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ENGINEERING STUDENTS' SELF-EFFICACY RELATED TO PHYSICS LEARNING

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Abstract. *Various studies have demonstrated that students who have high levels of academic high levels of academic self-efficacy are better at overcoming obstacles, have higher targets and are more confident. So, the aim of this research was to determine the self-efficacy levels of engineering students regarding physics, and to analyse the effect of their alma mater, class levels, the type of engineering programme in which they are being educated and academic success variables on their self-efficacy regarding physics. In the present research "Physics self-efficacy scale" including two factors which were developed by the authors was used to collect the data. Considering one of the independent variables, such as their alma mater, it can be seen that students who graduated from private high schools had a higher level of self-efficacy. In addition, compared to other students, those in their first year had a higher level of self-efficacy, which led to greater academic success.*

Key words: *engineering students, learning, self-efficacy, physics education, physics learning.*

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Introduction

Physics is a discipline which is based on experimental observations and quantitative measurements related with understanding natural events. It is a field which is directly related with the natural events and events occurring in daily life and it can explain these natural events in terms of mathematics (Eren & Gürdal, 2010). Depending on progress in basic sciences, in particular physics, technology develops as well (Halliday & Resnick, 1991). Thereby, a physics education is significant in creating new generations, who can perceive and interpret technological developments and contribute to the development of technology and science (Öztürk, 2009). Apart from a few of them, engineering sciences apply the laws and principles of physics. Students sometimes think that physics is not connected to engineering. However, technology pushes the applications of engineering towards the limits of quantum physics. For the most part, engineering aims to use information about the basic structure and properties of substances, in order to promote technology. Progress in technology and in accessing the required information is an essential condition of the 21st century. This explains why a physics education is important for future engineers and professionals from many areas, who want to work successfully in the developing world (Malkawi & Al-Araidah, 2013).

Bandura (1997) defined self-efficacy as "the beliefs of students about their competence in overcoming the difficulties in achieving the determined targets". Although an individual has the skills for achieving a task, when the self-confidence and in other words self-efficacy level of that individual is low; there is the possibility of failure or even not trying to achieve (Bandura, 1997). According to social learning theory, self-efficacy perception of an individual is affected by four resources. These are identified as the individual's own personal experiences, others' experiences, verbal persuasion and psychological state (Tatar & Buldur, 2013; Ekici, 2012). Direct experiences are the motivation for future similar behaviours by analysing the previous experiences about the obtained failure or success; indirect experiences are the success or failures in which the individual observes in other individuals, in other words, the individual expects that he will also show the same success. Verbal persuasion as another resource is the situation in which encouragement and advice about failure or success of an individual might lead to changes in the self-efficacy

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expectations of that individual. The last resource, which is the psychological state, is the expectation of an individual about himself in achieving the task. Bandura indicated that among these four basic resources, the information which an individual acquires directly from his experiences mostly affects self-efficacy (Timur & Taşar, 2013).

Self-efficacy is a dynamic aspect of the composition of other elements of the self–system, such as an individual's capacity, their success, their incentives and self-regulation mechanisms (Vardarlı, 2005). Gürcan (2005) defines self-efficacy as the judgements individuals make by using their abilities, but not as a function of their abilities. Self-efficacy contributes to students' success, because it affects their behaviour when asking for academic help and their use of learning strategies. Self-efficacy has a bearing on many things, such as academic success, social abilities, stopping smoking, athletic success, career choice, assertiveness, surviving a heart attack and dealing with feared events, among others (Açıkgöz, 2000). Research carried out in this area shows that students who have high levels of academic self-efficacy are more willing to work in challenging areas of study and show more of an effort in them. They are better at overcoming obstacles, have higher targets and are more confident, and as a result their academic success is higher (Gülten & Soytürk, 2013). A student with higher levels of self-efficacy on physics learning actively participates in the lecture, allocates time for studying physics subjects and develops various learning strategies (İsrael, 2007). Thereby, the most important factor affecting academic success in physics is the level of self-efficacy. It is crucial to take this into consideration when organising teaching activities for students, in order for them to achieve better learning outcomes (Dowd et al., 2015). Besides, there are studies showing self-efficacy perception towards physics lecture as an indicator of academic achievement of the students (Capri et al., 2012; Karakoyun & Kavak, 2008).

