a higher level of science anxiety than boys. It was also set forth that chi-square analysis showed that the higher level of science anxiety found in girls in previous studies by Mallow (1994) and Udo, Ramsey, Reynolds-Alper & Mallow (2001) displayed even greater differences. Like other negative emotions, anxiety is not only related to the concept of learning physics but is the product of messages such as, "If I don't pass this physics course, I will never be able to graduate" that generate anxiety and lower performance in the physics class (Mallow & Greenburg, 1983). Complaints of students about physics anxiety and low academic performance in physics class are frequently heard and it is known that situations that suggest failure stimulate reactions of anxiety. In this context, the student who is confronted with a threatening situation while studying for physics class may rightly feel anxious or uncomfortable. Also, the lack of interest students with physics anxiety show towards the class may play an obstructive role and lead to low achievement and to barriers such as thoughts of abandoning related career plans (Şahin, 2014). It is thus obvious how important students' anxiety levels are in terms of their physics courses. At the same time, while there are numerous studies in the literature on anxiety concerning science and mathematics (Akman, İzgi, Bağçe, & Akıllı, 2007; Akgün, Gönen, & Aydın, 2007; Beilock, Gunderson, Ramirez, & Levine, 2010; Brownlow, Jacobi, & Rogers, 2000; Chiarelott & Czerniak, 1987; Czerniak & Chiarelott, 1985; Ho, Şentürk, Lam, Zimmer, Hong, Okamoto, Chiu, Nakazawa, & Wang, 2000; Kuan & Tek, 2007; Mallow, 1994; Sharon & Corenna, 1990; Udo, Ramsey, & Mallow, 2004; Yüksel & Geban, 2016; Uluçınar Sağır, 2012; Uysal & Dede, 2016), there is also a study of note that explores whether or not physics teaching causes science anxiety depending upon gender (Udo, Ramsey, Reynolds-Alpert, & Mallow, 2001) and a study that seeks to determine the most appropriate structural equation model of the relationship between affective variables and the physics achievement of freshmen high school physics students (Güngör et al., 2007), where the 12 affective variables selected in the subscales of the affective characteristics scale include physics exam anxiety and physics course anxiety. Furthermore, there is only a negligible number of studies on the specific concept of physics anxiety in the literature (Cari, Suparmi, & Handhika, 2016; Dilek, Şahin, Güler, & Eslek, 2013; Şahin, 2014). Treating physics anxiety as a separate concept might contribute to gaining knowledge about the complex interaction between the anxiety felt towards physics and achievement (Şahin, 2014).

Self-Efficacy and Physics Education

Bandura (1977) defines the belief individuals have in their ability to take the necessary action to cope with a situation as self-efficacy belief. An individual's expectation about his/her own success or failure affects that individual's perception of self-efficacy. An individual with a high perception of self-efficacy makes more of an effort to succeed at something compared to an individual with a low perception of self-efficacy, acting with determination and perseverance. At the same time, an individual with a high perception of self-efficacy is less afraid of trying something out, of bringing something to fruition (Senemoğlu, 2005). While students with high levels of self-efficacy tend to have higher levels of achievement in a subject, those with low self-efficacy beliefs are likely to be less successful (Stipek, 1998). Israel (2007) asserts that a person with a high sense of self-efficacy feels more self-confident

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and that this self-confidence is reflected in his/her behavior. A student, for example, with a high perception of self-efficacy will be an active participant in class, will take the time to study topics in physics and develop various learning strategies. In this context, the most important factor that impacts academic achievement is the level of self-efficacy (Tezer & Aşıksoy, 2015). Self-efficacy is a powerful predictor variable of achievement (Lane, Lane, & Kyprianou, 2004; Schunk, 1991). According to Shaw, students in a class as well as the teacher coming into that class bring along with them not only their prior thoughts about physics but also their prior thoughts on their ability to be successful in the physics class (Shaw, 2004). In the light of this, the thoughts of students and teachers about their own abilities point to their self-efficacy beliefs and in this sense, self-efficacy becomes an important variable in physics teaching, and a topic that has produced an increasing number of studies in the literature on physics and self-efficacy in recent years (Borrachero, Brigido, Costillo, Bermejo, & Mellado, 2013; Çalışkan, Selçuk, & Özcan, 2010; Fencl & Scheel, 2004; Maskan, 2010; Nissen & Shemwell, 2016; Selçuk, Çalışkan, & Erol, 2008; Tanel, 2013; Tezer & Aşıksoy, 2015; Yener, Aydın, & Köklü, 2012; Yerdelen & Peşman, 2013). For example, in a study that examines the variables of the present study in terms of the relationship between the physics self-efficacy of pre-service teachers and gender and achievement, many significant differences were found in favor of male pre-service teachers and pre-service teachers with high perceptions of achievement (Selçuk, Çalışkan, & Erol, 2008).

In the light of this information, the limitation in the literature is that these variables (anxiety, self-efficacy, course achievement and gender) have not previously been examined together with respect to the physics course.

Aim of Research

The research was carried out to examine the predictive level of physics self-efficacy with regard to physics anxiety and the correlations between these variables among pre-service teachers, and whether or not the physics anxiety and self-efficacy beliefs of pre-service teachers displayed any differences in terms of achievement in the physics course or depending upon gender. The research questions examined in the research were:

1) What is the predictive level of physics self-efficacy with regard to physics anxiety of pre-service teachers? 2) What is the correlations between physics anxiety and self-efficacy? 3) Does the physics anxiety of pre-service teachers show significant differences in terms of the level of their achievement in the physics course? 4) Does the physics self-efficacy of pre-service teachers show significant differences in terms of the level of their achievement in the physics course? 5) Does the physics anxiety of pre-service teachers show significant differences in terms of their gender? 6) Does the physics self-efficacy of pre-service teachers show significant differences in terms of their gender?

Methodology of Research

General Background

The relational survey model was used in the research. This model determines the degree of covariance between two or more variables, expressing variance through symbolization using measurements or assigned values in order to analyze the relationship between the variables (Karasar, 2000, p.81). In the present research, the variables of self-efficacy and anxiety were symbolized with the help of scales in an effort to provide a representation of the interaction between these variables and academic achievement in physics and gender. The research was conducted in the Spring term of the academic year 2015-2016. The researcher collected the data over a period of approximately 3 weeks.

