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THE EFFECT OF ATTITUDES TOWARDS PHYSICS LESSON ON PROBLEM SOLVING SKILLS OF WORD PHYSICS PROBLEMS: A STRUCTURAL EQUATION MODELLING STUDY[*]

Nilüfer CERİT BERBER[**] - Alaaddin CERİT[***]

ABSTRACT

According to Bloom's taxonomy, learning happens in three domains including cognitive, affective and psychomotor domains. Attitudes are among the most significant affective features which might positively or negatively affect learning. The conducted researches show that the relationship between attitudes and gains is important, and it is necessary to consider it in curricula. Unfortunately, most of the studies which search students' attitudes towards Physics lesson have detected that students have negative attitudes towards physics lesson. Students describe physics as a difficult, boring and unnecessary lesson. This situation has many reasons. However, it is important to change these negative attitudes of students for an effective physics teaching. The purpose of this research is to examine the effect of attitudes towards physics lesson on word physics problem solving skills through structural equation modelling. For this purpose, Physics Attitude Scale was employed on 190 undergraduates who were studying in different departments of Necmettin Erbakan University Faculty of Engineering and Architecture. Five open-ended word mechanical problems were asked with this scale. The collected data were analyzed using Structural Equation Modelling, which is one of the relational screening models. The results of the research have shown that the beliefs of the undergraduates in understanding and comprehending physics have considerable effects on problem solving skills of word physics problems.

Keywords: Attitudes towards Physics Lesson, Word Physics Problems, Structural Equation Modelling.

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[**] Doç. Dr., Necmettin Erbakan Üniversitesi, Ahmet Keleşoğlu Eğitim Fakültesi, KONYA.
[***] Dr. Öğr. Üyesi, Necmettin Erbakan Üniversitesi, Ereğli Kemal Akman Meslek Yüksekokulu, KONYA.

The Effect Of Attitudes Towards Physics Lesson On Problem Solving Skills Of Word Physics Problems: A Structural Equation Modelling Study

Fizik Dersine Yönelik Tutumun Rutin Fizik Problemlerini Çözme Becerisi Üzerine Etkisi: Bir Yapısal Eşitlik Modellemesi Çalışması

ÖZET

Bloom taksonomisine göre öğrenme bilişsel, duyuşsal ve devinişsel olmak üzere üç alanda gerçekleşir. Tutum ise öğrenmeyi olumlu yada olumsuz yönde etkileyebilen en önemli duyuşsal özelliklerdendir. Yapılan araştırmalar tutum ile erişi arasındaki ilişkinin önemli olduğunu ve öğretim programları içinde dikkate alınması gerektiğini ortaya koymuştur. Fakat fizik dersine yönelik öğrenci tutumlarının araştırıldığı çalışmaların çoğu öğrencilerin fizik dersine karşı olumsuz tutumlar içinde olduğunu ortaya koymuştur. Öğrenciler fizik dersini zor, sıkıcı ve gereksiz olarak nitelendirmektedirler. Bunun pek çok sebebi vardır. Fakat etkili bir fizik öğretimi için herşeyden önce öğrencilerin bu olumsuz tutumlarını değiştirmek gerekir. Bu araştırmanın amacı Fizik dersine yönelik tutumun rutin fizik problemlerini çözme becerisi üzerine olan etkisini yapısal eşitlik modellemesi yoluyla incelemektir. Bu amaçla Necmettin Erbakan Üniversitesi Mühendislik Mimarlık Fakültesinin farklı bölümlerinde öğrenim gören 190 öğrenciye "Fizik tutum ölçeği" uygulanmıştır. Beraberinde ise 5 rutin mekanik problemi açık uçlu olarak sorulmuştur. Toplanan veriler ilişkisel tarama modellerinden Yapısal Eşitlik Modellemesi yöntemi ile analiz edilmiştir. Araştırma sonuçları öğrencilerin fiziği anlayabilme ve kavrayabilme inançlarının rutin fizik problemlerini çözme becerileri üzerinde anlamlı ve olumlu yönde etkisinin olduğunu ortaya koymuştur.