Since Bandura (1977) explained the self-efficacy concept in the 1970s, there have been a lot of studies referenced in literature about developing self-efficacy scales and showing the importance of students' academic self-efficacy (Woo, 1999; Ekici, 2009; Ekici, 2012). Önen and Kaygısız (2013) identified the levels of self-efficacy of science teacher candidates regarding science education, and determined that they were generally "good". In their research, Selçuk et al. (2008) analysed the change in students' self-efficacy regarding physics related to gender, and found that there was a meaningful difference in favour of male students. Shaw (2004) investigated the relationship between gender and students' self-efficacy and success for those studying physics at college and university level. Shaw determined that there was a significant difference between self-efficacy scores according to the gender of students, with female students having lower average scores. Mujtaba and Reiss (2014) investigated the factors that influence 15-year-old students' intentions to study physics post-16, when it is no longer compulsory. The result of the study indicated that extrinsic motivation in physics was the most important factor associated with intended participation. Maskan (2010) identified the self-efficacy levels of teacher candidates, who were still partaking in the physics teacher training programme, and determined that the mean of the self-efficacy score of the fifth grade students was higher than that of the first grade students. In their research, Yener et al. (2012) worked with student science teachers and analysed the effect of the use of animation and simulation in physics laboratories on students' self-efficacy. It was determined that when used solely in a laboratory, animation and simulation based learning methods do not change students' self-efficacy in a meaningful way. In their research which examined if taking the course of "Didactic Physics" increase the self-efficacy perception levels of prospective classroom teachers, Juuti, Lavonen and Meisalo (2005) concluded that there is a significant relationship between gender and this course with a minor effect on self-efficacy related with physics. There have been numerous papers and research done on student self-efficacy and its place in the classroom (Aloe, et al., 2014; Tanel, 2013; McKinnon & Lamberts, 2013; Arslan, 2013; Louis & Mistele, 2012; Velayutham, Aldridge, & Fraser, 2012)

In the light of the information mentioned above, it was found out that although there are studies examining self-efficacy on physics learning, no research was found examining the self-efficacy of engineering students. Nevertheless, it is believed that this research would contribute to the related literature and shed light to possible regulations for physics lectures in engineering education programmes. In consideration of all these explanations, the aim of this research is to analyse the self-efficacy of students in the Faculty of Engineering at Near East University regarding physics, and to determine the effects of their alma mater, class levels, the type of engineering programme in which they are being educated and academic success on their self-efficacy. Within the framework of the research, the answers were sought from the engineering students to the following questions:

- What is their level of self-efficacy regarding physics?
- Are there significant differences between their self-efficacy regarding physics based on their alma mater?
- Is there a meaningful difference between their self-efficacy regarding physics based on their class level?

- Are there significant differences between their self-efficacy regarding physics based on the engineering department in which they are studying?
- Are there significant differences between their self-efficacy regarding physics based on their academic success?
- Is the level of academic success a predictor of students' self-efficacy regarding physics?

Methodology of Research

Research Model

This research aimed to determine self-efficacy levels of engineering students regarding physics, and analyse the effect of their alma mater, class levels, the type of engineering programme in which they are being educated and academic success variables on their self-efficacy regarding physics. For this reason, this research is based on the survey model and has a descriptive nature. The survey model aims to describe an occasion, which happened in the past or which still exists (Karasar, 2012). The research was conducted during the autumn semester of the 2014-2015 academic year.

Sample of Research

Participants in the research are n=243 engineering students in the Faculty of Engineering at Near East University. Demographic characteristics of the participants are shown in Table 1.

Table 1. Demographic features of the students who participated in the research.

Demographic Characteristics	f	%
Alma Mater		
Vocational School -VS	158	65.0
High School (General)-HS	47	19.3
Private High School (College)-PHS	38	15.7
Department		
Electrical Engineering	48	19.8
Mechanical Engineering	37	15.2
Computer Engineering	42	17.3
Civil Engineering	36	14.8
Biomedical Engineering	36	14.8
Food Engineering	15	6.2
Information Engineering	29	11.9
Academic Success Level		
Unsuccessful	40	16.5
Average level of success	126	51.9
Successful	77	31.6
Grade		
Grade	153	63.0
Grade	52	21.4
Grade	27	11.1
Grade	11	4.5

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It was identified that according to their alma mater, n=158 (65%) the participants were vocational school (VS) graduates, n=38 (15.7%) of them were high school (general) (HS) graduates and n= 47 (19.3%) of them were private high school (college) (PHS) graduates. Considering the departments in which they are studying, n=48 (19.8%) the participants are studying in the Electrical Engineering department, n=37 (15.2%) of them are studying in the Mechanical Engineering department, n=42 (17.3%) of them are studying in the Computer Engineering department, n=36 (14.8%) of them are studying in the Civil Engineering department, n=36 (14.8%) of them are studying in the Biomedical Engineering department, n=15 (6.2%) of them are studying in the Food Engineering department and n=29 (11.9%) of them are studying in the Information Engineering department.

