DEVELOPMENT OF AN ATTITUDE SCALE FOR PHYSICS COURSES AND A REVIEW OF STUDENT ATTITUDES

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Abstract. *The aim of present research was to develop a Likert type scale that determines the attitudes of 9th grade students towards physics courses so as to identify the physics students' attitudes towards this course. The research started with a draft scale of 30 items. The draft scale was applied to 177 ninth grade students as a pilot research. According to results obtained from factor analysis, a scale that has 21 items and covering six sub-sets was developed. KMO value of the scale was .82; the Bartlett's test value was 1997.3; and the internal consistency coefficient (Cronbach's alpha) was .90. The scale was then applied to 460 ninth grade students from different schools to conduct a confirmatory factor analysis. It was found that the types of upper-secondary school influence students' attitudes towards physics courses while gender and educational level of the parents had no significant influence on these attitudes. Therefore, it was also found that the students had an ambivalent attitude towards physics courses.*
Keywords: *factor analysis, physics course, scale development, student attitude.*

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Introduction

Physics courses in secondary education are one of the primary lessons that contribute to the cognitive development of students. In this course, students try to make sense of natural phenomena unfolding around them by using the laws of physics and scientific methods (Taşlıdere & Eryılmaz, 2012). Since physics is quintessentially an intellectual pursuit mainly based on mathematical processes, students find it difficult and boring (Tekbıyık & Akdeniz, 2010). Therefore, students develop a certain bias that no matter what they do, they will fail the course. The prerequisite for effectively teaching this course is to increase the students' interest and motivation (Whitelegg & Parry, 1999). To improve interest and motivation, students should first develop a positive attitude towards the course. Science educators also agree on this and argue that one of the most important objectives of the curriculum should be to help students develop a positive attitude towards science courses (Aiken & Aiken, 1969). For this context, while drafting the physics curriculum for the academic term 2018-2019, the Ministry of National Education (MoNE) significantly reduced the proportion of mathematical processes in the 9th and 10th grade physics courses, making physics more relatable to everyday life (MoNE, 2018). The objective of the simplification of physics courses through purging them of mathematical operations was to increase positive attitudes towards physics courses. In physics, the students' attitudes towards scientific methods, learning physics, subjects of physics and physics are important (Mbajiorgu & Reid, 2006). For learning to take place effectively and for students to learn a subject or skill, they must have the required cognitive entry behaviors and the affective entry characteristics. Cognitive entry behavior represents the behavioral prerequisites required to acquire the targeted skills while affective entry characteristics express students' interests in and attitudes towards the course and their confidence. The student's interest in and attitude towards a course corresponds to the motivation for learning that expresses the student's desire and efforts to learn (Yaşar & Anagün, 2008). Teachers, family, gender, peers, motivation, and anxiety about scientific subjects affect students' attitudes towards science courses (George, 2006). Academic confidence is a form of self-perception of whether a student can learn something or not, based on his/her previous learning experiences (Sağlam, 2001).

In order to raise individuals who can adapt to the advancing technology, it is necessary to develop a positive attitude towards science courses among students from their first years in school. After all, one of the most critical factors for the academic performance of students is their academic attitude (Abell & Lederman, 2007). By helping them develop a positive attitude towards science, students' interest in science can be increased and they can be employed in scientific-related fields in the future (Mattern & Schau, 2002). In short, it was seen that there were significant differences in terms of academic achievement between students who love science and have self-confidence and those who dislike science and have no self-confidence (Oral & McGivney, 2011).

When reviewing the literature on scales developed to study students' attitudes towards science courses, many studies were found that examine success and the cognitive characteristics of students, while fewer studies were found that examine success and the affective characteristics of students, particularly in our country (Yanpar Yelken & Ulusoy, 2013). Yiğit, Kurnaz, and Şahinoğlu (2015) examined the impact of the physics curriculum 2007 on student attitudes in terms of variables such as class level, gender, and the parents' education level. The research found that a higher-class level did not automatically translate into positive attitudes towards physics, and attitudes did not show significant variations in terms of variables such as the parents' education level or gender. Şata (2015), on the other hand, found that the variables with the greatest impact on high school students' attitudes towards the physics course were "utilizing the skills and knowledge acquired in physics courses in daily life situations" and "liking the physics course." Balbağ and Karademir (2015) found in their research focusing on the pre-service science teachers' attitudes towards physics based on certain variables that the pre-service science teachers' attitudes towards physics were generally positive. Furthermore, it was observed that there was no significant difference in the attitude of teacher candidates towards physics in terms of graduated high school type and gender, but students with a higher grade average and third and fourth grade students had a more positive attitude towards physics courses than first grade students. A review of foreign literature shows that gender and quality of teaching are crucial for students' attitudes towards science courses (Osborne, Simon, & Collins, 2003). Manuel (2013) examined in a research the correlation between the attitudes and motivations of 446 engineering and technology students towards learning physics. The research found no significant differences between the attitudes and motivations of students towards learning physics. Sitotaw and Tadele (2016) found in their research conducted with some primary and secondary school students in Dire Dawa that the students were not very satisfied with their physics teachers' methods, that they found physics a difficult lesson, and that they had particularly negative attitudes towards the mathematical aspects of the lesson. In their research, Awan, Sarwar, Naz, and Noreen (2011) found that students around the world had different attitudes towards science. It was established that students in developing countries such as Japan and Korea had a more positive attitude towards science than students in rich and developed countries. In addition, it was found that girls had a positive attitude towards biology, while boys had a positive attitude towards physics.

Research Problem

Students' anxiety, attitudes and behaviors towards lessons play an important role in their academic success (Yaşar & Anagün, 2008). The attitude of students towards any lesson has a decisive influence on their learning outcomes (Koballa, 1988). People with a positive attitude towards learning are more willing to learn (Duarte, 2007). People who have a positive attitude towards a course or topic display cognitive and affective readiness and find it easier to learn because they are highly motivated (Adıgüzel, 2014). The attitudes of individuals are not immediately visible to the eye, but one can derive an idea about their attitude towards an object by looking at their behavior (Morgan, 1991). It is important to measure attitudes in the process of teaching and education. By determining learner attitudes, learners' future behavior can be predicted, their attitudes can be changed, or even new attitudes can be created (Nuhoğlu, 2008). If learning environments in which students feel successful are created, students will develop a positive attitude towards science and enjoy learning science for life. However, when students experience negative situations in science education, they will develop a negative attitude towards science and will avoid learning it for the rest of their lives (Simpson & Oliver, 1990). Affective characteristics towards a course have many proven effects on learning (Bloom, 1979).

