"Why Do I Slog Through the Physics?" Understanding High School Students' Difficulties in Learning Physics

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Abstract
The aim of this study is to develop a valid and reliable instrument to assess why physics courses are perceived as one of the most difficult courses among high school students and to investigate the reasons why students have difficulty in learning physics through this scale. This study includes the development and validation studies of the Difficulty in Learning Physics (DiLP-S) Scale for High School Students. A draft scale study was applied to a group of 1021 high school students. At the end of the study, a scale consisting of 25 items ($\alpha = 0.921$) was developed representing 52.372% of the total variance. Based on exploratory factor analysis, it has been observed that the scale was grouped under three factors and the factors were respectively, "Teacher" (ten items, α=0.892), "Content" (ten items, α=0.853) and "Student" (five items, α=0.851). The values obtained from the results of Confirmatory Factor Analysis (Chi-Square = 720.53 (p=0.00), df=272, p-value=0.00000; RMSEA= 0.064 and CFI = 0.97), put forward a good fit between the hypothesized theoretical model and the empirical data. According to results, students emphasize mostly the content of the physics course as a reason for perceiving it as difficult. Then, students, and lastly the teachers follow it. When the scale's score means are compared according to the students' class levels, it was found out that the 9th and the 11th grade students had more difficulty in learning the physics course than the 10th graders. When the students' academic success in the physics course and the scale scores were compared, there was not a significant difference. Namely, whether they are successful or not, the students perceive the physics course to be difficult.
Keywords: Difficulty, Learning Physics, Student, Teacher, Physics Content

1. Introduction

For more than a decade, in many western countries, the decreasing career interest in science and technology among young people was recognized and expressed (Department of Education and Science, Ireland, 2002; OECD, 2006). This appears particularly grave for physics (Institute of Physics, 2001) which has a very significant role in science and technology. For this reason, some efforts have been launched in some countries to obviate this situation (Department of Education and Science, Ireland, 2002; Institute of Physics, 1999; Main, 2011) and there have been various extensive attempts to teach physics in a better and more efficient manner and to make physics more attractive. Students' perceptions of the context of any courses influence their learning. Course context is perceived differently (for example in Chemistry) by students and teachers because their experiences, knowledge, goals, needs, and motivations are different (Carter and Brickhouse, 1989). Therefore, in some studies, findings of some questions were investigated and argued such as "What makes physics difficult?", "Which topics the students find difficult?", "How do students perceive the difficulty of physics?" or "Why are the students not interested in physics?" (Erinosha, 2013; Örnek, Robinson & Haugan, 2007; Şahin & Yağbasan, 2012; Williams, Stanisstreet, Spall, Boyes & Dickson, 2003).

Our main concern is to determine the core reason that causes the feeling that "physics is a difficult course" or "it is something that the learners are reluctant to learn and attend". Those who have been teaching physics have some specific experiences: A student can solve problems but cannot present a general view or a coherent opinion about them. The majority of students who have difficulties memorize even in the specifically designed ideal courses without comprehending (Redish, 1994).

Primarily, the identification of the perceptions of learners about the physics course is thought to be important to overcome the problem in teaching physics. For this aim, we investigated students' difficulties in learning physics and students were asked to write a composition related to question of "Why physics course is difficult?".

2. Theoretical Background

Physics is generally recognized as being conceptually difficult as a subject both to learn and to teach (Angell, Guttersrud, Henriksen & Isnes, 2004; Mualem & Eylon, 2007; Mulhall & Gunstone, 2008). In a study which investigated the views of high school students and teachers about physics, it was found that students find physics "difficult" but "interesting" (Angell et al., 2004). In the same study, teachers stated that competency in mathematics is essential for understanding the concepts of physics, and the students have lower mathematical competency. Unlike teachers, students do not consider this fact (mathematical competency) crucial. Predominant among secondary school students' negative views about physics are the notions that it is 'difficult', 'irrelevant' and 'boring' (Williams, Stanisstreet, Spall, & Boyes, 2003). Researchers have explained the cause of being viewed as difficult in their studies (Owen, Dickson, Stanisstreet, & Boyes, 2008). According to them, physics becomes increasingly difficult due to the changing nature of physics over the secondary school period. In addition, over this period physics becomes less descriptive and more mathematical (Owen et al. 2008).

Redish (1994) asserts that faculty members, teaching assistants (TAs) and students may have different views about learning and understanding of physics. According to him, faculty members and TAs should know and understand the views of students about physics courses, because they are teachers of students. Individuals who are learning and those who are teaching will live in different worlds, and it will be difficult to communicate, because they speak different languages (Carter, & Brickhouse, 1989). This study explained that an awareness about these difficulties may influence the curriculum choice and perceptions of difficulty are central to the classroom (Carter, & Brickhouse, 1989).

A more experienced teacher should get to know his/her students to be successful during teaching. Moreover, Redish stated that faculty members and TAs should be aware of how their views are different from students' views. In this way, they can understand why students have difficulties in physics (Redish, 1994).

For the past 20 years, researchers have carried out numerous studies on how children and adults learn physics, with much of the activity occurring in Europe, America, and Israel (McDermott, & Redish, 1999). Interests, goals, and motivation have been identified as the most important factors in learning and academic success (see Hidi & Harackiewicz, 2000; Nolen, 2003). In these studies, researchers found some correlations between learning environment, motivation, learning strategies, and achievement among high school pupils (Hidi & Harackiewicz, 2000; Nolen, 2003).

According to the results of studies done by these researchers, teachers think that students hold the preconception that physics concepts are difficult (Oon & Subramaniam, 2011). It has been asserted by the researchers that students consider the concepts in physics too abstract to understand. Moreover, teachers also believe that students must have a high level of competency in mathematics to understand physics concepts better (Oon & Subramaniam, 2011). In another study, teachers have emphasized that students need to possess mathematics competency to understand physics better (Angell et al., 2004). Similar views have been put forward by the other studies (Gill, 1999; Politis, Killeavy & Mitchell, 2007).

In another study aiming to determine the obstacles faced by teachers in teaching physics, it was stated that students have negative feelings and prejudices about physics courses and the difficulty of using mathematical formulae (Aycan & Yumuşak, 2002; Karakuyu, 2008). When researchers asked physics teachers and high school graduates what they considered to be the most difficult and easiest physics topics, they found that according to the participants, the most difficult subject is "electromagnetic induction" and the easiest one is "substance and its features". In the study, some reasons why students have difficulty understanding physics subjects have also been determined (Aycan & Yumuşak, 2002; Karakuyu, 2008). These were "students lacking background about the physics subjects (prior to high school)", "students were not familiar with the subject from daily life" and "students couldn't embody abstract concepts". In another study (Şahin, & Yağbasan, 2012), pre-service physics teachers who have completed their introductory physics courses were asked to indicate the most difficult physics subjects. In this study, researchers also tried to find out the reasons why respondents felt those subjects were difficult. When researchers coded the answers from the open-ended questions, 24 reasons emerged under four domains. The first one was the "Content of the subject" (such as too many formulae and complex, abstract, need rote learning, etc.), "Student Profile" (having prejudice, lacking background, having wrong knowledge, etc.), "Application of the Subject" (having difficulties in visualizing, relating to daily life, etc.), "Teaching the Subject" (lack of time, superficiality, teaching as complex-abstract-rote, etc.) (Şahin, & Yağbasan, 2012).