According to undergraduate education regulations, under the quatrain grading system, students are considered as successful (having very satisfactory score) if they score an average of 3.0 or more; their success is considered as average (having average score) if their average score is between 1.5 and 2.5 and they are considered as unsuccessful (having unsatisfactory score) if they score 1 or less. Accordingly, it was determined that from the participants the number of unsuccessful students was n= 40 (16.5%), the number of average students was n=126 (51.9%) and the number of successful students was n=77 (31.6%). N=153 (63%) participants were in the first grade, n=52 (21.4%) of them were in the second grade, n=27 (11.1%) of them were in the third grade and n=11 (4.5%) of them were in the fourth grade. The gender factor was not considered in this research as the number of female students at the Faculty of Engineering is considerably lower than the number of male students.

Data Collecting Tool

A pre-trial form of "physics self-efficacy scale" that was developed by the researchers was used as the data collection tool. It was a Likert type-scale with 5 choices, which were "Strongly Agree", "Agree", "Neither Agree nor Disagree", "Disagree" and "Strongly Disagree". The scale was presented to a group of 10 experts; 5 being experts in the field of physics and 5 being experts in the assessment area, in terms of content validity. Content validity relates to the compatibility of the scale with regards to physics, in terms of content and technique. Considering expert opinion, some clauses were taken out of the scale and some were added, resulting in a scale with 34 clauses. A pilot trial of the scale was applied to a group of 30 students studying at the Faculty of Engineering. The Cronbach Alpha reliability coefficient of the data obtained from the pilot trial was calculated as 0.985. Factor analysis was carried out to provide the construct validity of the physics self-efficacy scale and to identify the load factor of the scale's clauses. In addition, Kaiser-Meyer-Olkin (KMO) and Bartlett's tests were applied beforehand, in order to identify the compatibility of the data to the factor analysis. The results of the Barlett test and KMO value are presented in Table 2.

Table 2. Analysis of data compatibility for factor analysis.

Kaiser-Mayer-Olkin (KMO) Measure of Sampling Adequacy		0.975
Barlett's Test	Chi-square value	11576,256
	df	561
	sig	0.00

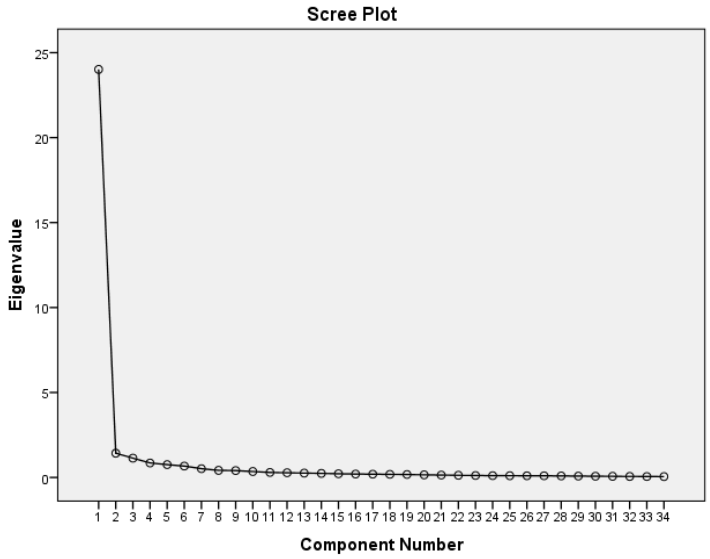

Figure 1: Scree plot graph.