Research Sample

The purposeful sampling approach of criterion sampling was used in the research. In the criterion sampling approach, units to be observed may comprise persons or objects having certain determined qualities. As such, units that meet the determined sampling criteria are taken into the sample (Büyüköztürk, Çakmak, Akgün, Karadeniz, & Demirel, 2012). In this research, the sampling criterion was the enrollment of the pre-service teachers in the physics course that was a part of their department's curriculum. Data was collected from 344 of the total of 351 pre-service teachers who were taking General Physics or the course Physics II given in the first- or second-year programs during the spring term during which the research took place at the faculty of education of a state

university in Turkey, where the researcher worked as an instructor. Third- and fourth-year pre-service teachers who had taken the physics course more than 1 or 2 years ago were not included in the research.

Instruments and Procedure

The Physics Anxiety Rating Scale (PARS) and the Physics Self-Efficacy Scale (PSES) were used as data collection tools in the research. The implementation of the data collection tools took approximately 10 minutes. Both of the data collection tools contained questions at the beginning about the student's gender, the department the student was studying in, and the grade received on the last or nearest physics test. Participation was voluntary in the implementation of the scales and the pre-service teachers were asked not to write their names on the questionnaires. It was explained to the participants before they started to fill out either one of the questionnaires that the data collected would be used entirely for scientific research and they were urged to answer each question candidly.

Physics Anxiety Rating Scale (PARS)

Developed by Şahin, Çalışkan and Dilek (2015), PARS initially comprised 60 items, but in line with the recommendations of an expert (a physics educator), 10 items were removed and revisions were made in two of the items, resulting in a trial questionnaire of 50 items in the form of a 5-item Likert-type scale (from 1: I definitely do not agree to 5: I definitely agree). The scale was implemented with 495 pre-service teachers and the data obtained were analyzed for validity and reliability. To examine the factor structure of PARS, an exploratory factor analysis with Varimax rotation was carried out. Eliminating factor cross loadings and factors with loadings of less than 0.40 led to the exclusion of 18 items from the analysis. Using the factors with eigen values greater than 1 and the scree plot test, four factors were formed that included 32 items. A 4-factor model was decided on as the best factor structure for PARS. The final form of the scale has a maximum point of 160, and a minimum of 32. The higher the score, the higher the level of anxiety. Descriptions and sample items concerning PARS subscales are given in Table 1.

Table 1. Descriptions and sample items concerning PARS subscales.

Subscales	Descriptions	Sample Items
Physics course/test anxiety (C/TA)	Being anxious in physics class or when studying for a physics exam	*Among all the other courses, the course which makes me most anxious is physics. *I am usually stressed out before a physics exam.
Anxiety about lack of physics knowledge (LPKA)	Anxiety about not being able to explain physics concepts to others or about displaying physics content knowledge to others.	*Helping a primary school student with her/his physics project tenses me up. *If my instructor asked me to explain a physical event from daily life, I would be worried.
Mathematics anxiety (MA)	Anxiety about having a shortage of the mathematical knowledge that is needed to be successful in the physics course, not being able to remember the mathematical relationships between physical variables, and having to study from a physics textbook that is full of mathematical formulas.	*I worry about not being able to remember the mathematical formulas of physics laws. *When I open a physics book, seeing a page full of formulas without any explanation scares me.
Physics laboratory anxiety (PLA)	Anxiety about performing a physics experiment in the laboratory	*Explaining the findings of an experiment that I conducted in the physics lab to the instructor stresses me out. *Physics experiments make me very tense.

In Table 2, the number of items for each subscale, calculated using Cronbach's Alpha reliability coefficients, are presented.

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Table 2. Results of the reliability calculations concerning PARS.

Subscales	Number of items	Cronbach's Alpha Coefficient
C/TA	9	.92
LPKA	8	.85
MA	8	.86
PLA	7	.83
PARS	32	.95

Physics Self-Efficacy Scale (PSES)

The PSES was developed by the researcher (Çalışkan, 2007) in order to determine the physics self-efficacy beliefs of pre-service teachers. This scale, containing 5-choice Likert type items with choices of "Strongly Agree", "Agree", "Undecided", "Disagree", and "Strongly Disagree," consists of a total of 24 items. To investigate the factor structure of PSES, an exploratory factor analysis with Varimax rotation was carried out. Items in the scale are grouped in 4 dimensions and explain 56.68% of total variability. The highest score that can be obtained from this scale is 120, and the lowest score is 24. Descriptions and sample items concerning PSES subscales are given in Table 3.

Table 3. Descriptions and sample items concerning PSES subscales.

Subscales	Descriptions	Sample Items
Problem solving self-efficacy belief (PSSEB)	Self-judgments about how successful the individual can be in solving physics problems.	"I have every confidence that I can ultimately solve a physics problem, no matter how hard it may be." "I am certain that I can come up with the needed formulas to solve a physics problem."
Self-efficacy belief towards achievement (SEBTA)	Self-judgments about how successful the individual can be in the physics class.	"I believe that I can get a 70 or better in the physics tests." "I don't believe that I can be successful in physics class."
Self-efficacy belief in applying physics knowledge (SEBAPK)	Self-judgments about how successful the individual can be in applying physics knowledge to different situations.	"I am sure I can write up a simple problem about a subject I've learned in physics." "I believe I can effectively explain something I've learned in physics class to my friend."
Self-efficacy belief in recalling physics knowledge (SEBRPK)	Self-judgments about how successful the individual can be in remembering physics knowledge when it is needed.	"I believe I can remember the important formulas I learned in physics when I need to." "I believe I can remember the basic knowledge I gained in physics class when I need to."

In Table 4, the number of items for each subscale, calculated using Cronbach's Alpha reliability coefficients, are presented.

Table 4. Results of the reliability calculations concerning PSES.

Subscales	Number of items	Cronbach's Alpha Coefficient
PSSEB	10	.91
SEBTA	5	.84
SEBAPK	6	.76
SEBRPK	3	.70
PSES	24	.94

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Data Analysis

In the event that the ANOVA results were significant, the post-hoc multiple comparison Bonferonni test was used to find out which group the difference stemmed from. The independent variables in the study were the level of achievement in physics and gender; the dependent variables were physics anxiety (C/TA, LPKA, MA, PLA) and physics self-efficacy (PSSEB, SEBTA, SEBAPK, SEBRPK), and the control variable was the department the pre-service teachers were studying in. Before examining each independent variable's effect on the dependent variables, the MANOVA hypotheses were tested. It was found that the scores related to the dependent variables showed univariate and multivariate normal distribution. For each dependent variable, the assumption of homogeneity of variance was tested with Levene's test and Box's M test was employed to determine homogeneity in variance-covariance matrices. The effect size of the independent variables on the dependent variable scores was measured with the partial eta-squared statistic (η^2). The partial eta-squared values, according to Stevens' (1992) recommendation, were taken as small for $\eta^2 \leq 0.01$, medium for $\eta^2 = 0.06$ and large for $\eta^2 = 0.14$. The analysis of the data was performed at a significance level of .05.

