Development of Science Motivation Scale

Mustafa Doğru*
Faculty of Education
Akdeniz University
Antalya,Turkey
mustafadogru@akdeniz.edu.tr

Tuna Gencosman,
Antalya Yeditepe College
Antalya,Turkey
tunagencosman@gmail.com

Cem Oktay Güzeller,
Turizm Faculty
Akdeniz University
Antalya, Turkey
cemg@akdeniz.edu.tr

Kevser Korumaz
Faculty of Education
Mehmet Akif Ersoy University
Burdur,Turkey
korumazkevser@gmail.com

***Abstract* - Motivation is the most important factor which affects the academic success of the students. Students who have higher motivation engage more to the class activities. One of the reasons for having negative perspective and low academic success of student in science is that students have low motivation for science lessons. The purpose of the study is developing a scale to show motivation of middle school students towards science lessons. Data used in research gained from two independent study groups. The first study group (N=498) is used to determine the structure of factor of the study. The second study group (N=275) is used to test consistence of model and data. Total number of students in the study group is 773. The expression of the motivation of middle school students is shown with 52 items consisting of 2 sub-dimensions which are internal motivation and external motivation. 12 of these items are negative substances for the motivational elements of the science lessons. According to data obtained from the scales, explanatory and confirmatory factor analyzes were carried out during the process of testing the structural validity of the scale. As a result of exploratory and confirmatory factor analysis, model which consists of 21 items and 1 factor is appropriate for both theoretically and statistically. Reliability of the scale is examined by Cronbach Alpha coefficient calculated based on the internal consistency of the items and testing again. The Cronbach Alpha internal consistency reliability coefficient of the scale is 0.79. Considering the results of reliability, it can be said that the scale has sufficient level of reliability. It can be thought that the scale can show the motivation of the students.**

Keywords: **Science motivation, science education, secondary school, motivation scale, Development of Scale**

I. INTRODUCTION

Individuals acquire basic knowledge and skills at pre-school and primary school levels.Well-education of students at elementary school in science makes acquire problem solving skills to them. Besides, they enable students to understand the natural world through the concepts they learn in science [1]

The science course can be complex, incomprehensible and boring to students because it involves abstract concepts. In order not to bring educational process into this situation, the students need to be motivated to the science course [2] If the motivation of the students is ignored during the learning process, the learning process will fail [3] The basis of the motivation concept is the power that drives the organism to act, in other words motive [4] . Motives are divided into two categories called internal and external. Individuals can be stimulated by external stimuli.

For instance, motivation of the student, who demonstrates the desired behavior in the course of the lesson, can be increased by saying nice words such as “good work” or by symbols like stars and plus. Teachers' expectations from students, reinforcements given to students, rewards, punishments and desires are external motivational elements. Individuals react according to ways of understanding and interpreting of these stimuli rather than extarnal stimuli. Wondering, trying, receiving back, achiving and desire to success of students are internal motivation elements [5] When the body of literature is examined, it is seen that the concept of motivation is expressed in many different forms. [6] defined as internal and external causes that motivate the organism and direct the behavior; [7] as the degree of power that individuals spend to achieve a certain goal, [8] as one's efforts in the direction of his own desire and desire, , [9] as a multifaceted personal phenomenon that affects the individual both internally and externally. Therefore, we can define motivation as a driving force that moves the organism for a specific target, initiates behavior.

Motivation is an important factor influencing learning and academic achievement. Students with high motivation to lesson tend to have more participation and effort in classroom activities and tasks. For this reason, motivation is one of the main factors influencing learning [10] .

The needs and desires of the individual, who form the basis of motivation in the influence of the social and cultural structure of the student are shaped and they learn the topics they are curious more quickly. Therefore, no interest in learning is developed unless there is a reason to refer the student to learning. A student, who is not sufficiently motivated, is also not ready to learn [11] .

Students may be afraid of science, disappointed due to failure because they are not sufficiently motivated [12] Yet, the motivation of the student in the educational activities constitutes the basis of the learning process. For this reason,

the student must be motivated during the learning process [2] . Because while individuals continue their lives, they need a driving force, in other words motivation. Motivation is an important factor affecting success in the educational process. Even some teachers explain the academic achievement of students in the learning process with the concept of motivation [13].

Different expectations and needs of students cause motives that motivate themselves to occur in different forms. Individual differences in learning therefore necessitate differences in the elements that will motivate the student [14]. Expectations, pre-learning of students, which are different from each other, the physical and social environment of the class influence their motivation in the learning process [15].