Table 3. Results of the factor analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	24.014	70.628	70.628	24.014	70.628	70.628	13.780	40.529	40.529
2	1.426	4.194	74.822	1.426	4.194	74.822	11.660	34.293	74.822
3	1.137	3.344	78.167						
4	.853	2.509	80.676						
5	.755	2.221	82.896						
6	.670	1.969	84.866						
7	.515	1.516	86.381						
8	.420	1.235	87.616						
9	.406	1.194	88.810						
10	.351	1.031	89.842						
11	.297	.874	90.716						
12	.276	.811	91.528						
13	.256	.753	92.281						
14	.240	.707	92.988						
15	.219	.644	93.632						
16	.201	.592	94.223						
17	.193	.567	94.791						
18	.181	.532	95.323						
19	.175	.515	95.837						
20	.154	.452	96.289						

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
21	.140	.413	96.703						
22	.127	.375	97.077						
23	.114	.335	97.413						
24	,106	.311	97.723						
25	,103	.304	98.027						
26	.098	.290	98.317						
27	.096	.281	98.598						
28	.091	.268	98.866						
29	.080	.234	99.101						
30	.075	.221	99.322						
31	.067	.197	99.519						
32	.059	.173	99.691						
33	.055	.162	99.853						
34	.050	.147	100.000						

Extraction Method: Principal Component Analysis.

Having a KMO value of 0.975 shows that the sample size is suitable for factor analysis. It was identified that the chi-square value obtained from the result of the Bartlett's Sphericity test was meaningful (χ^2=11576.256; df =561; p<0.01). The line graph was analysed to identify the number of factors (Karagöz & Kösterelioğlu, 2008). The line graph, which was obtained for the Physics self-efficacy scale, can be seen in Shape 1.

Büyüköztürk (2007) mentions that the clauses of the line graph are obtained by combining eigenvalues, and for this reason drops (breaking points) in the graph might give the factor number. Looking at Shape 1, it can be understood that the components which drop in the graph are factor numbers 1 and 2, and also that after factor number 3 the graph takes a horizontal view. Accordingly, it was shown that the scale contains two meaningful factor numbers.

Later, the Varimax rotation technique was used, and it was determined that the scale focuses around two factors with an eigenvalue of more than 1. Table 3 shows the variance values of each of the two factors detected and their effect on the total variance value (cumulative variance).

As can be seen in Table 3, the percentage of the variance explained for the first factor after the Varimax rotation is 40.529 and the percentage of the variance explained for the second factor is 34.293. The total variance explained with the help of the two factors was determined to be 74.822. In research carried out on social sciences, having a total variance rate between 40% and 60% indicates the strength of the factor structure of the scale (Tavşancıl, 2002). This shows that the total variance rate of the scale has an adequate value. After the Varimax rotation process, the rotated factor load values of the scale can be seen in Table 4.

Table 4. Load values of the clauses, according to the factors after the rotation process.

Rotated Component Matrix[a]

Clauses	Rotated Factor Load Values	
	Factor 1	Factor 2
I can help my friends to solve physics problems.	.808	
I can criticise my friends' ideas with my physics knowledge.	.797	

Clauses	Rotated Factor Load Values	
	Factor 1	Factor 2
I can understand the important concepts in the physics book	.753	
I can design examples about the content of the physics book.	.746	
I can use my physics knowledge to understand the problem discussions in the physics book.	.742	
I can write a simple example about any physics subject I have learned.	.736	
I can understand physics terms.	.728	
I can make an effective use of my knowledge while solving physics problems.	.723	
I am sure I can make the necessary connections in order to solve a physics problem.	.719	
I can make connections between recently learnt subjects and my physics knowledge.	.717	
I can discover little things by using physics theorems.	.717	
I can make connections between physics terms.	.709	
I can interpret a physics subject I have seen for the first time with my previous knowledge.	.707	
I can identify the important physics points of a physics subject I read about.	.679	
I know how to behave when I encounter a new challenge in physics.	.671	
I believe that I have the ability to learn physics.	.665	
I know how I can make an effective use of my previous knowledge when I encounter a new challenge in physics.	.648	
I can use my physics knowledge to learn similar concepts in other lessons.	.639	
I can find clues in physics problems.	.625	
I can solve physics problems by using self-specific solutions.	.590	
I can concentrate in physics lessons.	.578	
I strongly believe that I can solve a difficult physics problem.		.794
I can guarantee the accuracy of a result I find for a physics problem.		.782
I can get compliments for my physics homework.		.774
I always have a feeling that I solve a physics problem correctly.		.769
I can get good marks in physics exams.		.735
I can solve physics problems by concretising them.		.660
I can make a good solution plan for physics problems.		.659
I have my own ideas about questions related to physics.		.656
I can analyse the event in a physics problem.		.654
I study alone to solve problems in the learning step.		.623
I can relate the information I learn in physics to daily life events.		.622
I think with a physics mentality when planning daily life events.		.614
I can use the physics knowledge I have learned in my daily life.		.586

When the factor load values of the scale clauses are analysed, it can be seen that there are twenty-one clauses under the first factor, and the factor loads of the clauses alter between 0.578 and 0.808. There are 13 clauses under the second factor, and their load factors alter between 0.586 and 0.793. The first one of these two factor components is named as "Learning level" and the second one is named as "Solving physics problems".