Results of the Research

Regression Analysis for Physics Anxiety and Self-Efficacy

To ascertain the relationship between the physics anxiety and physics self-efficacy of the pre-service teachers, one of the two variables was set up as dependent, the other as an independent variable and the relationship between them was examined using simple regression analysis and expressed as a mathematical equation. To examine the predictive level of physics self-efficacy with regard to physics anxiety, the total physics anxiety and self-efficacy scores were considered and, defining physics anxiety as the independent (X-variable) and physics self-efficacy as the dependent variable (Y-variable), whether or not the pre-service teachers' physics anxiety was a significant predictor of their physics self-efficacy was explored, and in this context, simple regression analysis was used to identify the relationship between the two variables. Before the analysis, a scatter diagram was drawn up to understand whether there was a linear relationship between physics anxiety and physics self-efficacy and, as can be seen from the figure below, it was seen that there was a linear relationship between the two variables.

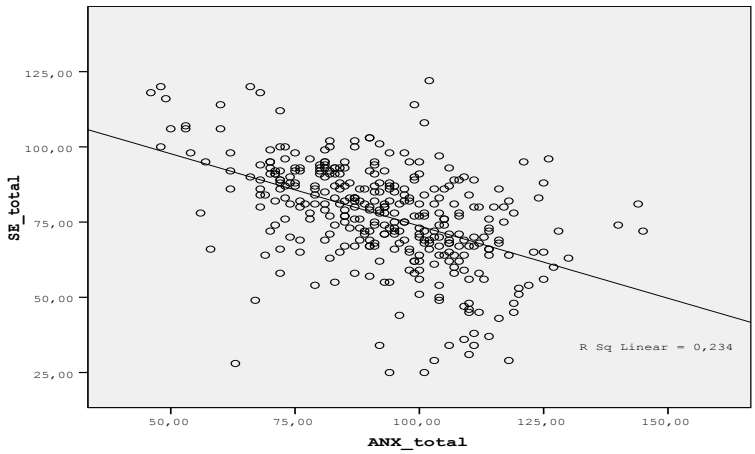

Figure 1: Scatter diagram and regression line for physics anxiety and physics self-efficacy.

After this step, linear regression analysis was performed on the physics anxiety and physics self-efficacy variables.

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Table 5. of simple regression analysis on predictability of physics self-efficacy according to physics anxiety.

Variable	B	Standard Deviation$_B$	β	t	p
Fixed	121.722	4.416	-	27.565	.0001*
Physics Anxiety	-.480	.047	-.484	-10.227	.0001*
R=.484, R^2=.234					
$F_{(1,342)}$=104.602 p<.001					

**p<.001*

A review of the analysis results in the table show that the physics anxiety of the pre-service teachers was a significant predictor of their physics self-efficacy (R= .484, R^2= .234, F (1,342)=104.602, p=.0001). It can be said that physics anxiety accounted for 23% of the total variance with respect to physics self-efficacy. It can also be seen from the results of the t test related to the significance of the regression coefficients that physics anxiety was a significant predictor of physics self-efficacy. The results of the regression analysis showing the regression equation or the mathematical model of predicted physics self-efficacy is given below: "Physics Self-efficacy=121.722-480 Physics Anxiety."

Correlation between Physics Anxiety and Self-Efficacy

In order to examine the sub-dimensions of the correlation between the physics anxiety and self-efficacy of the pre-service teachers, the Pearson product-moment correlation coefficients displaying the relationship between the physics anxiety and self-efficacy subscale scores were calculated. The correlation coefficients were evaluated as recommended by Büyüköztürk (2012), with absolute values of .70 - 1.00 signifying a high correlation, .70 - .30 signifying a moderate correlation and .30 - .00 signifying a low correlation.

Table 6. Level of correlation between the pre-service teachers' physics anxiety and physics self-efficacy.

	PSSEB	SEBTA	SEBAPK	SEBRPK	C/TA	LPKA	MA	PLA
PSSEB	1							
SEBTA	.812**	1						
SEBAPK	.747**	.696**	1					
SEBRPK	.767**	.683**	.672**	1				
C/TA	-.364**	-.439**	-.284**	-.264**	1			
LPKA	-.378**	-.387**	-.283**	-.316**	.522**	1		
MA	-.497**	-.514**	-.434**	-.394**	.618**	.652**	1	
PLA	-.262**	-.238**	-.191**	-.177**	.439**	.619**	.529**	1

***p<.01*

A review of the correlations of the subscales of physics anxiety and physics self-efficacy in Table 6 reveals a negative and low level of correlation in all the subscales of physics laboratory anxiety and physics self-efficacy (r< .30). However, it was found that outside of the laboratory anxiety dimension, all of the anxiety and self-efficacy scales displayed a negative, moderate and significant correlation. The highest negative and significant correlations in the table were between physics course achievement and self-efficacy with regard to solving physics problems and mathematical anxiety (r= -.514, r= -.497, p<.01, respectively).

Physics Course Achievement and Physics Anxiety

To determine the level of the pre-service teachers' physics course achievement, at the time they were filling out the questionnaire, they were asked to write down the last grade they received on the mid-term. The physics course achievement grades (PCAG) written down were classified as follows: PCAG<50: "unsuccessful" (US), 50<PCAG<70:

"mediocre" (MS) and PCAG>70: "successful" (S). An answer was sought to the question, "Does the physics anxiety of pre-service teachers show significant differences in accordance with the level of their achievement in the physics course?" Table 7 shows the descriptive statistics for PSES subscales according to the pre-service teachers' PCAG's. The mean values for the dependent variables measured in the study were compared with the one-way MANOVA, with the physics course achievement level taken as the fixed variable. It was seen that the multivariate effect was significant [Wilks' Lambda (Λ)=.813, $F(4,338)=9.238$, $p<.0001$, $\eta^2=.10$]. The differences between the variables in terms of achievement level were determined with the one-way ANOVA. The results revealed significant differences in the following dimensions: C/TA [$F(2, 341)=21.985$, $p<.0001$, $\eta^2=.11$], LPKA [$F(2, 341)=16.68$, $p<.0001$, $\eta^2=.09$], MA [$F(2, 341)=31.05$, $p<.0001$, $\eta^2=.15$] and PLA [$F(2, 341)=9.79$, $p<.0001$, $\eta^2=.05$]. While significant differences were found in all the physics anxiety scales according to physics achievement levels, when the eta squared values related to the effect of physics achievement were examined, it was seen that the effect was moderate in the course and knowledge deficiency anxiety dimension and small in the laboratory anxiety dimension, but large in the mathematics anxiety dimension.