2.1 The Aim of This Study

The aim of this study is to develop a valid and reliable instrument to understand why physics is perceived as difficult among high school students and to investigate the reasons why students have difficulty in learning physics through the scale. It has been emphasized that physics is recognized as being conceptually difficult as a subject both to learn and to teach (Angell et al., 2004; Mualem & Eylon, 2007; Mulhall & Gunstone, 2008). According to some researchers, this difficulty is derived from the fact that its content, over the period of secondary education, becomes less descriptive and more mathematical (Redish, 1994; Owen et al., 2008).

Teachers are another reason for students' difficulties in learning physics because of their active role in the learning and teaching process. Carter and Brickhouse (1989) stated that students and teachers live in different worlds and they have different languages. This dissimilarity is causing a lack of student-teacher communication. If the teachers don't understand their students, they can't discover their students' needs and they can't organize their instruction effectively for their students.

Consequently, it is worthwhile to develop an instrument addressing why the physics courses are perceived as difficult among undergraduate teacher candidates. The instrument could help physics teachers to understand the reasons. Thus, they could take precautions for their instruction and teaching tools and methods. If the reasons why physics is perceived as difficult by students are determined, taking precautions against these reasons will be possible.

In literature, there are several studies concerning how physics content is taught in a better and more efficient way. In this study, we aimed to develop a measurement tool intending to reveal why students find physics difficult and to investigate the reasons why students have difficulty in learning physics through the scale.

3. Methodology

3.1 Research Model

The survey model was adopted in this research (Fraenkel & Wallen, 2006). Survey model is a research approach aims to describe an existing case (Karasar, 1984). Survey model serves to two purposes (Yıldırım, 1966). These are a) to be acquainted with existing case, b) to gather information and to summarize them for the aim of solving or explaining the problem.

3.2 Participants

313 students who are studying in five high schools at the center of Denizli were included in this study. Approximately 80% of students are 9th and 10th grade students. Nearly half of the participating students stated that their physics course grade average are between 65 and 80. Mother of 20% of students are university graduates and 34% are high school graduates while father of 33% are university graduate and 25% are high school graduate. 82% of students stated that they have a computer with internet access while half of them stated that they have the regular reading habit. The following table (Table 1) summarizes the characteristics of the participating students.

Table 1. Characteristics of the participants

	Category	**n**	**%**	**Category**	**n**	**%**
Grade Level	9. Grade	179	57,2	11. Grade	61	19,5
	10. Grade	73	23,3	Total	313	100
Achievement	Poor (<50)	14	4,5	Good (65-80)	138	44,1
	Middle (50-65)	80	25,6	Better (>80)	81	25,9
Mother Education Level	Illiterate	2	0,6	High School	105	33,5
	Literate	46	14,7	Associate Degree	8	2,6
	Primary School	2	0,6	University	62	19,8
	Middle School	72	23	M.S. or Doctorate	4	1,3
				Not Known	12	3,8
Father Educational Level	Illiterate	2	0,6	High School	77	24,6
	Literate	9	2,9	Associate Degree	21	6,7
	Primary School	37	11,8	University	103	32,9
	Middle School	40	12,8	M.S. or Doctorate	12	3,8
				Not Known	12	3,8

		n	%		n	%		n	%
Computer Ownership	**Yes**	257	82,1	**No**	44	14,1	**Not Known**	12	3,8
Book Reading Habit	**Yes**	158	50,5	**No**	143	45,7	**Not Known**	12	3,8

3.3. Data Collection Tool

Difficulty in Learning Physics Scale for Students (DiLP-S) has been developed by the researchers. The scale comprises of 25 items under three sub-dimension (Teacher “10 items”, content “10 items”, student “5 items”). Data were collected from 1021 high school students for the validity and reliability study and data of the 708 participants who either gave incomplete answers or made an impression of not filling the form by reading carefully were excluded from the analysis. According to the data obtained from the 313 participants, the internal consistency coefficient scale’s Cronbach alpha α was calculated for all of dimensions as 0,921, for 1st dimension (teachers) as 0,892, for 2nd dimension (content) as 0,853 and for 3rd dimension (student) as 0,851. The model complies well with the data according to the confirmatory factor analysis results in the phase of scale development.

3.4. Development of the DiLP-S Scale

We followed all steps necessary for the development of a measurement scale in the study. Although different sources claim that the number of these steps varies with respect to the details of the actions to be taken, the process of developing this scale included five main phases (Hinkin, 1995). These steps was explained as below:

3.4.1. Item Pool Phase (Development of Draft Form)

Studies of the scale development are generally carried out through following experimental and institutional processes. In the experimental process, with the help of the literature and expert opinion approaches, a prospective scale form is developed. Therefore, the final form which consists of ideal items is created through determining the psychometric characteristics of scale items by applying an experimental application to a sample group which has several characteristics in common with the target group (Yurdagül, 2005).

In this phase, initially the relevant literature (Aycan & Yumuşak, 2002; Grassmann, 2008; Ertaş et al., 2009; Süzük, Çorlu & Gürel, 2011) was reviewed by researcher and item proposals were constituted from this related research reports. Additionally, for the aim to constitute more item for the item pool, students were asked to write a compositions about why they have difficulties in physics courses. This compositions was coded by 5 researchers who are experts in science and physics education. As a result, an item pool with 59 items was developed through coding and reviewing the literature. From this pool, a draft form with 44 items thought to be in accordance with the nature of the study was converted into a scale by the researcher.

The sampling approach with the rating totals developed by Likert (1932) is selected as the baseline. In this approach, numerous positive or negative statements are applied to the numerous responders with regard to subject attitude. Responders choose one of the options for each statement: “Totally agree”, “Agree”, “Not sure”, “Disagree”, or “Totally Disagree”. In this way, every participant states the degree of “agree/disagree” against the component of attitude covered by each statement in the scale. In the study, the rating method developed by Likert (1932) is used with the scoring from 5 to 1.

3.4.2. Expert View Phase

a) Language validity: The draft scale developed was analyzed by Turkish language experts (n=5) for language validity in terms of sentence structure and meaning. Following the language validity study, four statements were excluded from the draft scale as suggested by the experts.

b) Content validity: There is a considerable agreement on how to compute the Item-level Content Validity Index (I-CVI). A panel of content experts (Büyüköztürk, 2010) is asked to rate each scale item in terms of its relevance to the underlying construct (Polit & Beck, 2006). It is advised that a minimum of three experts are enough, but indicated that more than 10 was probably unnecessary (Lynn, 1986).