Motivation is dealing with the source of human behavior directly. Motivation of students towards science course is a multidimensional structure influenced by the personal characteristics of teachers and students, teaching methods and techniques, social and physical learning environment, and curriculum [16].The main objective of the teacher is to guide the attention of the students to activities, to develop their learning controls and to increase their learning motivation during the education and training process [17].

The main objective of the teacher is to guide the attention of the students to activities, to develop their learning controls and to increase their learning motivation during the education and training process. The Science Motivation Scale that measures the motivational elements of the students mentioned in the body of literatüre is found in our country. However, with the changes in the Turkish Education Programs, a new re-structured motivation scale is required. In carried out studies factors affecting student motivation in the science course are identified as their interest to the course, notes they take, academic achievements and failures, goals and tendencies to [18]. For this purpose, in this study "Science Motivation Scale" was developed for elementary school students.

II. METHODS

A.Study Group

In the study, data was obtained from two independent study groups.

The study group consisted of a total of 773 students receiving education in Antalya central secondary schools during the academic year of 2016-2017. The first study group (N = 498) was used for determining the factor structure of the scale and the second study group (N = 275) was used for testing compliance of this structure with the model data.

B. Data Collection

In the first phase of the development of a tool to measure students' motivation to science lessons, papers related to this subject were reviewed. Then, a pool of substances, which can express motivations of middle school students relating to science lesson, was formed. Thus, the motivation of middle school students for science lessons; 52 items consisting of 2 sub-dimensions expressing "internal motivational elements" (student experiences, objectives, affective values) and "external motivational elements" (family, teacher and school environments) were written. 12 of these items are negative for the motivational elements of science lessons.

10 items for obtaining demographic information of students and a 5-measured Likert-type scale form of 52 items obtained from sentences formed for motivation was prepared by the researchers. The prepared items were applied to the first study group after being presented to the expert opinion.

Each student answering the scale responded by marking one of the options graded between 1-5 based on the emotions, thoughts and behaviors expressed in the scale items, depending on how well these expressions fi to into them. For the motivation found on the scale, the items were scored between 1 to 5 from "not correct" to the "very correct" option.

C. Data Analysis

Explanatory and confirmatory factor analyzes were carried out in the process of testing the construct validity of the scale according to the data obtained from the scale. In addition, warimax axis rotation is performed during construction validity. The model fit was tested by confirmatory factor analysis of the item-factor structure obtained from exploratory factor analysis. The reliability of scale was tested with the Cronbach Alpha coefficient calculated based on the retest and the internal consistency of the items.

In the study the exploratory factor analysis and internal consistency coefficients were determined using the SPSS 16 package program and the confirmatory factor analysis was performed using the LISREL 8.71 package program. Scale subdimensions are named according to the substance content.

III. RESULTS

Statistical procedures in the study were given under the titles of validity and reliability.

A. Development of Science Motivation Scale Construction Validity

A.1. Explanatory Factor Analysis

Firstly exploratory factor analysis was performed for the structure validity of the “Science Motivation Scale”. In order to be able to perform this analysis, we first looked at the KMO test that tested the adequacy of the study group. KMO value was found as 0,875. According to [19]. it was concluded that because this value is greater than .70, factor analysis can be done via these data. Secondly, since the data obtained from the Bartlett Sphericity test ($\chi 2 = 3108{,}901$, $p = .000$) showed a significant difference, it was found to be suitable for factor analysis [19]. After determining that the data were suitable for factor analysis, basic components factor analysis was performed without defining extent on the 52 items, 12 of which were scored inversely and non-rotated factor analysis was examined.

It was observed that there are 3 factors, which has the eigenvalue higher than 1. The criterion that is the factor loads of the items should be at least .40 [20] and the difference

between the factor loadings of the two factor items (overlap/ dish) should be at least .10 was accepted [19] ; [21] ; [22] After the applied varimax rotation method, it was decided to provide conceptual significance by examining properties of items under the factors and to include items in the 3rd factor to first two factors by considering the "scree plot" graph. For this reason, the substances were groped under two factors. After deciding on the factors in the structure, 25 items with factors under the rotated factor load of .40 and overlapping factors with high load values in two or more factors were removed from the scale and scale of 27 items was achieved.