Table 7. Descriptive statistics according to the pre-service teachers' physics anxiety PCAG.

Scale	PCAG	N	M	SD
C/TA	US	114	29.42	4.41
	MS	204	27.38	4.44
	S	26	23.46	2.93
LPKA	US	114	21.51	4.92
	MS	204	19,71	5.32
	S	26	15.15	4.85
MA	US	114	27.29	5.39
	MS	204	23.61	6.27
	S	26	17.65	6.73
PLA	US	114	20.89	4.29
	MS	204	20.47	4.42
	S	26	16.81	3.32

Differences according to physics achievement levels were examined with the Bonferroni test. The results of the Bonferroni test are presented in Table 8. According to the results of the analysis, the physics self-efficacy of the pre-service teachers who were successful in the physics course in the PSSEB, SEBTA, SEBAPK and SEBRPK dimensions was significantly higher than that of the pre-service teachers who were mediocre or unsuccessful. Similarly, it was determined that there were significant differences between the physics anxiety of the mediocre and unsuccessful pre-service teachers in the first three dimensions, that the anxiety of the mediocre pre-service teachers was significantly lower, but that there were no significant differences between the physics anxiety of the mediocre and unsuccessful pre-service teachers in the PLA dimension.

Table 8. Results of the Bonferroni test according to the physics achievement levels of pre-service teachers.

Physics Anxiety Subscales	Level of Achievement	US	MS	S
C/TA	US		.000*	.000*
	MS	.000*		.000*
	S	.000*	.000*	
LPKA	US		.009*	.000*
	MS	.009*		.000*
	S	.000*	.000*	

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Physics Anxiety Subscales	Level of Achievement	US	MS	S
MA	US		.000*	.000*
	MS	.000*		.000*
	S	.000*	.000*	
PLA	US		1.000	.000*
	MS	1.000		.000*
	S	.000*	.000*	

**p<.001*

Physics Course Achievement and Physics Self-Efficacy

An answer was sought to the question, "Does the physics self-efficacy of pre-service teachers show significant differences according to their gender?" Table 9 shows the descriptive statistics for PSES subscales according to the pre-service teachers' PCAG's. The mean values for the dependent variables measured in the study were compared with the one-way MANOVA, with the physics course achievement level taken as the fixed variable. It was seen that the multivariate effect was highly significant [Wilks' Lambda (Λ)=.548, $F(4,338)=29.678$, $p<.0001$, $\eta^2=.26$]. The differences between the variables in terms of achievement level were determined with the one-way ANOVA. A review of the results revealed that there were significant differences between the dimensions PSSEB [$F(2, 341)=94.857$, $p<.0001$, $\eta^2=.36$], SEBTA [$F(2, 341)=131.503$, $p<.0001$, $\eta^2=.43$], SEBAPK [$F(2, 341)=62.527$, $p<.0001$, $\eta^2=.27$] and SEBRPK [$F(2, 341)=54.852$, $p<.0001$, $\eta^2=.24$]. While significant differences were found in all the physics anxiety dimensions according to physics achievement levels, when the eta squared values related to the effect of physics achievement were examined, it was seen that the effect was significantly large in all the subscales.

Table 9. Descriptive Statistics according to the pre-service teachers' physics self-efficacy PCAG's.

Scale	PCAG	N	M	SD
PSSEB	US	114	24.32	6.40
	MS	204	32.38	6.05
	S	26	39.81	6.54
SEBTA	US	114	11.89	3.65
	MS	204	17.45	3.40
	S	26	21.38	2.56
SEBAPK	US	114	8.46	2.39
	MS	204	10.70	1.83
	S	26	12.42	1.92
SEBRPK	US	114	18.29	4.61
	MS	204	22.09	3.15
	S	26	25.15	3.54

Differences according to physics achievement levels were examined with the Bonferroni test. The results of the Bonferroni test are presented in Table 10. According to the results of the analysis, the physics self-efficacy of the pre-service teachers who were successful in the physics course in the PSSEB, SEBTA, SEBAPK and SEBRPK dimensions were significantly higher than the pre-service teachers who were mediocre or unsuccessful. Similarly, there were significant differences between the physics self-efficacy of the mediocre and unsuccessful pre-service teachers in all the dimensions, and it was found that the pre-service teachers with mediocre grades were significantly higher in self-efficacy than the unsuccessful pre-service teachers.

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Table 10. Results of the Bonferroni test according to the physics achievement levels of pre-service teachers.

Physics Self-Efficacy Subscales	Level of Achievement	US	MS	S
PSSEB	US		.000*	.000*
	MS	.000*		.000*
	S	.000*	.000*	
SEBTA	US		.009*	.000*
	MS	.009*		.000*
	S	.000*	.000*	
SEBAPK	US		.000*	.000*
	MS	.000*		.000*
	S	.000*	.000*	
SEBPRK	US		.000*	.000*
	MS	.000*		.000*
	S	.000*	.000*	

**p<.001*

Gender and Physics Anxiety

An answer was sought to the question, "Does the physics anxiety of pre-service teachers show significant differences according to their gender?" Table 11 shows the descriptive statistics for PARS subscales according to the pre-service teachers' gender.

Table 11. Descriptive statistics related to the pre-service teachers' physics anxiety according to their gender.

Scales	Subscales	Female (n=250)		Male (n=94)	
		M	SD	M	SD
PARS	C/TA	28.04	4.50	27.00	4.77
	LPKA	20.37	5.15	18.87	5.85
	MA	24.88	6.46	23.03	6.58
	PLA	20.87	4.19	18.92	4.70

The mean values related to physics anxiety were compared with the one-way MANOVA, with gender taken as the fixed variable. It was seen that the multivariate effect (physics anxiety) was significantly low [Wilks' Lambda (Λ)= .961, $F(4,339)=3.481$, $p= .008$, $\eta^2= .04$]. The differences between the variables according to gender were determined with the one-way ANOVA. The results showed small-sized significant effects in the following dimensions: LPKA [$F(1, 342)=5.334$, $p= .022$, $\eta^2= .02$], MA [$F(1, 342)=5.573$, $p= .019$, $\eta^2= .02$] and PLA [$F(1, 342)=13.716$, $p= .000$, $\eta^2= .04$]. Also, the anxiety scores of the female pre-service teachers were significantly higher than those of the male pre-service teachers. At the same time, in the C/TA [$F(1, 342)=3.576$, $p= .059$, $\eta^2= .01$] dimension, it was seen that there were no significant differences between the pre-service teachers in terms of gender.