Anahtar Kelimeler: Fizik dersine yönelik tutumlar, Rutin fizik problemleri, Yapısal eşitlik modellemesi.

INTRODUCTION

The developments related to human life provided by science have enabled many countries to place more importance on the process of science education (Çepni et al., 1995; Akdeniz, 1997). It is because changing and developing technology is based on science and the way to catch up with it and shape it depends on the importance placed on science education (Akgün, 1996). Accordingly, it is necessary for today's people to experience basic physics general knowledge in order to perceive and interpret technological developments affecting every phase of their lives (Çepni et al., 1997). However, although physics is a branch of science which is directly associated with life, its abstract

and theoretical characteristic causes students to describe physics as a difficult and boring lesson (Tekbıyık and Akdeniz, 2010).

As far as it is known, behavior is the process of building the change and it happens in three domains, which are cognitive, affective and psychomotor. There is a close relationship between these domains and they do not diverge from each other with certain boundaries. As it is stated in the curriculum belonging to the Ministry of National Education, the main purpose of physics is to improve scientific literacy, and it is necessary to target development not only in the cognitive domain but also in the affective and psychomotor domains. It is important to inspire an interest in physics in students by arousing their curiosity. (MEB, 2013). Attitudes are the leading behaviors which are included in the affective domain because the belief of students in whether they will be able to learn a topic or not has a great effect on learning physics. This belief is a big obstacle for them to striving and searching other ways. (MEB, 2013).

Attitudes are one of the most significant characteristics of affective domain which have the power of affecting learning positively or negatively. In education, attitudes are a research area independently (Bındak, 2004). Attitudes are the tendency to react positively or negatively to things, people, events, places or organizations, to act or to feel in a particular way (Eagly and Chaiken, 1993; Robbins, 1994; Petty, 1995; Güney, 2000; Öncül, 2000; İpek and Bayraktar, 2004). When the literature on attitudes towards physics lesson are examined, it is seen that there are studies which were conducted on the effects of different teaching methods and techniques on attitudes and how attitudes take form by different variables (Simpson et al., 1994; Kurnaz and Yiğit, 2010; Tanel and Tanel, 2013). The purpose of this research is to examine the effect of attitudes towards physics lesson on word physics problem solving skills by using structural equation modeling.

When it comes to physics problem, two types of problem should spring to mind; routine and nonroutine problems. Routine problems are those problems which are frequently included in course books, require transferring information mentioned in a problem to mathematical equations, putting thoughts down into shapes, understanding written and visual expressions. Routines problems which aim at developing basic problem solving skills in addition to understanding concepts and principles of physics in theory are also called as “word problem” or “story problem”. Nonroutine problems are real-life connected problems which

need skills such as organizing, classifying and association (Altun, 2000; Gök and Sılay, 2008) because a real problem requires research for its solution and it is a question whose result is uncertain (Van De Walle John, 1994).

The purpose of this research is to examine the effect of attitudes towards physics lesson on word physics problem solving skills by means of Structural Equation Modeling (SEM)**.** Considering this purpose, the hypotheses to be tested in the research are as follows;

H1: The technological and social significance placed on physics lesson and physics is effective on word physics problem solving skills.

H2: The belief in understanding and comprehending physics is effective on word problem solving skills.

H3: The need to learn physics is effective on word problem solving skills.

H4: Being interested in physics and physics lesson is effective on word physics problem solving skills.

METHOD

Research Model

The research was done in accordance with "relational screening model" which is among qualitative research designs. The purpose in screening models is to describe a circumstance existed in the past as it was or a currently existing circumstance as it is, whereas the purpose of relational screening models is screening based on comparison and correlation (Karasar, 2005). In this research, a structural equation model was formed for relational screening. Structural Equation Modeling (SEM) is a statistical approach depending on describing measurable variables and unmeasurable variables on a causal and relational base.