In the literature, in order to obtain the rating of experts, a 4-point ordinal scale is also advised by the writers (such as Lynn, 1986; Waltz and Bausell, 1981) to avoid having a neutral and ambivalent midpoint (Polit and Beck, 2006).

Several different labels for the four points along the item-rating continuum have appeared in the literature, but the one that was advocated by Davis (1992) appears to be in frequent use: 1=not relevant, 2=somewhat relevant, 3=quite relevant, 4=highly relevant. Then, the I-CVI is calculated for each item, and this calculation was found as a result of dividing the number of the opinions of experts who rates either 3 or 4 into the number of total experts who took part in the study.

The draft scale was analyzed by two experienced physics teachers from two high schools and four academic teaching staff members who give basic physics lectures at the university level in three education faculties in Turkey. Scale items were assessed one by one and re-arranged based on the expert opinions. For showing the content validity of the study in numeric values, Davis technique as a scale rating criterion was applied in order to prove the scope validity of the study in numeric values. In this step, 6 items have been withdrawn from draft form of the scale.

3.4.3. Pilot Experiment Phase (Implementation and Data Analysis)

The final form of the developed scale was applied to the 1021 high school students from five schools in Denizli. After the application, item analysis was carried out to evaluate the scale in terms of internal consistency, stability and the power of stimulating the reactions which are aimed to be observed without stimulating the ones which are not aimed to be observed (Tezbaşaran, 2008). For assessing the reliability of the scale, item total correlations, item distinctiveness with the method of comparing the groups of upper and lower 27% of the item total grades and Cronbach’s Alpha internal consistency coefficients were examined (Tezbaşaran, 2008). Cronbach’s Alpha value (α) is a scale of internal consistency among the test grades of the scale and the values above 0.70 are considered sufficient for the test consistency (Büyüköztürk, 2010).

Exploratory and confirmatory factor analyses were applied to ensure structure validity of the scale. While trying to reach the factor structures with reference to the relationship between the variables through exploratory factor analysis, a hypothesis or a theory which had already been determined beforehand was tested through confirmatory factor analysis (Büyüköztürk, 2010).

a) Sample Characteristics for Pilot Application

Draft scale with 34 items was applied to 1021 high school students who were enrolled five different schools in Denizli. Before the application, a control item was added to draft scale to check whether scale items were read carefully or not. The item was requested to mark the “totally agree” choice. Due to this control item, data of 399 participants has been used for validation study. Characteristics of these 399 students was summarized in table 2. Half of the participants were male students and about 75% of students from 9th and 10th grade of high school. Mean of age for students was 15.76 and majority of the students physics achievement were middle and good according to their statements.

Table 2. Distribution of the Participants for Pilot Application

	Category	**n**	**%**	**Category**	**n**	**%**
Gender	Male	196	49.1	Female	203	50.9
Class Level	9. Grade 10. Grade	179 125	44.9 31.3	11. Grade 12. Grade	77 18	19.3 4.5
Age	14 15 16	14 157 141	3.5 39.3 35.3	17 18	85 2	21.3 0.5
Physics Course Achievement	Bad Middle	12 89	3.0 22.3	Good Better	192 106	48.1 26.6
	Total	399	100			

b) Item Analysis

Scale items of a measurement instrument were analyzed in terms of relevancy to the case subject to assess the characteristics of being able to distinguish the degree of the case from each other. The ones whose relation to the case are strong or the distinctive ones could be selected for the scale (Tezbaşaran, 2008). Two different "item analysis" were suggested specifically by Likert (1932) in order to determine every item's strength of scaling. These are item-total correlations and the methods of t-test analysis related to the distinctiveness in terms of the groups of top-bottom 27%. At this state, one item (fourth item) has not been included to the calculation because it was a control item.

In this study, item-total correlations are firstly examined during the item analysis. Generally, it can be said that the items whose item total correlations are 0.30 and above can differentiate the individuals better, the items which are between 0.20 – 0.30 can be included into the test in the case of they are considered as necessary, the items below 0.20 should be excluded from the test (Büyüköztürk, 2010). In the analysis, item total correlations of 4 items have values below 0.20 (3, 6, 29 and 34). Therefore, it has been decided that these items should be excluded from the scale. In the scale, there are not any items in the range between 0.20 and 0.30, which could be called "uncertain". Consequently, 3 items were excluded from the scale and item-total correlations for the remaining 30 items were re-calculated.

Table 3. Item-total correlation coefficients and t values for the rest of the items

No	r**	t		No	r**	t		No	r**	t
S1	0,61	14,862*		S14	0,58	16,066*		S24	0,52	11,147*
S2	0,44	10,829*		S15	0,48	10,949*		S25	0,56	12,688*
S5	0,58	13,396*		S16	0,59	13,755*		S26	0,45	9,628*
S7	0,63	16,721*		S17	0,59	14,184*		S27	0,41	10,275*
S8	0,66	15,961*		S18	0,62	15,335*		S28	0,54	12,983*
S9	0,48	10,144*		S19	0,36	7,118*		S30	0,53	11,950*
S10	0,60	15,056*		S20	0,56	12,974*		S31	0,59	13,791*
S11	0,59	12,120*		S21	0,39	6,426*		S32	0,59	13,736*
S12	0,45	9,398*		S22	0,49	10,061*		S33	0,57	14,019*
S13	0,49	11,840*		S23	0,55	12,303*		S35	0,51	12,777*

* $p < .05$, two-tiled

**Item-Total correlation coefficients

Note: t-Test values regarding item distinctiveness according to the difference between the groups of bottom-top 27%

According to re-calculation results, It has been determined that the item total correlations of the rest of the items vary between 0.36 and 0.66. T values regarding to item distinctiveness according to the difference between the groups of the bottom and top 27% were significant at $p < .05$ level.

3.4.4. Factor Analysis Phase

Before the factor analysis, normality of data was investigated. A Shapiro-Wilk's test ($p > .05$) (Öztuna, Elhan, Tüccar, 2006; Shapiro & Wilk, 1965; Razali & Wah, 2011) and a visual examination of the histograms, normal Q-Q plots and box plots showed that the instrument scores were approximately normally distributed, with a skewness of -0.195 (SE=0.122) and a kurtosis of 0.229 (SE=0.244) (Cramer, 1998; Cramer & Howitt, 2004; Doane & Seward, 2011). Exploratory Factor Analysis was executed on the data acquired to determine the structure validity of the draft scale consisting of 30 items. Exploratory Factor Analysis is a technique used to group the items that measure the same structure or attribute among the items determined by the researchers and to clarify the scale through those limited number of substructures (the factors) (Büyüköztürk, 2010). Before this analysis,

Several criteria have been offered by researchers for the competent sample size for factor analysis (Kline, 2005; Bryman & Cramer, 2001). In terms of sample size, another criterion to investigate the competency of a data set for the factor analysis is the Kaiser-Meyer-Olkin (KMO) test (Leech, Barrett & Morgan, 2005). As shown in Table 4, the KMO was calculated as 0.927 which demonstrates that the size of the sample is perfect. When we examined the result of Bartlett's Test of Sphericity (chi-square = 5544.36; df = 435; p<.000), we observed that the data were appropriate for the factor analysis.