Also, in order to identify the relationship between the sub-factors of the scale, the correlation between factors was looked at and the results are given in Table 5.

Table 5. Pearson Correlation between the factors belonging to the scale.

Factors	Learning Level	Solving Physics Problems
Learning Level	--	.952**
Solving Physics Problems		--

***. Correlation is significant at the 0.01 level (2-tailed).*

It can be seen that there is a high-level, positive relationship between the learning level and solving physics problems sub factors, r=0.952, p=0.00 ($p<0.01$) and N=243. According to this, the level of physics problem solving increases as the level of learning increases. Considering the coefficient of determination (r^2 =0.906), we can say that 91% of the total variance in the physics problem solving factor is due to the learning level.

Data Analysis

In order to classify the data, frequency and percentage values were calculated. The arithmetic mean was calculated to identify the mean of the scores. Standard deviation was calculated to identify the distance of the values in the distribution to the arithmetic mean. "One Way Variance Analysis" (ANOVA) was used to determine if the scores of students' self-efficacy regarding physics form a meaningful difference with respect to the independent variables. In case of a meaningful difference from the ANOVA results, one of the post-hoc multiple comparison tests, the Bonferroni test, was used to determine which group causes the difference. A $p<0.05$ significance level is considered adequate in identifying the differentiation.

A Kolmogorov-Smirnov normality test was applied to determine if the distributions show a normal distribution before the analysis. It was determined that all the distributions show normal distribution in all groups after the Kolmogorov-Smirnov test was applied ($p>0.05$).

Results of Research

Physics Self-efficacy Levels of Engineering Students

Interval scale assessment was used to determine the self-efficacy levels of the participants. The self-efficacy levels were classified as "low", "average" and "good", with equal intervals considering the minimum and maximum scores obtainable for each dimension. When comparing the arithmetic mean of the Likert-type scale, an identification process was carried out by dividing five-point scale intervals into equal intervals, with a rate of 0.80 (5-1=4, 4/5=0.80) for the rating scale. Table 6 shows to which interval the average scores the participants got in the scale belongs.

Table 6. Score intervals of the Likert-type scale.

Score Range	Options
1,00 – 1,79	Strongly Disagree
1,80 – 2,59	Disagree
2,60 – 3,39	Neither Agree Nor Disagree
3,40 – 4,19	Agree
4,20 – 5,00	Strongly Agree

In order to identify the self-efficacy levels of participants, the average scores they received from each sub-dimension, standard deviation and minimum and maximum scores were identified and shown in Table 7.

The first factor of the physics self-efficacy scale consists of 21 questions, and the second one consists of 13 questions. Considering that each question has a minimum of 1 point and a maximum of 5 points, a maximum of 105 points and a minimum of 21 points can be obtained for the first factor and a maximum of 65 points and a minimum of 13 points can be obtained for the second factor.

Table 7. Sub-dimension results of the physics self-efficacy scale.

Sub dimensions of the Physics self-efficacy scale	N	Minimum	Maximum	$\bar{X}$	SD
Learning Level	243	25	103	64.70	20.273
Solving Physics Problems	243	13	64	38.91	13.024

The total average score of the learning level sub-dimension of the physics self-efficacy scale was determined to be 64.70 (average for each question 64.70/21=3.1) for 21 questions, and standard deviation was determined to be 20.273. Looking at this value, it can be said that students' self-efficacy regarding physics is at a mid-level, and that they were indecisive about the clauses in the learning-level dimension of the self-efficacy scale (score interval=3.1). The total average score of the solving physics problems sub-dimension of the physics self-efficacy scale was determined to be 38.91 (average for each question 38.91/13=3) for 13 questions, and standard deviation was determined to be 13.024. Looking at this value, it can be said that the students were indecisive about the clauses in the solving physics problems dimension (score interval=3).

The Effect of an Engineering Student's Alma Mater on their Self-efficacy regarding Physics

The scores the engineering students obtained from the learning level and solving physics problems sub-dimensions of the self-efficacy scale regarding physics in relation to their alma mater are given in Table 8.

Table 8. Analysis of the scores students obtained from the physics self-efficacy scale in relation to their alma mater.