In particular, when national and international studies on attitudes conducted in recent years (the last 4 years) are examined, it is seen that there are considerable studies on the attitudes of secondary school students towards science, on attitudes towards a particular subject in physics, on forming positive attitudes towards physics courses through the use of different techniques and on the attitudes of teacher candidates towards physics. Furthermore, there are studies on the attitudes of students towards physics courses (Nalçacı, Akarsu, & Kariper, 2011; Özyürek &

Eryılmaz, 2001; Yanpar Yelken & Ulusoy, 2013; Tekbıyık & Akdeniz, 2010; Yiğit, Kurnaz, & Şahinoğlu, 2015). However, most of these studies are old and limited in number. The direction (positive-negative) or intensity (more or less) of people's attitudes towards an object, person, or situation may change over time. For this purpose, an up-to-date and at the same time, a valid and reliable attitude scale was needed to measure the attitudes of 9th grade students towards physics courses.

Research Focus

This research aimed to develop an up-to-date, valid and reliable measurement tool that measures attitudes of 9th grade students towards physics courses. Why 9th grade students? Because it was considered necessary as the students come across physics for the first time in 9th grade and therefore, their attitudes in 9th grade affect their attitudes towards physics in other grades. Because of this reason, especially, it is focused on 9th grade students in this research. By searching the causes of negative attitudes of 9th grade students towards physics courses and finding solutions to counteract them, thus, it can be helped to exhibit a more positive attitude towards physics courses at teaching in higher education.

The aim of this research to answer the following questions:
1. What are the general attitudes of ninth grade students towards physics course?
2. Do ninth grade students' general attitudes towards physics course show a significant difference according to variables such as gender, the parents' educational level, and types of upper-secondary school attended?

Research Methodology

General Background

While knowledge and technology are growing very fast and spreading at the same time, paradoxically, the interest in science is declining and current state has become a concern for all academic of sciences (Klein & Macchi, 2003). The lot of research had been conducted on science attitudes of students in each level of education background in the science education literature (Bhardwaj & Kaushik, 2014; Shah & Mahmood, 2011; Gardner, 1975; Chiarelott & Czemiak, 1985; Kind, Jones, & Barmby, 2007). In this context, an attitude scale towards physics courses for 9th grade students had been developed in the present research. The research was conducted with 9th grade students attending the upper-secondary schools in the center of Nizip district of Gaziantep province in the academic year 2018-2019. The data were collected over a period of approximately 1 month.

Participants

The research population comprises of 3545 ninth grade students attending the upper-secondary schools in the center of the Nizip district of Gaziantep province in the academic year 2018-2019. The research sample consisted of 460 ninth grade students selected from the 3545 students according to the sampling method for maximum diversity. Maximum diversity sampling is defined as the determination of different situations that are homogeneous in themselves which are related to the research question and the conducting of the study based on these situations (Büyüköztürk et al., 2010). In the present research that searches the attitudes of 9th grade students towards physics courses, upper-secondary schools with different success levels (Anatolian Religious Vocational High School, Science High School, Private High School, Technical and Vocational High School, Social Sciences High School, Anatolian High School) located in the Nizip district center were selected. In the scale development stage, a pilot research was carried out by applying the draft scale to 177 ninth grade students. The sample group must represent the research population well. Nunnually (1978) thought that it is sufficient to have a sample of 300 individuals to conduct studies on scales. The sample of this research comprising of 460 individuals ranges between good to very good (Comrey & Lee, 1992). Considering that the draft scale consists of 30 items in the pilot research phase, and this has been applied to 177 students, the number of samples is approximately six times the total number of items (Bryman & Cramer 2001; Nunnually 1978; Gorusch, 1983). In addition, results of the KMO and Bartlett's tests carried out to determine whether the data were suitable for factor analysis and also to determine whether there was a correlation between the variables showed that the sample size was sufficient to perform factor analysis. Since during the attitude assessment phase, the sample contained 460 individuals, and the number of items was 21, the

number of samples is approximately twenty-one times the number of items. Based on all obtained results, it can be said that the sample size is large enough to represent the target population. In Table 1, general information on the working group for the attitude assessment phase is given.

Table 1

Demographic characteristics of the working group in the attitude assessment phase

Participants		f	%
Gender	Female	174	37.82
	Male	286	62.18
Types of Upper-Secondary School	Anatolian Religious Vocational High School	70	15.21
	Science High School	80	17.39
	Private High School	12	2.60
	Technical and Vocational High School	139	30.21
	Social Sciences High School	82	17.82
	Anatolian High School	77	16.73
Education Status of Mother	Elementary School	218	47.39
	Secondary School	131	28.47
	Upper-Secondary School	74	16.08
	University	31	6.73
	Graduate	6	1.30
Education Status of Father	Elementary School	109	23.69
	Secondary School	157	34.13
	Upper-Secondary School	119	25.86
	University	56	12.17
	Graduate	19	4.13

According to Table 1, 174 (37.82%) of the students participating in the research were female, and 286 (62.18%) were male. In addition, 139 (30.21%) of the students attended a technical and vocational high school, 82 of them (17.82%) attended a social sciences high school, 80 of them (17.39%) attended a science high school, 77 of them (16.73%) attended an Anatolian high school, 70 of them (15.21%) attended an Anatolian religious vocational high school and 12 of them (2.60%) attended a private high school. 218 students (47.39%) had mothers that were primary school graduates and 109 (23.69%) had fathers that were primary school graduates; 131 (28.47%) had mothers that were secondary school graduates and 157 (34.13%) had fathers that were secondary school graduates; 74 (16.08%) had mothers that were high school graduates and 119 (25.86%) had fathers that were high school graduates; 31 (6.73%) had mothers that were university graduates and 56 (12.17%) had fathers that were university graduates; 6 (1.30%) had mothers that had a post-graduate degree, and 19 (4.13%) had fathers that had a post-graduate degree.