Table 4. Kaiser-Meyer-Olkin and Bartlett's Test of Sphericity

KMO Measure of Sampling Adequacy.		0.927
Bartlett's Test of Sphericity	Approx. Chi-Square	5544.36
	df	435
	Sig.	0.000

After the scale's appropriateness for factor analysis was determined considering the results of KMO and Bartlett's tests, we applied principal component analysis. The purpose of this analysis was to determine the number of factors by using variations that were exposed to factor analysis.

The number of factors was determined by the total variance percentage which was explained by each factor. In this analysis, factors whose variances were below 1 were not taken into consideration because variable variances were equal to 1. The number of factors which are included in the model is equal to the number of factors whose Eigenvalues are over 1 (Morrison, 1990).

The first principal component analysis (PCA) determined five factors whose Eigenvalues were 1 or above. These factors explained 56.918% of total variance.

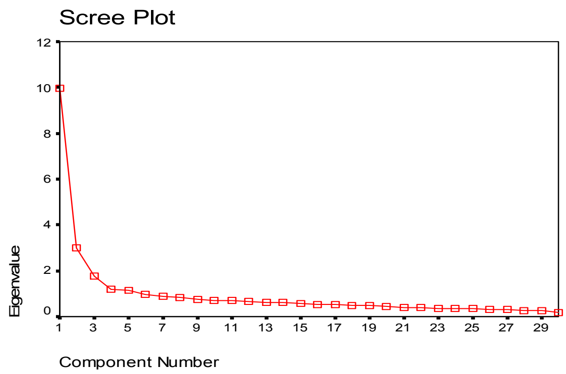

Figure 1. Scree Plot-Eigenvalue Diagram of First Principle Component Analysis

When PCA results were investigated, after the third components, contributions to the cumulative variance are both slight and close to each other. Furthermore, according to the Scree Plot-Eigenvalue diagram (see Figure 1), three factors were decided and the principle component analysis was repeated.

According to results of second PCA, three factors explained 49.126% of total variance (Table 5). However, all of these steps were repeated until the requirements of the principal component analysis and varimax rotation explained above were met. More than one item was excluded from the scale after each analysis because they were loaded under more than one factor (overlapped).

Table 5. Principle Component Analysis

DiLP Scale	Factor 1	Factor 2	Factor 3
Eigenvalue	9.967	2.992	1.779
Explained Variance %	33.223	9.974	5.928
Cumulative Variance %	33.223	43.198	49.126

At the end of the last analysis, there were not any items left to be excluded. Among the three factors determined, there were 25 items, which meant that five items were excluded from the 30-item scale. The three factors were determined as a result of the last analysis explaining 52.372% of the total variance. While the first component had an eigenvalue of 8.763 and explained 35.051% of total variance, the second component had an eigenvalue of 2.690 and explained 10.758% of the total variance and the third and the last component of the scale had an eigenvalue of 1.641 and explained 6.563% of the total variance.

To determine which item will be found in a factor, with regard to the factor loading of the items, the varimax rotation method was applied. The varimax rotation method helps to determine the limited number of factors with higher loadings and the abundant number of factors with zero (or lower) loadings (Ferguson & Cox, 1993). It determines the items that constitute a factor. Therefore, the items that form a factor are examined, and this factor is named (see Appendices).

3.4.5. Reliability Calculation Phase

To calculate the reliability of the scale, Cronbach's Alpha value was used. With this calculation, α values for the three factors in the scale were found between .852 and .892. For the whole scale, the alpha value was calculated as .921. α value for the evaluation of the reliability of a scale is suggested to be 0.70 or above (Hair, Anderson, Tatham, & Black, 1995). The reliability values for each factor on the scale can be seen in Appendix.

a) Correlations among the Factors

Pearson correlation analysis was used to determine the relation among the dimensions of the scale which consists of one-dimension and three sub-dimensions (Table 6). According to the analysis results, all the dimensions of the scale have significant levels of relations among each other.

Table 6. The relation among the dimensions of the scale (Pearson Correlation Analysis)

Relations	r
1. Teacher*Content	0.541(**)
2. Teacher*Student	0.409(**)
3. Content*Student	0.617(**)

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

Following the evaluation of the data with regard to why physics courses are difficult; it is observed that there is a low positive significant relation between teacher and student dimensions (r=0.409(**); $p \leq 0.001$), there is moderate positive relation between teacher and content dimensions (r=0.541(**); $p \leq 0.001$) and between student and content dimension (r=0.617(**); $p \leq 0.001$).

This relation indicates that the teacher factor has a low but effective impact on the students' perception of physics as a difficult course. Furthermore, the moderate relation between the dimension of content and the student indicates that content factor has an effective impact on students' perception of physics as difficult course. There is also moderate positive and statistically significant relation between the teacher and content factors.

b) Confirmatory Factor Analysis Results of the Scale

Confirmatory factor analysis (CFA) is a statistical technique used to verify the factor structure of a set of observed variables. While the main purpose in exploratory factor analysis is to find out the model appropriate for the structure of the data, the main purpose of the confirmatory factor analysis is to clarify the meaningfulness of the relation between the structure and the observed variables (Baydur & Eser, 2012).

The factors prepared following exploratory factor analysis which described how the structure represented are put forward by the confirmatory factor analysis. LISREL software was used during the confirmatory factor analysis. According to McDonald and Ho (2002), three measures of fit indices were used to evaluate the fit between the hypothesized theoretical model and the empirical data: the relative (normed) chi-square (X2/df), the CFI (Comparative Fit Index), and the RMSEA (Root Mean Square Error of Approximation).

There is no clear-cut guideline about what value of the relative chi-square is minimally acceptable. For example, Bollen (1989) notes that values of the relative chi-square of 2.0, 3.0 or even as high as 5.0 have been recommended and indicated as reasonably fit. It has also been suggested that with some consensus in the psychometric literature, a model tends to be reasonably fit if the statistic adjusted by its degrees of freedom does not exceed 3.0 (Kline, 2005).

Comparative Fit Index (CFI), also known as the Bentler Comparative Fit Index, compares the fit of a target model to the fit of an independent model in which the variables are assumed to be uncorrelated. In this context, fit refers to the difference between the observed and predicted covariance matrices, as represented by the chi-square index. Values that approach 1 indicate acceptable fit (Moss, 2014). In other studies, CFI values were recommended to be higher than 0.90 (Yu-Ling, 2012) or close to 0.95 (Hu & Bentler, 1999).