Alma Mater	Learning Level Dimension			Problem Solving Dimension		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Vocational School (VS)	157	57	18	157	34	11
High School (HS)	47	73	14	47	45	10
Private High School (PHS)	38	88	12	38	53	8

It can be seen in Table 8 that students who graduated from private high schools (college) have the highest average score in the learning level dimension ($\bar{X}\bar{X}$=88) and in the problem solving dimension ($\bar{X}\bar{X}$=53). Students who graduated from vocational schools have the lowest average score in the learning level dimension ($\bar{X}\bar{X}$=57) and in the problem solving dimension ($\bar{X}\bar{X}$=34). Also, the students who graduated from private high schools (college) have a higher self-efficacy average score for both sub-dimensions, compared to other high school graduates.

One way variance analysis was carried out, in order to determine whether there was a statistically meaningful difference between engineering students' averages on the physics self-efficacy scale, according to class levels. The results are presented in Table 9.

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Table 9. Variance analysis results of physics self-efficacy levels according to class levels.

Self-efficacy		Sum of Squares	SD	Average of Squares	F	p	Meaningful Difference
Learning Level	Intergroup	33523.384	2	16761.692	61.006	0.000	
	Within Groups	65941.686	240	274.757			HS-VS, PHS-VS, PHS-HS
	Total	99465.070	242				
Problem Solving	Intergroup	13449.279	2	6724.639	58.475	0.000	HS-VS, PHS-VS, PHS-HS
	Within Groups	27599.906	240	115.000			
	Total	41049.185	242				

According to the results of the variance analysis, there was a meaningful difference between class levels and the learning level sub-dimension ($F(2\text{-}242)=61.006$; $p=0.00<0.05$) and problem-solving sub-dimension ($F(2\text{-}242)=58.475$; $p=0.00<0.05$). In order to determine between which groups the differentiation occurred, a Bonferroni test was carried out, which identified that students who graduated from a vocational school (VS) have a low level of self-efficacy for both sub-dimensions, compared to students who graduated from high school (HS) and private high school (PHS). In addition, the self-efficacy of students who graduated from private high school (PHS) was significantly higher than that of high school (HS) and vocational school (VS) graduates.

The Effect of Class Levels on the Physics Self-efficacy of Engineering Students

Analysis of the scores engineering students obtained from the learning level and solving physics problems sub-dimensions on the physics self-efficacy scale are given in Table 10.

Table 10. Analysis of the points the students obtained from the physics self-efficacy scale relating to class levels.

Class Level	Learning Level Dimension			Problem Solving Dimension		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Grade	153	70	20	153	42	13
Grade	52	59	16	52	35	10
Grade	27	52	16	27	32	10
Grade	11	53	26	11	31	15

As can be seen in Table 10, first grade students have the highest score average in the learning level dimension ($\bar{X}\bar{X}=70$) and problem solving dimension ($\bar{X}\bar{X}=42$). The third grade students have the lowest average ($\bar{X}\bar{X}=52$) in the learning level sub-dimension, and the fourth grade students have the lowest average in the problem solving sub-dimension.

One way variance analysis was carried out, in order to determine whether there was a statistically meaningful difference between engineering students' averages on the physics self-efficacy scale, according to class levels. The results are presented in Table 11.

Table 11. Results of the variance analysis of physics self-efficacy levels according to class levels.

Self-efficacy		Sum of Squares	SD	Average of Squares	F	p	Meaningful Difference
Learning Level	Intergroup	11711.464	3	3903.821	10.632	0.000	
	Within Groups	87753.606	239	367.170			1-2, 1-3,1-4
	Total	99465.70	242				
Problem Solving	Intergroup	4504.556	3	1501.552	9.82	0.000	1-2, 1-3,1-4
	Within Groups	36544.530	239	152.906			
	Total	41049.185	242				

According to the results of the variance analysis, there is a meaningful difference between class levels and the learning level sub-dimension (F (3-242) =10.632; p=0.00<0.05) and the problem solving sub dimension (F (3-242) =9.82; p=0.00<0.05). In order to identify between which groups the differentiation occurs, a Bonferroni test was carried out and it was determined that the differentiation is between the 1st and 2nd grades, the 1st and 3rd grades and the 1st and 4th grades. It was also determined that the self-efficacy of 1st grade students was higher than that of 2nd, 3rd and 4th grade students.

The Effect of Different Departments on the Physics Self-efficacy of Engineering Students

Table 12 shows the analysis of the scores engineering students obtained from the learning level and physics problem solving sub-dimensions of the physics self-efficacy scale.