Gender and Physics Self-Efficacy

An answer was sought to the question, "Does the physics self-efficacy of pre-service teachers show significant differences according to their gender?" Table 12 shows the descriptive statistics for PSES subscales according to the pre-service teachers' gender.

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Table 12. Descriptive statistics related to the pre-service teachers' physics self-efficacy according to their gender.

Scales	Subscales	Female (n=250)		Male (n=94)	
		M	SD	M	SD
PSES	PSSEB	29.73	6.99	31.71	9.25
	SEBTA	15.61	4.43	16.69	4.82
	SEBAPK	10.06	2.20	10.15	2.82
	SEBPRK	21.10	3.97	20.95	4.99

The mean values related to physics anxiety and physics self-efficacy were compared with the one-way MANOVA, with gender taken as the fixed variable. It was seen that the multivariate effect (physics self-efficacy) was significantly moderate [Wilks' Lambda (Λ)= .952, $F(4,339)=4.272$, p= .002, η^2= .05]. The differences between the variables according to gender were determined with the one-way ANOVA. An examination of the one-way ANOVA results for physics self-efficacy showed that there were significant differences in the PSSEB dimension [$F(1, 342)=4.566$, p= .033, η^2= .01] and that the male pre-service teachers had a higher level of self-efficacy than their female counterparts. An examination of the other dimensions showed that in all of the dimensions SEBTA [$F(1, 342)=3.865$, p= .050, η^2= .01]; SEBAPK [$F(1, 342)$= .087, p= .769, η^2= .00] and SEBPRK [$F(1, 342)$= .080, p= .777, η^2= .00], the physics self-efficacy of the female pre-service teachers did not display significant differences according to gender.

Discussion

The research was carried out to examine the predictive level of physics self-efficacy with regard to physics anxiety and the correlations between these variables among pre-service teachers, and whether or not the physics anxiety and self-efficacy beliefs of pre-service teachers displayed any differences in terms of achievement in the physics course or depending upon gender. An examination of the correlation between the pre-service teachers' physics anxiety and their self-efficacy showed that physics anxiety was a significant predictor of physics self-efficacy. Although a negative and low correlation was seen in all of the subscales of physics laboratory anxiety and physics self-efficacy, in general, the level of correlation between the dimensions of anxiety and self-efficacy was moderate, negative and significant in all dimensions except laboratory anxiety. The highest negative and significant relationship in the table was between mathematics anxiety and achievement in the physics course and self-efficacy with regard to solving physics problems. This outcome is an expected one and is supported in the literature by numerous studies that report, similar to the present research, a negative correlation between self-efficacy and anxiety (Cocoradă & Pălăşan, 2014; Durndell & Haag, 2002; Efe, Efe & Yücel, 2016; Kurbanoğlu & Akın, 2012; Senler, 2016). On the other hand, it may be emphasized that the results of the present research are at first in the literature on physics education. The outcome revealed in the present research that indicated a high correlation between self-efficacy in problem-solving and physics course achievement and mathematics anxiety may stem from the fact that students generally regard mathematics as a course that is full of mathematical formulas and because mathematics is an important element in problem-solving in physics. This perception is supported by the way that problem-solving has been a fundamental part of teaching physics over the years, with the ensuing result that students believe that they have only learned physics when they can solve problems (McDermott, 1993). In a research by Şahin (2014), the researcher reported that the literature did not provide a definitive clue in this context but that a deficiency in students' perception of their mathematical knowledge and talent could lead to a fear of physics itself and to poor achievement in the course. In this context, mathematics may play a role in students' anxiety about the physics course (Şahin, 2014). At the same time, the outcome that there is a negative and low correlation between physics laboratory anxiety and physics self-efficacy may be related to the fact that the pre-service teachers are limited to only 2 hours of laboratory time in their weekly schedule or may not have taken it at all.

It was seen that in all of the dimensions, the physics anxiety of the pre-service teachers who were successful in the course was significantly lower than that of the pre-service teachers who were unsuccessful or mediocre. In the C/TA, LPKA, MA dimensions, there were significant differences between the physics anxiety of the mediocre and poor performers among the pre-service teachers and it was seen that the pre-service teachers who performed

at a mediocre level had significantly lower levels of anxiety. No research was discovered in the literature in which the relationship between physics anxiety and physic course achievement had been studied. In the sole research by Şahin (2014), in which the relationship between students' academic average in all courses and physics anxiety was explored, it was reported that students with high or low academic achievement display significantly greater anxiety than students who performed at a mediocre level. This indicates that a low level of anxiety may provide motivation and increase achievement, but that a high level of anxiety may be a barrier to achievement. At the same time, parallel to the results of the present research, there are studies in the literature that point to a general negative relationship between anxiety and achievement (Awan, Azher, Anwar, & Naz, 2010; Griggs, Rimm-Kaufman, Merritt, & Patton, 2013; El-Anzi & Owayed, 2005; Karimi & Venkatesan, 2009; Ma, 1999; Sherman & Wither, 2003; Stankov, 2010; Woodard, 2004; Zakaria & Nordin, 2008; Zakaria, Zain, Ahmad, & Erlina, 2012). As Şahin (2014) has expressed, hearing complaints from students about their physics anxiety and their low level of achievement in physics class is a common event and situations that endanger success stimulate a reaction of anxiety. In this case, there are two things that can be done. In other words, either the pre-service teachers should try to increase their perception of physics self-efficacy or find ways of reducing their physics anxiety. Firstly, it is up to the teacher/instructor to refrain from creating the perception that the course is difficult, too complex or hard to pass. In this context, Woodard's (2004) suggestions about how to reduce anxiety in mathematics class may be adapted to the physics class since mathematics may play a role in university students' physics anxiety in the physics courses they take (Şahin, 2014). When physics students do not feel threatened and are presented with a comfortable class setting, cooperative group work can be undertaken. In this type of group work, students see that others are experiencing the same problems and begin to believe that with a bit of determination and help, they will indeed be able to succeed in physics. At the same time, if students are given a second chance at a test or exam, they will feel that they have not altogether lost and will continue to keep trying. This way, the students will feel that the instructor is paying attention to them and is working to have them succeed. According to Woodard (2004), a decelerated teaching plan is useful in helping students to better understand the material.