Instrument and Procedures

The steps that must be followed to design an attitude scale have been given as following (Balcı, 2007):
1. Creation of attitude items
2. Obtaining expert opinion
3. Pre-trial
4. Factor analysis
5. Calculation of reliability

1. Creation of Attitude Items: Before getting on with the task of developing a scale, the researcher should thoroughly analyze whether or not there is already a scale developed that fits the purposes of the research, and if yes,

whether it is more appropriate to adapt that scale or develop a new one (Tavşancıl, 2002). In this research, attitude scales cited in the literature were reviewed before the development of the scale, and two attitude scales created by Abak (2003) and Şahin (2014) were utilized. Firstly, these two scales of 25 and 32 items were examined by two faculty members specialized in the area and a physics teacher. Then 30 items were selected from these two scales, and a draft scale was created. The 30-items draft scale is a 5-point Likert-type scale, and the items are "I fully agree," "I agree," "undecided," "I disagree," "I do not agree at all." The Likert-type scale is the most preferred scale, among others (Thurstone, Guttman, Likert, etc.). Likert-type scales are often preferred because they are practical and yield results on an equal-interval scale by increasing the rating level (Tezbaşaran, 2008).

2. Obtaining Expert Opinion: The draft scale was reviewed by two faculty members of the Department of Mathematics and Science Education, two faculty members of the Department of Educational Sciences and two physics teachers working at schools under the Ministry of National Education. The scale was reviewed from the following points of view: whether items in the scale are easy for the target group to understand and whether they are simple and clear; whether one item contains more than one judgment or thought and whether what is intended to be measured is represented strongly enough. It was decided that the items that make up the draft scale are clear and understandable and are capable of measuring the variable that is intended to be measured. The scope and face validity (superficial validity) of the scale were also verified through expert opinion.

3. Pre-trial: A trial application of the scale designed according to expert opinion is important to ensure optimum performance (Karakoç & Dönmez, 2014). After a trial run, items with insufficient reliability and validity that do not serve the purpose can be removed from the scale. Depending on the research topic, a pre-trial group of fifty people is usually enough for a survey type study (Karasar, 2009). To this end, a preliminary trial was carried out on 177 ninth grade students. Items that turned out not to have sufficient reliability and validity after the research were excluded from the scale.

4. Factor Analysis: It is one of the most fundamental statistics used to measure the structural validity of a scale (Aiken, 1985). It was designed to explain the structure of tests that measure psychological characteristics, such as intelligence, performance, and attitude (Thompson, 2004). In this research, an exploratory factor analysis was applied to a sample group to reveal the factor structure of the scale. While a confirmatory factor analysis was applied to another sample group to confirm the factor structure.

5. Calculation of Reliability: The Cronbach's alpha coefficient method is an internal consistency estimation method that is suitable for use when the items are not rated as true or false but rather through the assignment of scores like 1-3, 1-4, 1-5. In this research, the internal Cronbach's alpha consistency coefficient of the attitude scale, whose factor analysis has been performed, and the reliability coefficients of the sub-sets were analyzed.

Data Analysis

The scale was validated via exploratory and confirmatory factor analyses. KMO value of the scale was .82; the Bartlett's test value was 1997.3; and the internal consistency coefficient (Cronbach's alpha) was .90. Independent t-test was performed for correlation between attitude and gender. One-way variance analysis (ANOVA) was performed for correlation between attitude and types of upper-secondary school attended, educational level of parents. An alpha level (or significant level) of .05 was used for all statistical analyses. The package programs (IBM SPSS 21.0 and Lisrel 8.7) had been used in analyzing of data obtained.

Research Results

Findings through Scale Development

The scope, face (superficial), and structural validity were examined when determining the validity of the developed scale. In order to ensure the scope and the face (superficial) validity of the scale, an expert opinion was obtained. In order to ensure the structural validity of the scale, a factor analysis was performed. Following the factor analysis, items 4, 6, 7, 26, and 27 were removed from the scale due to having loading values below .45. Since items 5, 8, 9, and 28 overlapped, it was considered appropriate to remove these items from the scale. Thus, the draft scale was reduced from 30 items to 21 items. In order to perform a factor analysis, it must first be checked

whether the data obtained are suitable for a factor analysis. This in turn requires the Kaiser-Meyer-Olkin (KMO) test and the Bartlett's sphericity test. The KMO assumes a value between 0 and 1 (Kaiser, 1974). If the test result is greater than .50, the factor analysis is continued (Ünlü Yavaş & Çağan, 2017; Sharma, 1996). Since the Bartlett's sphericity test indicates the statistical chi-square value, the significance level of this value must be examined. A factor analysis can be performed only if the significance value is less than .05. The Kaiser-Meyer-Olkin (KMO) value and the Bartlett's sphericity test results of this research are given in Table 2.

Table 2

*Kaiser-Meyer-Olkin (KMO) sample measurement and Bartlett's test results*

Kaiser-Meyer-Olkin (KMO) Sample			
Measurement Value Adequacy	**.82**		
Bartlett's Test Approximate Chi-Square Value	1997.3	*df*=210	*p*<.05

In this research, the value of the KMO test was calculated as .82 and considered a valuable value (Kaiser, 1974). According to the results of the Bartlett's sphericity test, the chi-square value (*p*<.05) was significant. These values mean that factor analysis can be continued for scale development.

The principal component factor analysis was used to uncover the factor pattern of the attitude scale. One of the vertical rotation methods, maximum variability (varimax) was chosen as the rotation method. As a result of the Varimax analysis, six factors with eigenvalues greater than 1 were found. In order to determine the exact number of factors in the scale, the scree plot drawn according to the eigenvalues of the factors was examined (Büyüköztürk, 2007).

Figure 1

Scree plot for physics attitude scale
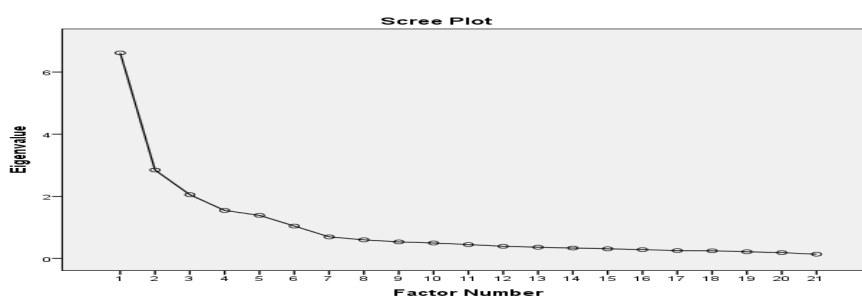
According to Büyüköztürk (2008), sharp decreases in a scree plot indicate the number of factors. When Figure 1 is analyzed, it can be seen that the diagram curve shows an accelerated decrease after the sixth factor. It is also seen that the curve progresses in the same direction starting from the sixth factor. And this shows that the scale has a six-factor structure. Eigenvalues, variance percentages and total variance percentages of the six factors are given in Table 3.