Table 12. Analysis of the scores the students obtained from the physics self-efficacy scale according to their department.

Department	Learning Level Dimension			Problem Solving Dimension		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Electrical	48	64	21	48	39	13
Mechanical	37	67	20	37	40	13
Computer	42	64	20	42	39	12
Civil	36	66	20	36	39	13
Biomedical	36	62	21	36	37	14
Food	15	64	22	15	39	15
Information	29	65	21	29	40	14

It was determined that self-efficacy score averages for students in the electrical, mechanical, computer, civil, biomedical, food and information engineering departments have values close to each other in both sub-dimensions. However, one way variance analysis was carried out to determine if the difference is statistically meaningful. According to the variance analysis results, there is not a meaningful difference between the departments the students are in and the learning level sub-dimension (F (6-242) =0.266; p=0.952>0.05) and problem solving sub-dimension (F (6-242) =0.180; p=0.982>0.05).

The Effect of Academic Success on Engineering Students' Physics Self-efficacy

The analysis of the scores engineering students obtained from the learning level and physics problem solving sub-dimensions of the physics self-efficacy scale according to academic success levels are presented in Table 13.

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Table 13. Analysis of the scores the students obtained from the physics self-efficacy scale according to academic success levels.

Success Level	Learning Level Dimension			Problem Solving Dimension		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD
Successful	77	85	11	77	52	7
Mid Successful	126	60	15	126	36	10
Unsuccessful	40	40	11	40	23	7

As can be seen in Table 14, successful students have the highest score average in the learning level ($\bar{X}\bar{X}$=85) and problem solving ($\bar{X}\bar{X}$=52) sub-dimensions. Besides this, unsuccessful students have the lowest score average in the learning level sub-dimension ($\bar{X}\bar{X}$=40) and problem solving sub-dimension ($\bar{X}\bar{X}$=23).

One way variance analysis was carried out to determine whether the difference between the physics self-efficacy score averages of engineering students, according to academic success, is statistically meaningful. The results are given in Table 14.

Table 14. Variance analysis results of physics self-efficacy levels of students according to their academic success.

Self-efficacy		Sum of Squares	SD	Average of Squares	F	p	Meaningful Difference
Learning Level	Intergroup	58410.562	2	29205.281	170.731	0.000	S-MS, S-U, MS-U
	Within Groups	41054.508	240	171.060			
	Total	99465.070	242				
Problem Solving	Intergroup	23708.661	2	11854.330	164.069	0.000	S-MS, S-U, MS-U
	Within Groups	17340.524	240	72.252			
	Total	41049.185	242				

According to the results of variance analysis, there is a meaningful difference between students' academic success levels and the learning level sub-dimension ($F(2\text{-}242)=170.731$; $p=0.00<0.05$) and problem solving sub-dimension ($F(2\text{-}242)=164.069$; $p=0.00<0.05$). The Bonferroni test was carried out, in order to determine among which groups there is differentiation. It was identified that differentiation occurs between academically successful students (S) and modestly successful students (MS), successful students (S) and unsuccessful students (U) and modestly successful students (MS) and unsuccessful students (U). In short, it occurs between each group. It was determined that the self-efficacy of successful students is significantly higher than that of modestly successful students and unsuccessful students. Also, it was pointed out that the self-efficacy of modestly successful students is higher than that of unsuccessful students.

Predictive Level of Academic Success with Regards to the Physics Self-efficacy of Students

Simple regression analysis was used to measure the predictive level of academic success with regards to the physics self-efficacy of students. The results are presented in Table 15.

Table 15. Results of regression analysis predicting the scores of students' physics self-efficacy with regards to their level of academic success.

Variable	B	Std. Error	β	t
Constant	-57.344	5.627		-10.192**
Academic success level	1.622	0.074	0.816	21.888**

*R^2=0.66 **p<0.01 F(1,241)=479.08 p<0.01*

Table 16 indicates that the level of academic success was significant in predicting students' self-efficacy, and 66% of the total variance on students' self-efficacy was explained by their level of academic success (R=.81, R^2=.66 p<.01). The level of academic success appeared to be a significant predictor of students' self-efficacy.

Discussion

In this research, the effects of various factors, including alma mater, class levels, departments and academic success on the self-efficacy of engineering students regarding physics were investigated.

The results of the present research indicated that students' level of self-efficacy is at medium level related to the learning level and physics problem solving sub-dimensions. In other words, it was pointed out that the level of self-efficacy of engineering students about physics generally lies in the medium of the scale.