It was found in this research that there were significant differences in all of the dimensions of physics self-efficacy according to the level of achievement in physics and that the physics self-efficacy of pre-service teachers who performed well in the physics course was higher than that of their counterparts who were unsuccessful or performed at a mediocre level. It was also seen that pre-service teachers who performed at a mediocre level had higher levels of self-efficacy compared to pre-service teachers who performed poorly. This is an expected result and in this context, it is consistent with the results of studies that demonstrated that self-efficacy is a strong predictor of academic achievement (Lane, Lane, & Kyprianou 2004; Schunk 1991) and that it is in strong correlation with achievement (Metallidou, & Vlachou, 2007; Witt-Rose, 2003). There are also a few studies in the literature on physics education that show that as the academic achievement of physics pre-service teachers increase, their self-efficacy will also be high (Çalışkan, Selçuk, & Özcan, 2010) as well as those that reveal that there is a correlation between the physics self-efficacy of pre-service teachers and their perception of physics achievement (Selçuk, Çalışkan, & Erol, 2008). On the other hand, contrary to the results of this research, Shaw (2004) reports that there is no significant relationship between the physics course grades of university physics students and their physics self-efficacy. Additionally, while Abak, Eryılmaz and Fakıoğlu (2002) assert that there is no significant relationship between the physics achievement of university first-year students and their perception of physics self-efficacy, in general, the literature points to a positive relationship between self-efficacy and achievement, emphasizing that the perception of self-efficacy affects academic performance through its impact on countless behavioral and psychological processes (Bandura, 1986). It is also reported that the mastery experiences of students whose self-efficacy is a basic source of their achievement in science are particularly impacted (Britner & Pajares, 2006).

A review of the findings on the effects of gender on the anxiety and self-efficacy of pre-service teachers reveals that in all the dimensions outside of C/TA, where there is no significant difference between the genders in terms of physics anxiety, female pre-service teachers display a higher level of physics anxiety compared to their male counterparts. Similarly, Kuan and Tek (2007) have examined the relationship between science anxiety and gender, discovering that outside of physics class anxiety, the Science Anxiety Scale showed that in all of the other dimensions, defined as danger anxiety, science test anxiety, mathematics or science problem-solving anxiety, squeamish anxiety and performance anxiety, females were significantly more anxious than males; Hensley (1996), too, reached the conclusion that the level of science anxiety was higher among females than males. Chiarelott and Czerniak (1987) also asserted in a research they conducted with 9-14 year-old schoolchildren that girls experienced a higher level of science anxiety than boys. Similarly, Mallow (1994) and Udo, Ramsey, Reynolds-Alper (2001) report

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that the conclusion they had drawn in their previous studies that science anxiety was at a higher level in girls compared to boys was even more pronounced in the results of the chi-square analysis. Zoller and Ben-Chaim (1990)'s research showed, similar to the results revealed in the C/TA dimension in the present research, that test anxiety did not show a significant difference between the genders. It was observed that as far as physics self-efficacy was concerned, only in the physics problem-solving dimension were male pre-service teachers on a higher level; in all the other dimensions, there was no significant difference between the female and male pre-service teachers in terms of their self-efficacy. In the literature, the suggestion of Junge and Dretzke (1995) that females' self-efficacy in work requiring quantitative skills is lower than males is supported by the present research, which reveals that in physics, which requires quantitative work such as problem-solving, males had a higher level of self-efficacy than the females in the research. Britner and Pajares (2006) however found in their research conducted with middle school pupils that the self-efficacy of girls in science were stronger in the emotional arousal domain but that boys were stronger in mastery experiences, a result set forth that is consistent with the present research's conclusion that science self-efficacy does not exhibit a difference according to gender. Similar to the results of the present research, Griggs, Rimm-Kaufman, Merritt and Paton (2013) showed in their research that mathematics and science self-efficacy levels did not display significant differences according to gender.

Conclusions and Implications

An examination of the results of the research and the discussion may lead to the conclusion that, based on the higher negative correlation between physics self-efficacy in the dimensions of course achievement and problem-solving and between physics anxiety in the dimension of mathematics anxiety compared to the other dimensions. At the same time, the findings suggest that pre-service teachers with higher levels of self-efficacy and lower levels of anxiety are more successful in the physics course. In this context then, it can be said that levels of anxiety and self-efficacy impact achievement. For this reason, physics teachers or faculty instructors should recognize the importance of reducing mathematics anxiety, especially in their physics classes. Moreover, methods and techniques of relieving physics anxiety should be examined through experimental studies with special attention being paid to this so far scantly explored aspect of physics education through more frequent and varied research.

The present research is the finding that, as is expressed frequently in the literature, female students have a higher level of science anxiety than their male counterparts. The higher level of anxiety that females carry in the science or physics class may be associated with whether they had a male or female science or physics teacher in their school years, the methods used in the classes in teaching physics, the nature of physics or science, and the fact that scientists dealing with physics throughout history have predominantly been males. Another conclusion of the research is that when it is considered that males display a higher level of self-efficacy in quantitative work such as problem-solving, it may be necessary, in order to increase the self-efficacy of female students and reduce their anxiety, for teachers/instructors to come to class with different teaching methods and go beyond concentrating on mathematical processes in physics, giving the students alternative measuring/evaluating methods (e.g., concept maps, conceptual change texts, structured grids) so that students are more widely introduced to conceptual physics and everyday life experiences about physics concepts.

Limitations

The author thinks that certain limitations to the present research must be expressed. Since the data for the research were collected using scales developed to identify a situation at any given point in time, the common changes in self-efficacy and anxiety, it may be useful to conduct further experimental research that looks into how changes may be achieved with different teaching interventions. Furthermore, qualitative studies conducted at different educational levels may be conducted in order to make an in-depth research of the sources of self-efficacy beliefs and anxieties and their causal relationships in the context of physics class.

References

Abak, A., Eryılmaz, A., & Fakıoğlu, T. (2002). Determining university students' selected affective characteristics. *V. National Science and Mathematics Education Congress*, Ankara, Turkey.