Table 3

Eigenvalues, variance percentages and total variance percentages of factors

Factor	Eigenvalue	Variance Percentage	Total Variance Percentage
1	6.61	14.80	14.80
2	2.84	11.79	26.60
3	2.05	10.74	37.34

11

Factor	Eigenvalue	Variance Percentage	Total Variance Percentage
4	1.54	10.54	47.89
5	1.38	9.17	57.06
6	1.04	7.25	64.32

When Table 3 is examined, the eigenvalues of the six factors on the attitude scale are 6.61; 2.84; 2.05; 1.54; 1.38; 1.04 respectively. While the variance percentages explained by the factors were 14.80; 11.79; 10.74; 10.54; 9.17; 7.25 respectively. According to Kline (1994), the number of factors on a scale should account for 41% and more of the total variance. While six factors on the attitude scale account for 64.32% of the total variance. The six factors on the attitude scale account for a variance that is well above the limit (41%). In this context, the scale can be considered a six-factor scale.

How the items are distributed according to the factors as well as the factor positions are shown in Table 4 based on the principal component and varimax rotation results used to see the distribution of 21 items in the draft scale according to six factors.

Table 4

Distribution of items on the attitude scale by factors and factor loads

Item No	Items	Factor Loadings					
		F1	F2	F3	F4	F5	F6
11	I try to do my best in physics courses.	.849					
8	I do my best to succeed in physics courses.	.839					
10	I try even harder when I fail in physics courses.	.764					
9	I do my best no matter how hard the task in a physics lesson.	.756					
5	Physics courses fill me with anxiety.		.829				
7	Physics courses make me feel nervous and confused.		.771				
4	I feel anxious during physics courses.		.742				
6	Physics courses make me feel uncomfortable and irritated.		.645				
1	Physics courses are fun.			.755			
3	I look forward to physics courses.			.754			
2	I find physics courses interesting.			.605			
15	I am capable of getting good grades in physics.				.829		
13	I am smart enough to handle physics.				.693		
14	I am proud of my success in physics courses.				.619		
12	I am proud of my skills in physics courses.				.541		
17	I'd like to know more about physics.					.690	
18	I'd like to improve my skills in physics.					.595	
16	I'd like to take physics courses even if I don't have to.					.569	
19	I want to take as many physics classes as I can during my educational life.					.561	

Item No	Items	Factor Loadings					
		F1	F2	F3	F4	F5	F6
20	I am very worried about having to use mathematical expressions in physics.						.990
21	Trying to read a sentence full of mathematical physics formulas containing unfamiliar symbols scares me a lot.						.680

Taking into account the factor loading values of the items in Table 4, the loading value of the first factor ranges between .849 to .756; the loading value of the second factor between .829 to .645; the loading value of the third factor between .755 to .605 while the fourth factor has a loading value of .829 to .541; the fifth factor has a loading value of .690 to .561 and the loading value of the sixth factor varies between .990 and .680. The factor loading value could be considered "weak" if it was .32, "average" if it was .45, "good" if it was .55, "very good" if it was .63 and "excellent" if it was .71 (Comrey & Lee, 1992; Tabachnick & Fidell, 2013). Accordingly, the factor loading value of item 12 lies between "average" and "good"; the factor loading values of items 2, 16, 18, and 19 are "good." The factor loading values of items 6, 13, 14, 17, and 21 are "very good" while the factor loading values of items 1, 3, 4, 5, 7, 8, 9, 10, 11, 15, and 20 are "excellent."

When naming the factors, items collected under the factors were reviewed. The first factor was called "motivation," the second "anxiety about physics," the third "interest in physics courses," the fourth "self-sufficiency," the fifth "student interest," and the sixth "anxiety about math." Abak's research (2003) was used as reference for this denomination. Table 5 shows the items on the scale and the names of the factors where the items are placed.

Table 5
Factor names and item numbers that factors contain

Factors	Item Numbers
Motivation	8, 9, 10, 11
Anxiety about Physics	4, 5, 6, 7
Interest in Physics Courses	1, 2, 3
Self-sufficiency	12, 13, 14, 15
Student Interest	16, 17, 18, 19
Anxiety about Mathematical Operations	20, 21

The "motivation" factor represents how much of an effort the student puts in while learning physics; the "anxiety about physics" factor represents how the student feels when learning physics; the "interest in physics courses" factor represents what the student thinks about physics courses; the "self-sufficiency" factor represents the student's confidence in his/her skills in physics; the "student interest" factor represents what the student thinks about physics courses; the "anxiety about math" factor expresses how the student feels when he/she has to use mathematical expressions during physics courses.
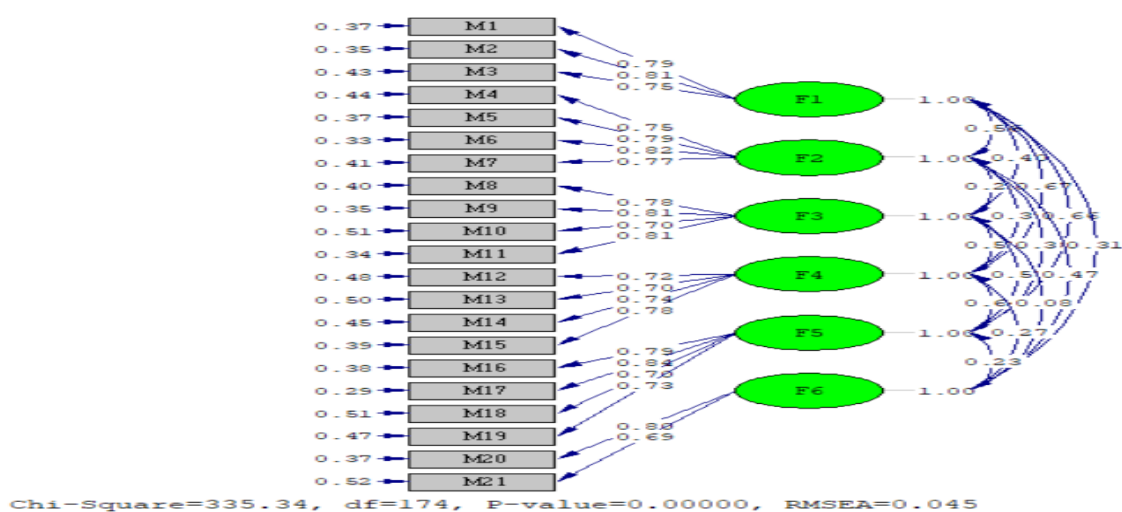
Confirmatory Factor Analysis Findings

In this research, Confirmatory Factor Analysis (CFA) was performed to test the theoretical structure of the Physics Attitude Scale, which consists of six factors and twenty-one items. Thus, the compatibility of the factor model obtained by exploratory factor analysis was examined. Analyzes were performed using the LISREL 8.7 package program. The analysis starts with the drawing of a path diagram. In this diagram, rectangular drawings show scale items and oval drawings show the factors. Factor loadings related to the model are shown in Figure 2.