Data Collection Tools

In the research, the data were collected from 190 first-year students studying at different departments of Necmettin Erbakan University, Faculty of Engineering-Architecture. Approximately 53% the students were male (N=100), 47% of them were female (N= 90).

Data Collection Tools

1) Physics Attitude Scale (PAS)

The scale was developed by Tekbıyık and Akdeniz (2010) in direction of the data collected from 166 students who were studying in Grade 9. As a result of conducted validity and reliability analyses, it was determined that the scale included 4 factors which were called significance, comprehension, requirement and interest. The Cronbach Alpha coefficient calculated for these factors for the whole scale was 0,873.

2) Measuring Word Physics Problem Solving Skills

In order to measure word physics problem solving skills physics problem solving skills, 5 open-ended word physics problem solving skills mechanical problems were asked to the students. The problems were related to movement in a single dimension, shooting movement, inclined plane, work and energy, conservation of energy respectively. The skills necessary to solve the problems were determined and scored when they were exhibited. Scores that the students got from the test ranged from 0 to 18.

Data Analysis

To test the hypotheses, first of all, a structural equation model describing causal relationship among variables was formed. Before the examination of the structural model, the measurement model was tested. AMOS 19 (Analysis of Moment Structures) and SPSS 22 (Statistical Packages for the Social Sciences) statistical programs were used to analyze the data and to test the research model. The research hypotheses were tested at the .05 significance level.

FINDINGS

Findings Related to the Measurement Model

In the research, the measurement model was investigated using the confirmatory factor analysis before analyzing the structural model. Goodness of fit values related to the measurement model are given in the Table 1.

Table 1. Goodness of fit values related to the measurement model

Goodness of fit values	Measured value	Limit value
χ^2 / df	2.104	.10 ≤ …≤ 3
RMSEA	.070	.05 ≤ …≤ .08
RMSR	.071	0 ≤ …≤ 1
IFI	.932	.90 ≤…≤ 1
GFI	.904	.90 ≤ …≤ 1
AGFI	.875	.85 ≤ …≤ 1
NFI	.912	.90 ≤ …≤ 1
CFI	.922	.90 ≤ …≤ 1
TLI	.897	.90 ≤ …≤ 1

According to Table 1, chi square goodness of fit index belonging to the measurement model (χ^2 = 606.063 ; df = 288 ; p = .000 ; χ^2 / df = 2.104) is meaningful. When other goodness of fit indices are examined, it is seen that indices are within acceptance boundaries, except for TLI. Among these indices, RMSEA, RMSR and IFI are the ones which are suggested to be considered in particular because these indices are not affected by different variables and they have advantages in determining a model's fit (Çerezci, 2010). In consequence of the analysis, a physics attitude scale having construct validity with 4 factor and 21 item was obtained.

As a result of conducted reliability studies, Cronbach Alpha internal consistency coefficient of the whole scale was determined as 0.91. Besides, internal consistency coefficients for each sub-dimension of the measurement device were calculated as; 0.87 for significance; 0.85 for comprehension; 0.80 for requirement and 0.86 for interest.

Findings Related to the Structural Model

In the research, a model predicting the relationship between attitudes towards physics lesson and word physics problem solving skills problem solving skills was developed and it was analyzed in the frame of structural equation modeling. The developed structural model is given in the Figure 1.