The RMSEA is currently the most popular measure of model fit and it is now reported in virtually all papers that use CFA or SEM and some preferably refer to the measure as the "Ramsey" (Kenny, 2014). In a study, 0.01, 0.05, and 0.08 values were advised to indicate excellent, good, and medium fit, respectively (MacCallum, Browne & Sugawara, 1996). In our study, according to results of the confirmatory factor analysis, these values were calculated as (272) = 720.53 (p= .00); the relative chi-square (X^2/df) = 2.649; the CFI = 0.97; the RMSEA = 0.064. According to suggestions done by researchers (Hu & Bentler, 1999; Byrne, 2001; Luis Vieira, 2011; Yu-Ling, 2012; Bollen, 1989; Moss, 2014; Kline, 2005; Kenny, 2014; MacCallum et al., 1996), these results indicated that the model provided a good fit to the presented data (Table 7).

Table 7. Ideal and measured fit indices

Measures for fit indices	Ideal fit indices	Results for this model
Relative X^2	X^2/df <3	2.649
CFI	CFI>0.90	0.97
RMSEA	RMSAE<0.080	0.064

c) The Use of This Instrument and Interpretation of Its Results

The students were asked to evaluate not only the physics course they had been attending but also physics courses in general. In addition, the data gathered can be used as a tool to evaluate the physics courses in which they have been enrolled. If the scale is aimed as part of a data collection tool for a specific physics course, the students should be informed about it. The data gathered from the scale can be used for physics courses in general. In both cases, the data gathered can be interpreted by the teachers, administers and other educational policy makers and executives.

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This scale is a measurement tool that instructors may apply to their students at the beginning of a physics course or at any time they need. The scale aims to give information to the teachers or lecturers about students in the process of physics instruction.

A directive instruction could be added for participants to the scale. It contains 25 items which are grouped under three sub-dimensions. Each item has five options: “Strongly Disagree”, “Disagree”, “Uncertain”, “Agree”, and “Strongly Agree”. Respondents are requested to mark the most appropriate option which represents their opinion.

Respondents can give scores ranging between 1 and 5 from each item. Through collecting these scores, the level of difficulty in learning physics is determined. Different scores are calculated for the whole scale and each sub-dimensions. The lowest score that can be taken from the whole scale is 25, the highest score is 125. The participants can give 10 at the minimum level and 50 at the maximum level from the “teacher” and “content” sub-dimensions. For the other sub-dimension (student), scores can be between 5 and 25.

In the interpretation of the results, the scores taken from the whole scale and sub-dimensions are used. A total score which is close to 125 indicates that the students are having a high level of difficulty in learning physics. Conversely, a total score which is close to 25 indicates that students are having little difficulty in learning physics.

To interpret the scores of the sub-dimensions, we offer that high scores from each dimension indicate the factors for having difficulty in learning physics.

For example, a high score from the “teacher” sub-dimension (close to 50) indicates that the teacher is the perceived reason for difficulty in learning physics. In this situation, the instructor should examine the mean scores of the items of this dimension. For example, if the educators obtain a high mean score for the item “The teacher does not employ visual materials during the course”, they will realize that the students need more visual materials for understanding physics concepts. After this detailed examination, the instructor may understand the shortcomings of their teaching in the eyes of the students.

If the participants have a high score from “student” dimension (close to 25), the items under this dimension should be examined and necessary precautions may be taken. If the participant has a high score from the “content” dimension (close to 50), the content of the course may be re-designed by the teachers or/and other educators according to the interests and needs of the students.

d) Analysis of the Data

Statements of scale should be completed by selecting one of five ranges from “Strongly Agree” to “Strongly Disagree”. “Strongly Agree” statement was evaluated as five point and “Strongly Disagree” was evaluated as one point. In this step, descriptive statistics, t-test and variance analysis were utilized (Büyüköztürk et al., 2013).

4. Findings

When the mean scores for sub dimensions were compared, as it was summarized in figure 3, it is seen that the students mostly emphasized the course content as the reason of having difficulty in learning physics. The student and the teacher factors follows this respectively. According to this result, mean scores of the content factor were investigated. The mean scores and the standard deviations of these items were given in the Appendix.

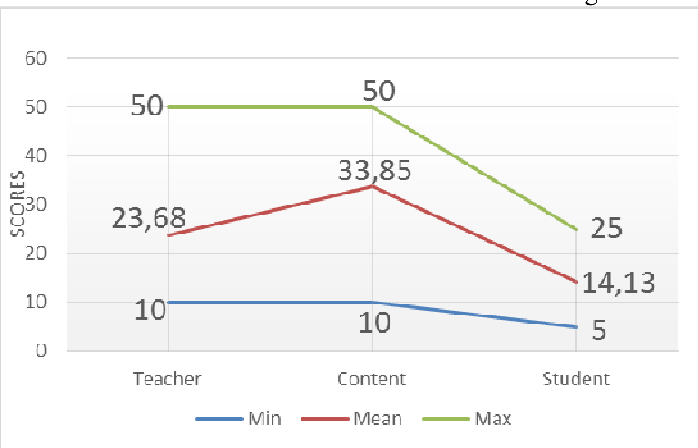

Figure 2. Total mean scores for sub-dimensions

Table 8. Mean scores and Standard Deviations for Items of Content Factor

Item No	Content Factor	Mean	SD
C1	There are too many subjects and concepts in physics course.	3,79*	1,069
C2	Physics subjects have too many formulas.	3,43	1,142
C3	Physics subjects have complicated formulas.	3,60	1,156
C4	Physics courses have formulas based on memorization.	3,59	1,152
C5	I am lacking background knowledge about physics.	3,29	1,147
C6	Physics is considered as a difficult subject in my environment.	3,84*	1,050
C7	Physics is a memorization-based course.	2,80	1,221
C8	I cannot allocate time for physics course	2,87	1,068
C9	Physics course books are boring for me.	3,63*	1,250
C10	Most of the subjects in physics course are abstract concepts	3,02	1,210

* *Three highest mean scores*

There are 10 items in the scale related to course content. Among the items under this factor, "Physics is considered as a difficult subject in my environment" has the highest mean (M=3.84, sd=1.05) and respectively the item of "There are too many subjects and concepts in physics course" (M=3.79, sd=1.07) and the item of "Physics course books are boring for me" (M=3.63, sd=1.25).

According to these results, it can be said that the students have a prejudice towards the physics course that originates from their environment (friends, parents, etc.) and they perceive this prejudice as a reason for having difficulty in the course. Moreover, the students think that the physics course has too many subjects and concepts. The students see the course content's intensity as a reason for having difficulty in learning physics. Another important emphasis is students' seeing the course books as boring, and it can be said that this also causes them to have difficulty in learning the physics course.