Akgün, A., Gönen, S., & Aydın, M. (2007). The investigation of anxiety levels of primary school science and mathematics teacher students' according to some variables. *Electronic Journal of Social Sciences, 6* (20), 283-299.

Akman, B., İzgi, Ü., Bağçe, H., & Akıllı, H. İ. (2007). The effect of elementary students' attitude towards science on their levels of test anxiety. *Education and Science, 32* (146), 3-11.

Alsop, S., &Watts, M. (2000). Facts and feelings: Exploring the affective domain in the learning of physics. *Physics Education, 35,*132-138.

Awan, R. N., Azher, M., Anwar, N. M., & Naz, A. (2010). An investigation of foreign language classroom anxiety and its relationship with students' achievement. *Journal of College Teaching & Learning, 7* (11), 33-40.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191-215.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *PNAS, 107* (5), 1860-1863.

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching, 43* (5), 485-499.

Brownlow, S., Jacobi, T., & Rogers, M. (2000). Science anxiety as a function of gender and experience. *Sex Roles, 42* (1/2),119-131.

Borrachero, A. B., Brígido, M., Costillo, E., Bermejo, M. L., & Mellado, V. (2013). Relationship between self-efficacy beliefs and emotions of future teachers of Physics in secondary education. *Asia-Pacific Forum on Science Learning and Teaching, 14* (2), Article 5, 1.

Büyüköztürk, Ş. (2012). *Data analysis manual for social sciences (16th ed.).* Ankara: Pegem Academy Publishing Company.

Büyüköztürk, Ş., Çakmak, E. K., Akgün, Ö. E., Karadeniz, Ş., & Demirel, F. (2012). *Scientific Research Methods (13th ed.)*. Ankara: Pegem Academy Publishing Company.

Cari, C., Suparmi, A., & Handhika, J. (2016). Student's preconception and anxiety when they solve multi representation concepts in Newton laws and it's application. *8th International Conference on Physics and its Applications (ICOPIA)* (pp.1-5), Indonesia.

Chiarelott, L., & Czerniak, C. (1987). Science anxiety: Implications for science curriculum and teaching. *The Clearing House, 60* (5), 202-205.

Cocoradă, E., & Pălăşan, T. (2014). Computer anxiety and computer self-efficacy for the high school students. *The 10th International Scientific Conference e-Learning and Software for Education* (pp. 102-109), Bucharest.

Czerniak, C., & Chiarelott, L. (1985). Science anxiety among elementary school students: Equity issues. *Journal of Educational Equity and Leadership, 5* (4), 291-308.

Çalışkan, S. (2007). *The effects of problem solving strategies teaching on the physics achievement, attitude, self-efficacy, and the strategy usage.* (Unpublished doctoral thesis), Dokuz Eylül University, Turkey.

Çalışkan, S., Selçuk, G. S., & Özcan, Ö. (2010). Self-efficacy beliefs of physics student teachers': effects of gender, class level and academic achievement. *Kastamonu Education Journal, 18* (2), 449-466.

Dilek, U., Şahin, M., Guler, B., & Eslek, S. (2013). An investigation of university students' anxiety in physics courses. *2nd World Conference on New Trends in Science Education*. Cracow, Poland.

Durndell, A., & Haag, Z. (2002). Computer self efficacy, computer anxiety, attitudes towards the Internet and reported experience with the Internet, by gender, in an East European sample. *Computers in Human Behavior, 18*, 521-535.

Efe, H. A., Efe, R., & Yücel, S. (2016). A comparison of Swiss and Turkish pre-service science teachers' attitudes, anxiety and self-efficacy regarding educational technology. *Universal Journal of Educational Research, 4,* 1583 - 1594. doi: 10.13189/ujer.2016.040711.

El-Anzi, & Owayed, F. (2005). Academic achievement and its relationship with anxiety, self-esteem, optimism, and pessimism in Kuwaiti students. *Social Behavior and Personality: An International Journal, 33* (1), 95-104.

Fencl, H. S., & Scheel, K. R. (2004). Pedagogical approaches, contextual variables, and the development of student self-efficacy in undergraduate physics courses. *AIP Conference Proceedings, 720* (1), 173-176.

Griggs, M. S., Rimm-Kaufman, S. E., Merritt, E. G., & Paton, C.L. (2013). The Responsive Classroom approach and fifth grade students' math and science anxiety and self-efficacy. *School Psychology Quarterly: The Official Journal Of The Division Of School Psychology, American Psychological Association, 28* (4), 360-373.

Güngör, A., Eryılmaz, A., & Fakıoğlu, T. (2007). The relationship of freshmen's physics achievement and their related affective characteristics. *Journal of Research in Science Teaching, 44* (8), 1036-1056.

Hensley, C. A. (1996). *Analysis of the interrelationships between science anxiety and the variables of gender, course of study, parent background, achievement, test anxiety, and attitude toward science* (Unpublished doctoral thesis), The Ohio State University, USA.

Higbee, J. L., & Thomas, P. V. (1999). Affective and cognitive factors related to mathematics achievement. *Journal of Developmental Education*, *23* (1), 8–10.

Ho, H-Z., Senturk, D., Lam, A. G., Zimmer, J. M., Hong, S., Okamoto, Y., Chiu, S-Y., Nakazawa, Y., & Wang, C-P. (2000). The affective and cognitive dimensions of math anxiety: A cross-national study. *Journal for Research in Mathematics Education, 31* (3), 362-379.

Israel, E. (2007). *Self-regulated education, science achievement and self-efficacy* (Unpublished doctoral thesis), Dokuz Eylül University, Turkey.

Jerusalem, M., & Pekrun, R. (Eds.). (1999). *Emotion, motivation und leistung.* Gottingen: Hogrefe.

Junge, M. E., & Dretzke, B. J. (1995). Mathematical self-efficacy gender differences in gifted/talented adolescents. *Gifted Child Quarterly, 39,* 22–28.

Karasar, N. (2000). *Scientific research methods* (10th Ed.). Ankara: Nobel Publication.

Karimi, A., & Venkatesen, S. (2009). Mathematics anxiety, mathematics performance and academic hardiness in high school students. *International Journal of Educational Sciences, 1* (1), 33-37.

Kuan, F. L., & Tek, O. E. (2007). Science anxiety among form four students in Penang: A gender comparison. *Journal of Science and Mathematics Education in Southeast Asia, 30* (1), 84-109.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Kurbanoğlu, N. İ., & Akın, A. (2012). The relationships between university students' organic chemistry anxiety, chemistry attitudes, and self-efficacy: A structural equation model. *Journal of Baltic Science Education, 11* (4), 347-356.