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Figure 2

The path diagram of overall model fit for the six-factor solution of the physics attitude scale

Chi-Square=335.34, df=174, P-value=0.00000, RMSEA=0.045

Note: (where F1=interest in physics courses; F2=anxiety about physics; F3=motivation; F4=self-sufficiency; F5=student interest; F6=anxiety about mathematical operations).

In confirmatory factor analysis, the correlations between factors and items are indicated by arrow lines, also called routes. Each route shows the representation load of factors in the items. In exploratory factor analysis, this load is called the factor load (Şencan, 2005). When Figure 2 is examined, it is seen that the factor load values of the items vary between 0.69 and 0.84 in the model. Even if the factor load values of the items are very good, goodness-of-fit indices may not reach normal values. In this research, goodness-of-fit values were examined for compliance of the model with the data structure. In the literature, various goodness-of-fit indices are used to determine the degree of compliance of the model tested by confirmatory factor analysis. These goodness-of-fit indices are the chi square (χ^2), the degree of freedom *(df)*, goodness-of-fit index *(GFI)*, adjusted goodness-of-fit index *(AGFI)*, Root Mean Square Error of Approximation *(RMSEA)*, Root Mean Square Residuals *(RMR)*, and Standardized Root Mean Square Residual *(SRMR)*. There is no consensus on which of these goodness-of-fit indices should be accepted as standard (Munro, 2005). Goodness-of-fit values of the model tested with confirmatory factor analysis are given in Table 6.

Table 6

Confirmatory factor analysis goodness-of-fit values

Analysis	χ^2	χ^2/df	GFI	AGFI	CFI	RMSEA	RMR	SRMR
Result	335.34	1.92	.93	.91	.99	.038	.071	.041

When Table 6 is examined, *χ2* (p>.05) , *χ2/df* (<2), *CFI* (>.95), *RMSEA* (<.05), *SRMR* (<.05) values are normal values while *GFI* (>.90), *AGFI* (>.90), *RMR* (<.08) values are acceptable values. These values indicate a good measure of compliance for the factor structure of the physics attitude scale. In addition, the previously determined factor structure for the scale was confirmed by Confirmatory Factor Analysis.

Discriminative Power of Items

One of the methods used in item analysis is to test the differences between the item averages of the lower 27% and upper 27% groups based on the total values using the independent t-test (Büyüköztürk et al., 2010). In this research, discriminative power of the items constituting the scale was calculated. When calculating the discriminative power of the items, the total score of each subject was calculated first. Then these scores were ranked on a scale ranging from "small" to "large". 27% (124) of the group consisted of the upper group and 27% (124) of the lower group. The independent t-test for groups was used to determine whether there was a significant difference between upper and lower groups.

Table 7

Item discriminative powers of the scale (Upper and lower group t-values)

Item no.	t	Item no.	t	Item no.	t
1	18.39*	8	9.74*	15	17.77*
2	16.74*	9	13.06*	16	20.26*
3	14.95*	10	10.32*	17	19.26*
4	11.73*	11	13.79*	18	13.49*
5	11.66*	12	13.54*	19	14.25*
6	13.71*	13	15.78*	20	7.65*
7	12.87*	14	13.97*	21	9.48*

(p<.05)

Table 7 reveals that all items that make up the scale for physics anxiety are significant ($p<.05$). Significant differences between the groups in the desired direction indicate the internal consistency of the test (Büyüköztürk et al., 2010). Since the *t*-values of the items of the scale are significant, it could be argued that the items of the scale are high in validity and capable of measuring the same behaviors.

Scale Reliability

Cronbach's alpha reliability coefficients were calculated for the general and sub-factors of the scale. The Cronbach's alpha value for the entire scale was .90. The Cronbach's alpha value for the sub-factors ranged from .71 to .86. Cronbach's alpha values and interpretations of the factors included in the scale are given in Table 8.

Table 8

Cronbach's alpha values and interpretations of the factors included in the scale

Factors	Cronbach's alpha	Remark
Motivation	.85	Good
Anxiety about Physics	.86	Good
Interest in Physics Courses	.82	Good
Self-sufficiency	.82	Good
Student Interest	.84	Good
Anxiety about Math	.71	Good

With respect to Table 8, it can be argued that the reliability coefficients of the factors in the scale are "good."

Findings Regarding Students' Attitudes Towards Physics Courses

The attitudes of the students towards physics courses were evaluated based on the factors and items. For this purpose, the gap width of the scale was first calculated with the formula "sequence width/number of groups to be included" (Tekin, 2001). According to this formula, the gap width was .80. The means, general means and frequencies of the scores given to the scale items based on options were assessed based on the score intervals:

"1.00-1.80 = Do not agree at all",

"1.81-2.60 = Disagree",

"2.61-3.40 = Undecided",

"3.41-4.20= Agree,"

"4.21-5.00 = Fully agree".