Besides the demographic information in the scale, the students were asked to indicate their grade point averages as "Poor (Below 50)", "Middle (between 50 and 65)", "Good (between 66 and 80)" and "Better (81 and above)". This information was used in comparison the mean scores by student success.

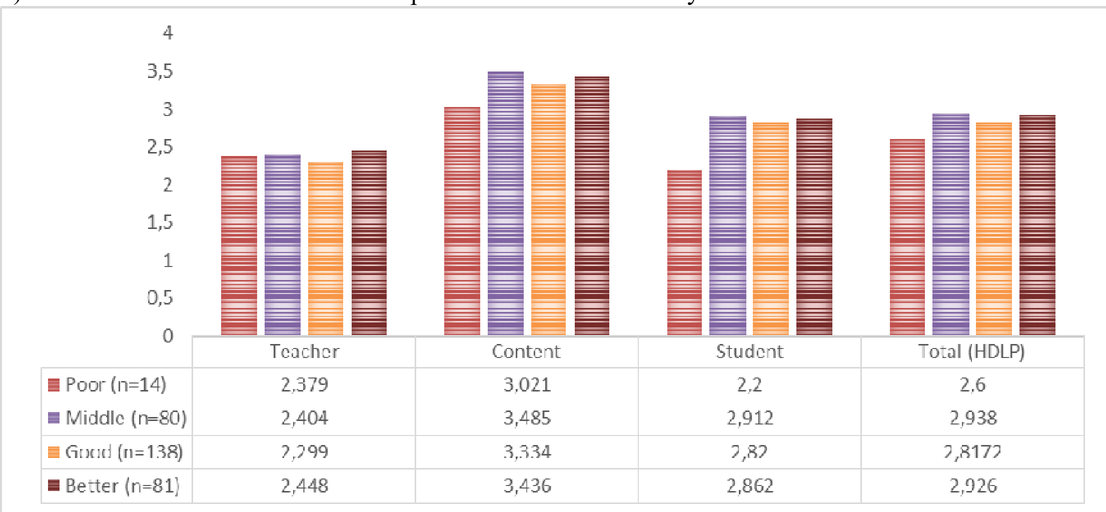

Figure 4. Comparison of the Mean Scores According to Students' Physics Course Achievement

According the results in figure 4, the students mostly emphasized the course content as the reason for having difficulty in learning physics. When the factor scores were compared by the success of students, all students put forward the course content as the reason of having difficulty in learning physics. This results got along well with the results in figure 3.

The mean scores of DiLP Scale were compared by the grade levels of the students. It was found out that 9th grade (X=75.48) and 11th grade (X=71.25) students have more difficulty when compared with the 10th grade students (X=62.64) (Table 9).

Table 9. Mean scores by grade levels

Grade Levels	**N**	$\bar{X}$	**SD**
9	179	75,48	19,227
10	73	62,64	13,544
11	61	71,25	13,366

When it was examined whether this difference appeared by sub-dimensions of the scale, in teacher sub-dimension, 9th (X=25.59) and 11th (X=23.77) grade level students emphasizes teachers as the reason of having difficulties in learning physics more than 10th (X=18.90) grade students. Similarly, in content sub-dimension, 9th (X=34.68) grade level students emphasizes curse content as the reason of having difficulties in learning physics more than 10th (X=32.03) grade students. In student sub-dimensions, 9th grade (X=15.21) and 11th grade (X=13.89) students consider themselves as the reason of having difficulty in learning physics more than 10th grade (X=11.71) students.

5. Conclusion and Discussion

According to results, students in the sample group put the course and the syllabus content forward as a reason for having difficulty in learning the physics course. The student and the teacher factors follow this (See Figure 3.). There is a common belief that the reason for the students' being successful (or unsuccessful) is only the teacher. Carter and Brickhouse (1989) even claim that the students and the teachers have different views of the world and so interact differently. This difference causes a communication gap and therefore they have difficulties in learning the physics course. However, according to the results of this study, contrary to this common belief, students exhibited the minimal effect of teachers on student difficulties in learning physics. According to the results summarized in figure 4, these mean scores do not differ according to the students' success in the physics course. Namely, no matter how much the student is successful in the physics course, s/he shows first the course content, then themselves, and lastly the teachers as a reason for having difficulty.

The content of the physics course comprises of the concepts related to the real lives the students live. However, the students see the content of the course as an important factor to think that the physics course is difficult. The students think that the physics course has more subjects and concepts than necessary and that the course is boring. In addition, the students have the prejudice that the course is a difficult one, and they get this feeling because of their environment. According to these findings, it can be thought that the content of the physics course and the books is not prepared accordingly with the students' real life.

According to this result, the 9th and the 11th grade students emphasize that the physics course is difficult more than the 10th class students. The students face the topics of the physics under the name 'physics' for the first time when they start high school. Before high school, the students learn these topics in the science classes together with the other fields of science. Nevertheless, Akdeniz et al. (2000) highlight that about 70% of the 8th grade students have difficulty in understanding the basic physics concepts. The researchers put forward the reasons behind this as the students' not being able to connect the subjects and the concepts of physics, chemistry and biology, and the insufficient mathematics knowledge. Therefore, the 9th grade students may not be facing these topics for the first time but they are facing them under a different title for the first time, and this might be the reason of this difference. The physics course teaching program that covers the 9th and the 10th grades consists of the basic concepts in the science of physics. However, at the 11th and the 12th grades, these same concepts are taught in a more detailed way (MEB, 2013). The reason why the 11th graders find physics course more difficult than the 10th graders is thought to be the structure of the teaching program. The reasons for students to think physics is difficult are more likely to be the course content, and the physics' naturally including mathematical calculations and formulas.

Sub-dimensions of the scale are important for giving us an idea about the underlying reasons of why the students have difficulty in understanding physics topics. According to the higher scores in the teacher sub-dimension, students consider their teachers as the reason for them to have difficulty in understanding physics. Accordingly, 9th and 11th grade students emphasize the teacher factor more than 10th grade students. According to a study conducted with the 9th grade students (n=303) by Alptekin and colleagues (2009), the students thought that the teacher plays a crucial role for them to understand and like studying physics. Aycan and Yumuşak (2003) argued in a study that one of the possible causes of having difficulties in understanding physics for the students is non-experimental and theoretical treatment of the subject. According to this statement, the teachers take on a significant task to manage the process of teaching the lesson well.

In terms of the student sub-dimension of the scale, the mean scores difference between 11th and 10th grade students and 11th and 10th grade students were statistically significant. This means that the 9th and 11th grade students consider themselves as the reason for having difficulty in understanding physics more than the 10th grade students.

By asking the students about their previous term physics course grade point averages, some information was gathered about their success in this course. When the students' physics difficulty scale means are analyzed according to their success levels, there was not a significant difference neither in the overall of the scale nor in the sub dimensions of it. According to this result, even if the students are successful in the physic course, even if they have a high grade point averages or not, they think that the physics course is difficult.