The important finding of this research suggests that the self-efficacy of vocational school graduates has lower average score in both sub-dimensions compared to students who graduated from state high school and private high school. In addition, the self-efficacy score averages of private high school (College) graduates are higher than those of students who graduated from other high schools in both sub-dimensions. When the previous research in literature was examined, there have been studies, which concluded that self-efficacy changes depending on a student's alma mater (Kurbanoğlu & Takunyacı, 2012; Macabebe et al., 2010; Akkuzu and Akçay, 2012; Kurt & Ekici, 2012), however, there have also been studies, which concluded that a student's alma mater does not affect self-efficacy (Çetin, 2008). It is thought that as students who graduate from private high schools (College) are given a high level of academic education, their self-efficacy regarding physics is higher than those who graduate from other types of schools. Macabebe et al. (2010) noted that the students from private schools perform well in physics; their level is high because these schools have more resources and are more equipped than public schools.

According to the results, it was indicated that first grade students have higher level of self-efficacy when compared to second, third, and fourth grade students regarding the sub-dimensions of learning level and problem solving in physics. This finding is in common with some studies, which claim that there is a meaningful difference in self-efficacy in terms of learning levels (Maskan, 2010; Çalışkan et al., 2010), however, it contradicts the findings of a research by Akkuzu and Akçay (2012). Also, Ormrod (2008) stated that learned course information can gradually fade away or decay, and eventually disappear from memory altogether. The students who have recently started the university have good knowledge with regards to basic subjects like mathematics and physics. They work hard at the end of the preparation period for the Student Selection Examination, in order to be successful. As a result, they are confident and think they can easily be successful with regards to physics at university as well. This can be considered as a reason why first grade students have higher self-efficacy. However, this confidence wanes after they understand that physics at university level is more complicated, and they become anxious and develop a fear of being unsuccessful. Therefore, this can be interpreted as a reason for the fall in their level of self-efficacy.

It was shown that there was not a meaningful difference in students' self-efficacy in terms of the engineering departments in which they are studying for both sub-dimensions. This finding contradicts studies, which show that the programme type under which students are educated creates a difference in self-efficacy (Çapri & Çelikkaleli, 2008; Seker, Deniz & Görgen, 2005).

According to another finding in this research the students who have a high level of academic success have significantly higher self-efficacy than those who have a modest or low level of academic success. In addition, it was found that students who have a modest level of academic success have higher self-efficacy than students who have a low level of academic success. It was pointed out that as the level of students' academic success increases their self-efficacy generally increases as well. This result is in common with some studies in literature (Purzer, 2011; Vuong et al., 2010; Aurah et al., 2014; Selçuk et al., 2008; Çalışkan et al., 2010; Fenci & Scheel, 2005).

Conclusions

This research revealed the effect of alma mater, grade level, programme and academic achievement on physics self-efficacy. The first considerable finding of the research indicated that students' physics self-efficacy levels of students vary according to the alma maters of the students. In other words, self-efficacy levels of private high school graduate students are higher when compared with other students. According to another finding of the research, there is a relationship between self-efficacy levels and grade levels of the students. Furthermore, the results also suggested no relationship between self-efficacy levels and type of engineering departments of the students that they study. Another result of the research indicated that there is a relationship between academic achievement levels and physics beliefs about physics self-efficacy levels of the students.

From the findings obtained at the end of the research, the following can be recommended, in order to move the self-efficacy of engineering students to a higher level:

In order to increase engineering students' self-efficacy regarding physics, and the necessity of physics lessons in all areas, the engineering can continuously be applied, which can have a positive contribution to how students perceive physics and on their self-efficacy, some solutions might be provided as follows:

- removing the differences between secondary education establishments from education policies and by providing the possibility of providing competent and quality education in all schools;
- tackling a decrease in motivation, after examining the reasons behind the distinctive fall in students' self-efficacy after the first grade and examining the reasons behind students' academic failure, might be a solution for increasing engineering students' self-efficacy regarding physics as well.

In conclusion, since there is no research examining the self-efficacy of engineering students in the literature, it is believed that this research would contribute to the related literature and shed light to possible regulations for physics lectures in engineering education programmes.

In this research, four factors (alma mater, class levels, department and academic success levels) were analysed, which were thought to affect students' self-efficacy regarding physics. In future studies, the effects of factors like gender, motivation and stress on self-efficacy could be researched.

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