Table 9

Distribution of students' attitudes towards physics courses by options

Item No	Items	f (%)	f (%)	f (%)	f (%)	f (%)	$\bar{X}$	SD
1	Physics courses are fun.	62 (13.5)	54 (11.7)	110 (23.9)	94 (20.4)	140 (30.4)	3.43	1.37
2	I find physics courses interesting.	65 (14.3)	76 (16.7)	117 (25.7)	107 (23.5)	90 (19.8)	3.18	1.31
3	I look forward to physics courses.	95 (20.9)	85 (18.7)	124 (27.3)	85 (18.7)	66 (14.5)	2.87	1.32
4	I feel anxious during physics courses.	145 (32.2)	122 (27.1)	78 (17.3)	60 (13.3)	45 (10.0)	2.42	1.32
5	Physics courses fill me with anxiety.	155 (34.8)	129 (28.9)	74 (16.6)	50 (11.2)	38 (8.5)	2.30	1.28
6	Physics courses make me feel uncomfortable and irritated.	190 (42.2)	127 (28.2)	54 (12.0)	39 (8.7)	40 (8.9)	2.14	1.30
7	Physics courses make me feel nervous and confused.	174 (38.6)	127 (28.2)	63 (14.0)	43 (9.5)	44 (9.8)	2.24	1.32
8	I do my best to succeed in physics courses.	23 (5.09)	28 (6.1)	65 (14.3)	124 (27.2)	216 (47.4)	4.06	1.14
9	I do my best no matter how hard the task in a physics lesson.	26 (5.7)	39 (8.5)	87 (19.0)	132 (28.8)	174 (38.0)	3.85	1.18
10	I try even harder when I fail in physics courses.	33 (7.2)	43 (9.4)	77 (16.8)	132 (28.9)	172 (37.6)	3.80	1.23
11	I try to do my best in physics courses.	27 (6.1)	29 (6.5)	59 (13.2)	141 (31.6)	190 (42.6)	3.98	1.15
12	I am proud of my skills in physics courses.	58 (13.2)	62 (14.1)	132 (30.1)	89 (20.3)	98 (22.3)	3.24	1.27
13	I am smart enough to handle physics.	57 (12.5)	48 (10.5)	115 (25.2)	109 23.9	128 (28.0)	3.44	1.32
14	I am proud of my success in physics courses.	58 (12.7)	63 (13.8)	98 (21.4)	129 (28.2)	110 (24.0)	3.37	1.32
15	I am capable of getting good grades in physics.	68 (15.0)	70 (15.5)	140 (31.0)	106 (23.5)	68 (15.0)	3.08	1.25
16	I'd like to take physics courses even if I don't have to.	93 (20.4)	59 (12.9)	92 (20.1)	102 (22.3)	111 (24.3)	3.17	1.44
17	I'd like to know more about physics.	68 (14.9)	52 (11.4)	92 (20.1)	105 (23.0)	140 (30.6)	3.43	1.40
18	I'd like to improve my skills in physics.	43 (9.5)	39 (8.6)	46 (10.1)	131 (28.9)	195 (43.0)	3.87	1.30

Attitude items		Options						
Item No	Items	f (%)	f (%)	f (%)	f (%)	f (%)	$\bar{X}$	SD
19	I want to take as many physics classes as I can during my educational life.	102 (22.3)	72 (15.8)	134 (29.3)	65 (14.2)	84 (18.4)	2.91	1.38
20	I am very worried about having to use mathematical expressions in physics.	148 (32.2)	86 (18.7)	87 (19.0)	63 (13.7)	75 (16.3)	2.63	1.46
21	Trying to read a sentence full of mathematical physics formulas containing unfamiliar symbols scares me a lot.	118 (25.7)	87 (18.9)	99 (21.5)	60 (13.0)	96 (20.9)	2.85	1.47

Table 9 shows that students are largely undecided about physics courses. Of the 21 items in the scale, 8 (43%) were within the "I agree" score range; 9 (38%) were within the "undecided" score range and 4 (19%) were within the "I disagree" score range. The following can be derived based on the answers of the students to the scale items.

All items measuring the motivation factor were within the "I agree" score range ($\bar{X}_{motivation}$=3.92). An individual assessment of the items revealed that 27.2% of the students agree with the option "I do my best to succeed in physics courses"; 28.8% agree with the option "I do my best no matter how hard physics courses are"; 28.9% agree with the option "I try even harder when I fail in physics courses" and 31.6% agree with the option "I try to do my best in physics courses". All items measuring the physics anxiety factor were within the "I disagree" score range ($\bar{X}_{physics\,anxiety}$=2.27). An individual assessment of the items shows that 27.1% of the students disagree with the option "I feel nervous in physics courses"; 28.9% disagree with the option "I feel anxious about attending physics courses"; 28.2% disagree with the option "I feel uncomfortable and irritated about attending physics courses" and 28.2% disagree with the option "I feel nervous and confused when I attend physics courses". 33% of the items measuring the interest factor in the physics courses were within the "I agree" and 66% were within the "undecided" score range. The general average was within the "undecided" score range ($\bar{X}_{interest\,in\,physics}$=3.16). 20.4% of the students agreed that physics courses were fun, 25.7% said that they were undecided about whether they found physics courses interesting while 27.3% were not sure about whether they were looking forward to physics courses. 25% of the items that measure the self-sufficiency factor were within the "I agree" and 75% were within the "undecided" score range. The general average was within the "undecided" score range ($\bar{X}_{self\text{-}sufficiency}$=3.16). 23.9% of the students stated that they agree that they were smart enough to deal with physics; whereas 30.1% stated that they were undecided about whether they were proud of their skills in physics, 21.4% stated that they were undecided about whether they were proud of their achievements in physics and 31% stated that they were undecided about whether they were capable of getting good grades in physics. 50% of the items measuring the student interest factor were in the "I agree" and 50% were within the "undecided" score range. The general average was within the "undecided" score range ($\bar{X}_{self\text{-}sufficiency}$=3.34). 20.1% of the students said they were undecided about wanting to take physics courses on a voluntary basis and 29.3% said they were undecided about wanting to take as many physics courses as they can during their time at school. 23% of the students said they wanted to learn more about physics, and 28.9% said they wanted to improve their skills in physics. All items that measure the anxiety of math operations factor were found within the "undecided" score range. ($\bar{X}_{anxiety\,about\,math\,operations}$=2.74). 19% of the students said that they were undecided about whether they were very concerned about having to use mathematical expressions in physics classes, and 21.5% said that they were undecided about whether they were pretty scared about trying to read mathematical physics formulas containing symbols they are not familiar with.

Findings Regarding the Evaluation of Students' Attitudes Towards Physics Courses According to Different Variables

It was examined whether the total average attitude scores of students with regards to physics courses varied according to gender, types of upper-secondary school attended, and the educational level of parents. As a result of this analysis, it was found that the data had normal distribution and the variances were homogeneous. Afterwards, the independent *t*-test (correlation between attitude score and gender) was performed for groups with two variables while the one-way variance analysis (ANOVA) (attitude scores, types of upper-secondary school attended

and educational level of parents) was performed to uncover differences between multiple groups.

The results of the independent *t*-test performed to determine whether the gender variable affects students' attitude scores in relation to physics courses are presented in Table 10.

Table 10
Average attitude scores of students in relation to physics courses by gender and results of the t-test

Gender	N	$\bar{X}$	SD	df	t	p
Female	173	3.41	.78	457	1.17	.23
Male	286	3.50	.75			

Table 10 shows that the average attitude scores of male students ($\bar{X}$=3.50) with regards to physics courses are higher than those of female students ($\bar{X}$=3.41). However, there was no significant difference between the attitudes of male and female students to physics courses (*p*>.05). This finding can be interpreted as the gender variable having no significant impact on the attitude of students towards physics courses.