Difficulty in Learning Physics Scale allows us to obtain information about the conditions and sources of difficulties students have in learning physics. The resulting information is expected to lead the teachers, researchers and administrators about measures to be taken in order to increase the success of students in physics course. It is thought that the scale has a great importance to reflect the difficulties in understanding and learning of the physics from the viewpoint of the students. Therefore, it is also expected to make a contribution to the researches to be made on this subject.

References

Akdeniz, A.R., Bektaş, U. & Yiğit, N. (2000). İlköğretim 8. sınıf öğrencilerinin temel fizik kavramlarını anlama düzeyi, [Understanding Levels of Basic Physics Concepts in 8th Grade Students], *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, Sayı 19*, s:5-14

Alptekin, S., Demirbaş, M. & Arıkan., N. (2009). 9. Sınıf öğrencilerinin fizik dersine ilişkin görüşlerinin incelenmesi [Examination of views related physics course of 9th grade students], *Sakarya Üniverstesi Eğitim Fakültesi Dergisi [The Journal of SAU Education Faculty],* 18, 1-10

Angell, C., Guttersrud, Ø., Henriksen, E. K. & Isnes, A. (2004). Physics: Frightful, but fun, Pupils' and teachers' views of physics and physics teaching (Electronic version). *Science Education, 88,* 683-706.

Aycan, Ş. & Yumuşak, A. (2002). Lise fizik müfredatındaki konuların analaşılma düzeyleri üzerine bir araştırma [A study on the levels of understanding of high school physics curriculum subjects], VII. *Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi [VII National Science and Mathematics Education Congress],* 16-18 Eylül, Ankara

Aycan, Ş. & Yumuşak, A. (2003). Lise fizik müfredatındaki konuların anlaşılma düzeyleri üzerine bir araştırma [A study on the levels of understanding of high school physics curriculum subjects], *National Education Journal,* 159, 171-180.

Baydur H. & Eser E. (2012). A practice: A psychometric analysis of life scales, *Journal of Health Savings,* 1(2), 99-123.

Bollen, K.A. (1989). *Structural Equations with Latent Variables,* New York: John Wiley & Sons, Inc.

Bryman, A. & Cramer, D. (2001). *Quantitative Data Analysis with SPSS Release 10 for Windows: A Guide for Social Scientists.* London: Routledge

Büyüköztürk, Ş. (2010). *Veri analizi el kitabı [Data analysis hand book for social science (11th edition)],* Ankara: PegemA Publishing.

Byrne, B.M. (2001). *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming,* Lawrence Erlbaum Associates, Inc., Mahwah, NJ.

Carter, S.C. & Brickhouse, N.W. (1989). What makes chemistry difficult? Alternate Perceptions. *Journal of Chemical Education,* 66, 223-225.

Cramer, D. (1998). *Fundamental statistics for social research.* London: Routledge.

Cramer, D. & Howitt, D. (2004). *The SAGE dictionary of statistics.* London:SAGE

Davis, L.L. (1992). "Instrument review: Getting the most from a panel of experts". *Applied Nursing Research,* 5, 194-197.

Doane, D.P. & Seward, L.E. (2011). Measuring Skewness. *Journal of Statistics Education,* 19(2), 1-18

Ertaş H., Şen, A.İ. & Eryılmaz O. (2009). Defining the complicating reasons of Secondary School Physics lessons, *XVIII. National Congress of Educational Sciences,* October 1-3, İzmir, Turkey.

Gill P. (1999). The physics/maths problem again*, Phys. Educ. v24*, 83-97

Grassmann, H. (2008). *Ahnung von der Materie – Physik für alle.,* Köln: Dumont

Hair, J. F., Jr., Anderson, R. E., Tatham, R. L., & Black, W. (1995). *Multivariate data analysis (4th ed.).* Englewood Cliffs, NJ: Prentice Hall.

Hidi S. & Harackiewicz, J. M. (2000). Motivating the Academically Unmotivated: A Critical Issue for the 21st Century, *Review of Educational Research, 70*(2), 151-179

Hinkin, T. R. (1995). A review of scale development practices in the study of organizations. *Journal of Management, 21*(5), 967-988.

Hu, L.T. & Bentler, P.M. (1999). "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives," *Structural Equation Modeling, 6 (1),* 1-55.

Karakuyu, Y. (2008). Problems of Physics Teachers in Physics Education: Afyonkarahisar Sample, *Mustafa Kemal University Journal of Social Sciences Institute, 10,* 147–159

Karasar, N. (1984). *Bilimsel Araştırma Metodu. [Scientific Research Methods].* Ankara: Hacettepe Taş Kitapçılık.

Kenny D.A. (2014). *Measuring Model Fit,* Retrieved from http://davidakenny.net/cm/fit.htm on August 12th. 2014

Kline, R.B. (2005). *Principles and Practice of Structural Equation Modelling. (2nd Edition).* NY: Guilford Publications, Inc.

Leech, N.L., Barrett, K.C. & Morgan, G.A. (2005). *SPSS for Intermediate Statistics: Use and Interpretation (2 nd ed.).* Mahwah, NJ: Lawrence Erlbaum Associates, Inc. Publishers.

Likert, R. (1932). 'The method of constructing an attitude scale' In Fishbein, M. (Ed) (1967) *Readings in attitude theory and measurement (pp. 90 – 95).* New York, NY: John Willey & Sons, Inc.

Luis Vieira, A. (2011). *Interactive LISREL in Practice Getting Started with a SIMPLIS Approach,* Springer Heidelberg Dordrecht London New York (p.14)

Lynn, M.R. (1986). Determination and Quantification of Content Validity. *Nursing Research,* 35, pp. 382–385.

Mazur, E. (2013). http://mazur.harvard.edu, (access date: May, 2013).

MacCallum, R. C., Browne, M. W. & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods,* 1, 130-149.

McDermott, L.C. & Redish, E.F. (1999), PER-01: Resource Letter on Physics Education Research, *American Journal of Physics,* vol. 67, 755-767

McDonald, R.P., & Ho, M.R. (2002). Principles and practice in reporting structural equation analysis. *Psychological Methods,* 58, 431–443.

M.E.B. (2013). *Ortaöğretim Fizik Dersi Öğretim Programı. [High School Physics Curriculum],* Talim Terbiye Kurulu Başkanlığı, Ankara, Turkey

Morrison, D. F. (1990). Multivariate statistical methods. New York: McGraw-Hill.

Moss, S. (2014). *Fit Indices for Structural Equation Modeling*, retrieved from http://www.psych-it.com.au/Psychlopedia/article.asp?id=277 on August 12th. 2014

Mualem, R. & Eylon, B.-S. (2007). "Physics with a smile" Explaining phenomena with a qualitative problem-solving strategy. *Physics Teacher,* 45(3): 158–163.