Lane, J., Lane, A. M., & Kyprianou, A. (2004). Self-efficacy, self-esteem and their impact on academic performance. *Social Behavior and Personality: An International Journal, 32* (3), 247-256.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. *Journal for Research in Mathematics Education*, *30* (5), 520-540.

Mallow, J. V. (1978). A science anxiety program. *American Journal of Physics, 46* (8).

Mallow, J. V. (1994). Gender-related science anxiety: A first binational study. *Journal of Science Education and Technology, 3,* 227–238.

Mallow, J. V., & Greenburg, S. L. (1983). Science anxiety and science learning. *The Physics Teacher, 21* (2), 95-99.doi:10.1119/1.2341214.

Maskan, A. (2010). An evaluation of prospective physics and maths teachers' self-efficacy beliefs toward physics. *Journal of Uludag University Faculty of Education*, *XXIII* (1), 31-42.

Metallidou, P., & Vlachou, A. (2007). Motivational beliefs, cognitive engagement, and achievement in language and mathematics in elementary school children. *International Journal of Psychology, 42* (1), 2-15.

Nissen, J. M., & Shemwell, J. T. (2016). Gender, experience, and self-efficacy in introductory physics. *Physical Review Physics Education Research, 12* (2), 020105-1-020105-16.

Schunk, D. (1991). Self-efficacy and academic motivation. *Educational Psychologist, 26* (3 & 4), 207-231.

Selçuk, G. S., Çalışkan, S., & Erol, M. (2008). Physics self-efficacy beliefs of student teachers': The relationships with gender and achievement perception, *Balkan Physics Letters (Special Issue: Turkish Physical Society 24th International Physics Congress),* 648-651.

Senemoğlu, N. (2005). *Development learning and from teaching-theory to application*. Ankara: Gazi Kitabevi.

Senler, B. (2016). Pre-service science teachers' self-efficacy: The role of attitude, anxiety and locus of control. *Australian Journal of Education, 60* (1) 26–41.

Sharon, W., & Corenna, C. (1990). Science anxiety: Relation with gender, year in chemistry class, achievement, and test anxiety. *Paper presented at the Annual Meeting of the Midwestern Educational Research Association*, Chicago.

Shaw, K. A. (2004). The development of a physics self-efficacy instrument for use in the introductory classroom. *AIP Conference Proceedings, 720* (1), 137-140.

Sherman, B. F., & Wither, D. P. (2003). Mathematics anxiety and mathematics achievement. *Mathematics Education Research Journal*, *15* (2), 138-150.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *Journal of Educational Research, 95,* 323-332. http://dx.doi.org/10.1080/00220670209596607.

Stankov, L. (2010). Unforgiving Confucian culture: A breeding ground for high academic achievement, test anxiety and self-doubt. *Learning and Individual Differences*, *20,* 555-563.

Stevens, J. C. (1992). *Applied multivariate statistics for the social sciences*. Hillsdale, NJ: Lawrence Erlbaum.

Stipek, D. (1998). *Motivation to learn from theory to practice* (3rd ed.). USA: Allyn and Bacon.

Şahin, M. (2014). The relationship between pre-service teachers' physics anxiety and demographic variables. *Journal of Baltic Science Education,13* (2), 201-215.

Şahin, M., Çalışkan, S., & Dilek, U. (2015). Development and validation of the physics anxiety rating scale. *International Journal of Environmental and Science Education*, *10* (2), 183-200.

Tanel, R. (2013). Prospective physics teachers' self-efficacy beliefs about teaching and conceptual understandings for the subjects of force and motion. *Journal of Baltic Science Education,12* (1), 6-20.

Tezer, M., & Aşıksoy, G. Y. (2015). Engineering students' self-efficacy related to physics learning. *Journal of Baltic Science Education, 14* (3), 311-326.

Udo, M. K., Ramsey, G. P., Reynolds-Alpert, S., & Mallow, J. V. (2001). Does physics teaching affect gender-based science anxiety? *Journal of Science Education and Technology, 10,* 237–247.

Udo, M. K., Ramsey, G. P., & Mallow, J. V. (2004). Science anxiety and gender in students taking general education science courses. *Journal of Science Education and Technology,13* (4), 435-446.

Uluçınar, S. Ş. (2012). The primary school students' attitude and anxiety towards science. *Journal of Baltic Science Education, 11* (2), 127-140.

Uysal, F., & Dede, Y. (2016). Mathematics anxiety and beliefs of Turkish pre-service elementary teachers. *Eurasia Journal of Mathematics, Science & Technology Education*, *12* (8), 2171–2186.

Uzuntiryaki, E. (2008). Exploring the sources of Turkish pre-service chemistry teachers'chemistry self-efficacy beliefs. *Australian Journal of Teacher Education, 33* (6), 12-28.

Witt-Rose, D. L. (2003). S*tudent self-efficacy in college science: An investigation of gender, age, and academic achievement*. Publication Manual of the American Psychological Association, 5th edition.

Woodard, T. (2004). The effects of math anxiety on post-secondary developmental students as related to achievement, gender, and age. *Inquiry, 9* (1), 1-5.

Yener, D., Aydın, F., & Köklü, N. (2012). Examination of students' self-efficacy who were applied animation-simulation in physics laboratory. *10th International Congress on Science and Mathematics Education*, Nigde University, Nigde.

Yerdelen, S. D., & Peşman, H. (2013). Relations of gender and socioeconomic status to physics through metacognition and self-efficacy. *The Journal of Educational Research*, *106* (4), 280-289. doi: 10.1080/00220671.2012.692729.

Yüksel, M. & Geban, Ö. (2016). Examination of science and math course achievements of vocational high school students in the scope of self-efficacy and anxiety. *Journal of Education and Training Studies, 4* (1), 88-100.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

Zakaria, E., & Nordin, N.M. (2008). The effects of mathematics anxiety on matriculation students as related to motivation and achievement. *Eurasia Journal of Mathematics, Science and Technology Education, 4* (1), 27-30.

Zakaria, E., Zain, N. M., Ahmad, N. A., & Erlina, E. (2012). Mathematics anxiety and achievement among secondary school students. *American Journal of Applied Sciences, 9* (11), 1828-1832.

Zoller, U., & Ben-Chaim, D. (1990). Gender differences in examination-type preferences, test anxiety, and academic achievements in college science education a case study. *Science Education, 74* (6), 597-608.

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