The results of the one-way variance analysis (ANOVA) performed to determine whether the "types of upper-secondary school attended" variable affects attitude scores in relation to physics courses are presented in Table 11.

Table 11
Central tendency and distribution levels of attitude scores of students for physics courses according to the types of upper-secondary school variable

Types of Upper-Secondary School	N	$\bar{X}$	SD
Anatolian Religious Vocational High School	70	3.87	.59
Science High School	80	3.70	.73
Private High School	12	3.48	.99
Technical and Vocational High School	139	3.31	.70
Social Sciences High School	82	3.54	.77
Anatolian High School	77	3.09	.77
Total	460	3.47	.76

Table 11 reveals that the ranking of average student attitude scores from high to low in relation to physics courses materializes as Anatolian Religious Vocational High School ($\bar{X}$=3.87), Science High School ($\bar{X}$=3.70), Social Sciences High School ($\bar{X}$=3.54), Private High School ($\bar{X}$=3.48), Technical and Vocational High School ($\bar{X}$=3.31), and Anatolian High School ($\bar{X}$=3.09) according to the types of upper-secondary school variable.

Table 12
Attitude scores of students for physics courses according to the types of upper-secondary school variable and the ANOVA results

Source of the Variance	Sum of Squares	df	Average of Squares	F	p
Intergroup	30.112	5	6.022	11.36	<.05
Intragroup	240.549	454	0.530		
Total	270.661	459			

ANOVA results in Table 12 show that there is a significant difference ($F_{(5-454)}$=11.36; *p*<.05) between students' attitudes to physics courses according to the types of upper-secondary school variable. The average attitudes of Anatolian Religious Vocational High School and Science High School students towards physics courses is higher than those of students from other upper-secondary schools (Social Sciences High School, Private High School, Technical and Vocational High School, and Anatolian High School).

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The results of the one-way variance analysis (ANOVA) performed to determine whether the "educational status of mother" variable affects attitude scores in relation to physics courses are presented in Table 13.

Table 13

Central tendency and distribution levels of attitude scores of students for physics courses according to the educational status of mother variable

Educational Status	N	$\overline{X}$	SD
Elementary School	218	3.49	.74
Secondary School	131	3.42	.80
Upper-Secondary School	74	3.52	.69
University	31	3.37	.89
Graduate	6	3.84	1.17
Total	460	3.47	.76

An analysis of Table 13 shows that the ranking of average attitude scores of students from high to low in relation to physics courses materializes as those with a post-graduate degree ($\overline{X}$=3.84), upper-secondary school graduates ($\overline{X}$=3.52), primary school graduates ($\overline{X}$=3.49), secondary school graduates ($\overline{X}$=3.42), university graduates ($\overline{X}$=3.37) according to the "educational level of mother" variable.

Table 14

Attitude scores of students for physics courses according to the educational status of mother variable and the ANOVA results

Source of the Variance	Sum of Squares	df	Average of Squares	F	p
Intergroup	1.798	4	0.450	0.76	.551
Intragroup	268.863	455	0.591		
Total	270.661	459			

ANOVA results in Table 14 show that there is no significant difference ($F_{(4-455)}$=0.76; p>.05) between students' attitudes towards physics courses according to the "educational status of mother" variable. In other words, attitudes of students whose mothers have a primary school, secondary school, upper-secondary school, university and graduate diploma are similar towards physics courses.

The results of the one-way variance analysis (ANOVA) performed to determine whether the "educational status of father" variable affects attitude scores in relation to physics courses are presented in Table 15.

Table 15

Central tendency and distribution levels of attitude scores of students for physics courses according to the educational status of father variable

Educational Status	N	$\overline{X}$	SD
Elementary School	109	3.48	.73
Secondary School	157	3.46	.77
Upper-Secondary School	119	3.44	.74
University	56	3.56	.78
Graduate	19	3.45	.99
Total	460	3.47	.76

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An analysis of Table 15 shows that the ranking of average attitude scores of students from high to low in relation to physics courses materializes as university graduates ($\bar{X}$=3.56), primary school graduates ($\bar{X}$=3.48), secondary school graduates ($\bar{X}$=3.46), those with a post-graduate degree ($\bar{X}$=3.45) and upper-secondary school graduates ($\bar{X}$=3.44) according to the "educational level of father" variable.

Table 16

Attitude scores of students for physics courses according to the educational status of father variable and the ANOVA results

Source of the Variance	Sum of Squares	df	Average of Squares	F	p
Intergroup	0.558	4	0.139	0.23	.919
Intragroup	270.103	455	0.594		
Total	270.661	459			

ANOVA results in Table 16 show that there is no significant difference ($F_{(4-455)}$=0.23; p>.05) between students' attitudes towards physics courses according to the "educational status of father" variable. In other words, attitudes of students whose fathers have a graduate, university, upper-secondary school, secondary school, and primary school diploma are similar towards physics courses.

Discussion

A review of the fundamentally changed physics curriculum for 2007 reveals that studies have been classified into two categories, namely information and skills, and that the most important part of the "skills" component is attitudes and values (MoNE, 2007). Similarly, one of the objectives of the physics curriculum revised in 2013 was set out as the education of individuals who have a positive attitude towards themselves and their environment, equipped with knowledge, and skills required by the information age (MoNE, 2013). Besides, the curriculum which was amended once again in 2017 came with a fresh focus on attitudes and values (MoNE, 2017). Physics and life are almost inseparable, closely intertwined with each other. However, students define it as a lesson that includes boring, difficult, and unnecessary information. The fact that the subjects of physics are filled with abstract mathematical operations is one of the main reasons for this (MoNE, 2017). In order to help students overcome their prejudices about physics and become more successful, student interest in the course must be reawakened (Whitelegg & Parry, 1999). Therefore, it is of great importance to research students' attitudes towards physics courses and exploit those insights when designing learning environments. For this purpose, an up-to-date and at the same time, a valid and reliable attitude scale was needed to measure the attitudes of 9th grade students towards physics courses. The developed attitude scale towards 9th grade physics courses is different in terms of its aim, content and factors when compared with other scales developed towards physics lessons and its topics. The Physics Anxiety Rating Scale (PARS) developed by Şahin, Çalışkan, and Dilek (2015) consists of 50 items and 4 factors. The factors were named physics course/test anxiety, anxiety about lack of physics knowledge, mathematics anxiety and physics laboratory anxiety. The sample gorup of this research was 460 ninth grade students while sample group of PARS was 495 university education students. The factor of "mathematics anxiety" in PARS is similar the factor of "anxiety about mathematical operations" in this research. But when these factors are compared, it can be seen that they consist of different items. The Attitude Scale towards High School Physics Lessons developed by Ünlü Yavaş and Çağan (2017) consists of 28 items and 4 factors. Although the aims of this research and the present research are the same, the factors of them are different. The factors were named as interest, anxiety, importance, self-efficacy. Although "self-efficacy" and "self-sufficiency" factors are named as differently, the meanings of these words are the same. But these factors consist of different items. Tekbıyık and Akdeniz (2010) developed Physics Attitude Scale towards 9th grade physics courses. Although the working group of this research consists of 9th grade students, item number (30 items) and factor names (importance, comprehension, necessity and intereset) of this research differ from the present research. The Physics Attitude Scale (PAS) developed by Kaur and Zhao (2017) consists of 60 items and 5 factors. The factors of the PAS are "enthusiasm toward Physics", "Physics learning", "Physics as a process", "Physics teacher" and "Physics as a future vocation". The factor of "enthusiasm toward Physics" creates a distinctness when compared