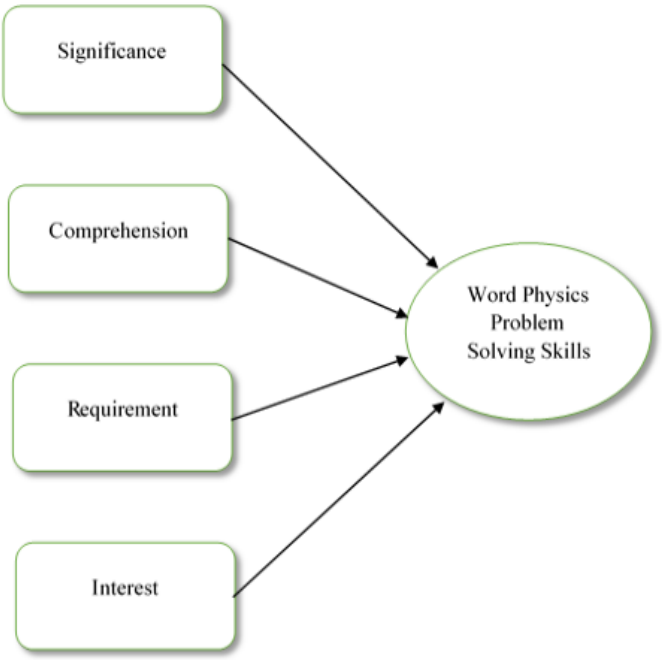

Figure 1. The structural model.

Goodness of fit values related to the measurement model are given in the Table 2.

Table 2. Goodness of fit values related to the structural model

Goodness of fit values	Measured value	Limit value
χ^2 / df	1.928	.10 ≤ …≤ 3
RMSEA	.070	.05 ≤ …≤ .08
RMSR	.113	0 ≤ …≤ 1
IFI	.911	.90 ≤…≤ 1
GFI	.944	.90 ≤ …≤ 1
AGFI	.903	.85 ≤ …≤ 1
NFI	.931	.90 ≤ …≤ 1
CFI	.909	.90 ≤ …≤ 1
TLI	.895	.90 ≤ …≤ 1

According to Table 2, chi square fit index (χ^2 = 385.631 ; df = 200 ; p = .000 ; χ^2 / df = 1.928) related to the measurement model is meaningful. When

other fit indices are examined, it is possible to say that the model harmonizes with the data.

According to the analysis results, the belief in understanding and comprehending physics directly affects word physics problem solving skills at a meaningful level ($\beta = 1.51$; $p < .05$), whereas technological and social significance placed on physics lesson and physics ($\beta = .25$; $p > .05$), the need to learn physics ($\beta = .17$; $p > .05$), the interest in physics and physics lesson ($\beta = -.84$; $p > .05$) do not affect them at a meaningful level.

RESULTS AND DISCUSSION

The results of the hypotheses which were tested by using the constructed model are given in Table 3.

Table 3. The results of the hypotheses

Hypotheses	p	Results
H_1: The technological and social significance placed on physics lesson and physics is effective on word physics problem solving skills.	.313	Rejection
H_2: The belief in understanding and comprehending physics is effective on word problem solving skills.	.002	Accept
H_3: The need to learn physics is effective on word problem solving skills.	.708	Rejection
H_4: Being interested in physics and physics lesson is effective on word physics problem solving skills.	.229	Rejection

The results obtained from the research show that the significance that students place on physics lesson and physics, their need for learning physics and their interest in physics lesson do not have a meaningful effect on word physics problem solving skills. Students' beliefs in being able to understand and comprehend physics affect their word physics problem solving skills positively.

This belief is basically related to their self-efficacy beliefs. When it is considered that self-efficacy belief is more successful in comparison with other concepts associated with learning, this result becomes meaningful in particular.

Self-efficacy is people's belief about their capacity to increase their learning to a targeted level. Conducted researches show that self-efficacy belief affects students' efforts, determination, learning and achievements. Individuals having high self-efficacy are in tendency to endeavor and persist more against difficulties (Bandura, 1997). The studies conducted on self-efficacy related to physics show that self-efficacy belief is one of those factors which is significant in achieving physics (Çalışkan, Selçuk and Özcan,2010; Güzel and Oral, 2017; Selçuk, Çalışkan and Erol, 2008; Shaw, 2004).

Consequently, increasing students' self-efficacy beliefs associated with physics will positively affect students' performance in both solving word physics problems and different assessment results. For this purpose, it is suggested to instructors and teachers to take cognitive precautions such as using active learning methods in addition to affective precautions such as displaying social models, verbal persuasion, rewarding.

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