Mulhall, P. & Gunstone, R. (2008). Views about physics held by physics teachers with differing approaches to teaching physics. *Research in Science Education,* 38(4): 435–462.

Nolen, S. B. (2003). Learning Environment, Motivation, and Achievement in High School Science, *Journal of Research in Science Teaching,* 40(4), 347-368

Oon, P-T & Subramaniam, R. (2011). On the declining interest in physics among students—from the perspective of teachers, *Int. J. Sci. Educ.* 33, 727-746

Owen, S., Dickson, D., Stanisstreet, M. & Boyes, E. (2008). Teaching physics: Students' attitudes towards different learning activities, *Research in Science and Technological Education,* 26(2), 113-128

Örnek, F., Robinson, W. R. & Haugan, M. R. (2007). What Makes Physics Difficult? *Science Education International,* 18(3), 165-172

Öztuna, D., Elhan, A.H. & Tüccar, E. (2006), Investigation of Four Different Normality Tests in Terms of Type 1 Error Rate and Power under Different Distributions, *Turk J Med Sci.,* 36 (3): 171-176

Polit, D., & Beck, C. (2006). The content validity index: Are you sure you know what's being reported? *Research in Nursing & Health,* 29 (5), 489-497

Politis, Y., Killeavy M & Mitchell P. I. (2007), Factors influencing the take-up of physics within second-level education in Ireland—the teachers' perspective, *Irish Educ. Stud.* v26, 39-55

Razali, N.M. & Wah, Y.B. (2011), Power comparisons of shapiro-wilk, kolmogorov-smirnov, lilliefors and anderson-darling tests, *Journal of Statistical Modelling and Analytics,* 2(1), 21-33

Redish, E. F. (1994). Implications of Cognitive Studies for Teaching Physics, *American Journal of Physics,* 62, 796-803.

Shapiro, S.S. & Wilk, M.B. (1965), An analysis of variance test for normality (complete samples), *Biometrika* 52, 591–611.

Şahin M., (2009). Exploring University Students' Expectations and Beliefs about Physics and Physics Learning in a Problem-Based Learning Context, *Eurasia Journal of Mathematics, Science & Technology Education,* 5(4), 321-333.

Şahin, E., & Yağbasan, R. (2012). Determining which introductory physics topics pre-service physics teachers have difficulty understanding and what accounts for these difficulties, *Eur. J. Phys.* 33, 315–325

Süzük, E., Çorlu, M.A. & Gürel, C., (2011). Students' Perceptions of Learning Efficacy of Introductory Physics Course, *Eurasian J. Phys. Chem. Educ.*, Jan, Special Issue: 65-71.

Tezbaşaran, A.A. (2008). *Likert type scale preparation guide, third edition e-Book,* Retrieved: 10.10.2013, from http://www.academia.edu/1288035/

Waltz, C.F. & Bausell, R.B. (1981). *Nursing Research: Design, Statistics, and Computer Analysis,* Philadelphia: F. A. Davis

Williams, C., Stanisstreet, M., Spall, K. & Boyes, E. (2003). Why aren't secondary students interested in physics? *Physics Education,* 38, 324–329.

Yıldırım, C. (1966). *Eğitimde Araştırma Metotları. [Research Methods in Education].* Ankara: Akyıldız Matbaası.

Yu-Ling Lan. (2012). Development of an Attitude Scale to Assess K-12 Teachers' Attitudes toward Nanotechnology, *International Journal of Science Education,* 34(8), 1189-1210, DOI: 10.1080/09500693.2011.651657

Yurdagül, H. (2005). Content validity index usage in scale development studies for content validity, XIV. *National Congress of Educational Sciences,* p.1-6, September 28-30, Denizli, Turkey.

Appendix Means, Standard Deviations, Item-Total Correlations and Component and Rotation Loadings

No	Factor 1: TEACHER, α=0.892, Eigenvalue=8.763, % of Variance=35.051	Mean	SD	r	CFL	VFL
T1	The teacher does not strive to make us like the lesson	2.38	1.29	0.73	.666	.775
T2	The teacher does not ask questions that encourage us for the lesson.	2.33	1.16	0.75	.693	.763
T3	The teacher is not able to communicate with the students (with us) during the course.	2.07	1.07	0.70	.635	.749
T4	The teacher is not able to associate the physics subjects with daily life.	2.41	1.27	0.69	.648	.741
T5	The teacher does not have any attitude encouraging the lesson.	2.39	1.21	0.69	.627	.741
T6	The teacher does not come to the class as prepared for the lesson.	1.88	1.02	0.59	.511	.686
T7	Prior to the course, the teacher does not consider that the students (we) are prepared for the lesson.	2.65	1.20	0.61	.590	.652
T8	The subjects are covered very quickly to fulfill the curriculum.	3.01	1.26	0.60	.638	.596
T9	The teacher does not employ visual materials during the course.	3.09	1.38	0.54	.545	.581
T10	What I have heard about the teacher from my friends affects me negatively	2.35	1.19	0.46	.473	.506
No	**Factor 2: CONTENT "α=0,853" "Eigenvalue=2,690" "% of Variance=10,758"**	**Mean**	**SD**	**r**	**CFL**	**VFL**
C1	There are too many subjects and concepts in physics course.	3.85	1.11	0.66	.626	.732
C2	Physics subjects consist too many formulas.	3.58	1.19	0.67	.655	.731
C3	Physics subjects consist complicated formulas.	3.63	1.17	0.71	.694	.714
C4	Physics courses consist formulas based on memorization.	3.68	1.14	0.64	.641	.659
C5	I am lacking background knowledge about physics.	3.47	1.24	0.52	.526	.615
C6	Physics is considered as a difficult subject in my environment.	3.97	1.11	0.40	.394	.546
C7	Physics is a memorization-based course.	2.80	1.25	0.51	.539	.517
C8	I cannot allocate time for physics course	3.02	1.16	0.46	.501	.487
C9	Physics course books are boring for me.	3.63	1.28	0.52	.575	.487
C10	Most of the subjects in physics course are abstract concepts	3.13	1.24	0.49	.580	.426
No	**Factor 3: STUDENT "α=0,852" "Eigenvalue=1,641" "% of Variance=6,563"**	**Mean**	**SD**	**r**	**CFL**	**VFL**
S1	I will not take advantage of physics in my upcoming professional life.	2.86	1.34	0.69	.503	.846
S2	I will not use physics during the rest of my life	.271	1.32	0.74	.545	.840
S3	I think that physics lesson unnecessary	2.35	1.22	0.69	.625	.729
S4	I cannot associate the terms included in physics course with daily life.	2.83	1.24	0.58	.611	.606
S5	Physics subjects are not interesting.	2.88	1.36	0.62	.647	.599
For whole scale α=0,921 % of variance=52,372						

r: item-total correlation, CFL: Component Factor Loadings, VFL: Varimax Factor Loadings