to other scales. Although this factor reminds us of the "interest in Physics courses" factor in this research, it is quite different in terms of its items. In addition, it was also examined whether the general attitudes of 9th grade students changed according to some variables (such as gender, types of upper-secondary school and educational level of the parents). An examination of the impact of gender differences on students' attitudes towards physics courses reveals that there is no significant difference between female and male students' attitudes towards physics courses. This result bears similarities with those obtained by other studies (Yıldırım & Kansız, 2017; Yiğit et al., 2015; Balbağ & Karademir, 2015; Kaya & Böyük, 2011; Yanpar Yelken & Ulusoy, 2013). However, literature research also reveals studies showing significant differences in attitude scores based on gender (Özyürek & Eryılmaz, 2001; Aydın, 2016). The reason for the incongruity in results may be ascribed to the fact that the attitude studies were conducted in different age groups. In addition, an examination of the 2007 physics curriculum shows that one of the objectives of the program is to eliminate performance differences between students of different sexes (MoNE, 2007). An examination of the impact of the "types of upper-secondary school attended" variable on students' attitudes towards physics courses reveals that there is a significant difference between students' attitudes towards physics courses according to the types of upper-secondary school attended. While students at Anatolian Religious Vocational High School and Science High School have a more positive attitude towards physics courses, students at Technical and Vocational High School, and Anatolian High School have a more negative attitude towards physics courses. This difference may be due to the fact that the Anatolian Religious Vocational High School where the study was conducted, is a project school and that students at Science High School are largely selected from students with exceptional success in branches such as math and science. Reasons why students of the Technical and Vocational High Schools, and the Anatolian High Schools have a more negative attitude towards physics courses might be that Technical and Vocational High Schools require fewer scores in the entrance to high schools examination and academically successful students prefer Anatolian High Schools less with the conversion of regular high schools into Anatolian High Schools. An examination of the impact of the "educational status of parents" variable on students' attitudes towards physics courses reveals that there is no significant difference between students' attitudes towards physics courses according to the educational level of parents. In other words, attitudes of students whose mothers and fathers have a primary school, secondary school, upper-secondary school, university, and post-graduate diploma are similar towards physics courses. The result is similar to those obtained by other studies (Yıldırım & Kansız, 2017; Yiğit, Kurnaz, & Şahinoğlu, 2015). On the other hand, there are studies in the literature that show a direct correlation between the educational level of parents and academic success of students (Savaş, Taş, & Duru, 2010; Yayan & Berberoğlu, 2004).

Conclusions and Implications

As a result of this research, attitude scale towards physics courses was developed by the researchers. As a result of exploratory factor analysis, a factor structure that consists of 21 items and 6 factors was formed. The "motivation" factor consisted of 3 items; the "anxiety about Physics" factor consisted of 4 items; the "interest in Physics courses" factor consisted of 4 items; the "self-sufficiency" factor consisted of 4 items; the "student interest" factor consisted of 4 items; the "anxiety about mathematical operations" factor consisted of 2 items. Determined factor structure for the scale was confirmed by Confirmatory Factor Analysis. The Cronbach's alpha value for the whole scale was .90 while Cronbach's alpha value for the sub-factors ranged from .71 to .86. It is believed that the scale will contribute to the literature as a valid and reliable measuring instrument for determining students' attitudes towards physics. In this research, the working group consists of 9th grade students, which is crucial in terms of revealing the extent to which attitudes developed in this grade have a positive or negative effect on attitudes towards physics in higher grades. An analysis of student answers to the scale items shows that the students do not have a clear attitude towards physics courses in general. Based on answers to the "motivation" dimension, students do their best no matter how difficult the physics course is, they try even more when they fail in physics courses, and they try to do their best in physics courses. It can be concluded that students are highly motivated for physics courses. When the answers to the dimension of "physics anxiety" are examined, it turns out that the students do not agree that they feel anxious, uncomfortable, nervous, confused and irritated in physics courses and that they feel anxious about going to physics courses. The conclusion can be drawn that students have almost no physics anxiety and they do not feel anxious or uncomfortable about physics courses. When the answers to the "interest in physics" dimension are examined, it turns out that some of the students find physics classes entertaining, but that the majority of them are undecided about finding the physics courses interesting

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and looking forward to physics courses. When the answers to the "self-sufficiency" dimension are examined, it turns out that some of the students think they are smart enough to handle physics, while most showed an indecisive attitude towards being proud of their skills and achievements in physics courses and getting good grades in physics courses. Answers to the question regarding "student interest" shows that half of the students want to learn more about physics and improve their skills in physics. The other half were undecided about wanting to take physics courses on a voluntary basis and also about wanting to take as many physics courses as they can during their time at school. Based on answers to the question regarding "math anxiety", students did not display a clear attitude as to being very concerned about having to use mathematical expressions in physics classes and being pretty scared about trying to read mathematical physics formulas containing symbols they are not familiar with. In addition, it has been found that the types of upper-secondary school influence students' attitudes towards physics courses. However, it was also found that the parents' educational level and gender had no significant influence on these attitudes. Based on these results, the following suggestions can be offered: The developed scale is an attitude scale that has been tested for reliability and validity. Researchers wishing to determine students' attitudes towards physics courses at different class levels can use this scale. Moreover, this scale can be rearranged in a suitable format to determine attitudes towards specific subjects of physics or other courses (chemistry, biology, natural sciences, etc.). However, it may be further investigated why students do not have a clear attitude towards physics courses and why they have such attitudes.

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