When the entire scale consisting of 27 items is considered, the scale shows a two-factor structure. The first of these factors has created the dimension of "internal motivation" related to science lesson. There are a total of 17 items on this extent. The second created the "external motivation" dimension for science lessons and is composed of 10 items. The load values of the 27 items in the scale range from 0.35 to 0.66. The two factors included in the scale account for 32,492% of the total variance. Accordingly, it can be said that the structural validity of the Science Motivation Scale is high.

The model fit of obtained values and structure was examined by confirmatory factor analysis.

A.2. Confirmatory Factor Analysis

The scale consisting of 27 items and two sub-factors was tested by confirmatory factor analysis for internal and external motivation dimensions separately.

Chi-square goodness ($\chi 2$), normed fit index (NFI), relative fit index (RFI), comparative fit index (CFI), goodness of fit index (GFI), adjusted goodness of fit index (AGFI), incremental fit index (IFI), root mean square error of approximation (RMSEA) were used in confirmatory factor analysis study of the research [23] ; [24] ; [25].

It was decided to make modification between 35th and 47th, 36th and 37th, 46th and 47th and 49th and 50th items, taking into account the proposed modification during analysis. As a result of all analyzes made statistics related to the harmonization of the confirmatory factor analysis results of the Science Motivation Scale are given in Table-1.

The ratio of the calculated Chi-square value to the degree of freedom is very important. It is desirable that this ratio (X2/df) is less than 2 (Eminoğlu & Nartgün, 2009). When Table-1 was examined it was seen that Chi-square value (X2=534.91, sd=320, X2/df=1.67, p=.000) is significant.

Table I: Values Related to the Tests of Adaptation Wellness for Motivation Related to Science Course

X^2	X^2 /df	P-Value	NFI	RFI	CFI	GFI	AGFI	IFI	RMSEA
534.91	1.67	.000	0.88	0.87	0.95	0.87	0.85	0.95	0.050

* p<0.01

In fit indices, GFI and AGFI values higher than .90 shows that there is a good fit (Marsh & Hocevar, 1988), besides 0.85-0.90 range for GFI value and AGFI value higher than 0.80 shows that there is an acceptable fit (Cole, 1987; Mars, Balla & McDonald, 1988). Additionally >0.90 for CFI and NFI, < 0.08 for RMSEA value (Anderson & Gerbing, 1984; Hu & Bentler, 1999), >0.90 for RFI and IFI values (Ayyıldız & Cengiz, 2006) show that there is an acceptable fit.

It is seen that RMSEA, AGFI, CFI, RMR and GFI indices are frequently used in the conducted studies (Kayri & Günüç, 2009), although it is not clear which of the given compliance indices will be taken into account for adaptation of the model (Şimşek, 2007). Fit indices calculated in the study were found as GFI = 0.87, AGFI = 0.85, CFI = 0.95, NFI = 0.88, RMSEA = 0.050 and IFI = 0.95. Taking these values into consideration, it can be argued that a two-factor structure obtained as a result of confirmatory factor analysis has a good model.

The item factor loadings (λ) and the explained variances (R2), as well as the compliance indices of the 27-item scale were examined in the confirmatory factor analysis. The obtained data are shown in Table-2.

According to the confirmatory factor analysis in Table 2, the factor loads (λ) varied between 0.55 and 0.96. The absolute values of these values are taken into consideration and it is desirable that they are larger than 0.10. If the value is less than 0.10 it is expressed as "small effect", if it is "0,30" expressed as medium effect "and if above 0.50" it is expressed as great effect [23] According to this situation, it can be said that factor loads generally have great influence. In addition, when the t values of the factor loads obtained are examined, it is seen that the t values of all the items are significant. As you see in the table, the R2 (expressed variance) values of the materials are quite high. With the confirmatory factor analysis made, the final scale consisting of 27 items (Appendix-1) and 2 sub-dimensions was achieved. When the results obtained are examined as a whole all items entering the model are consistent with the model.

Based on these findings, it can be said that each factor correctly represents the expressions that constitute itself and that the structure validity of the scale is ensured.

A.3. Reliability

The reliability of the scale was tested by the Cronbach Alpha coefficient, which is calculated based on test retest and internal consistency of the items. In the calculation of the reliability by the test re-test method, 62 students who are studying in a secondary school in Antalya city center were applied twice with an interval of three weeks.

The correlation between students' scores on the scale was found to be 0.85. This result shows that the scale gives decisive results when applied at different times. The Cronbach Alpha score, based on internal consistency, was calculated based on factor total scores and overall total scores of the scale. The coefficientd obtained range between 0.87 and 0.68 the Cronbach Alpha internal consistency reliability coefficient of the scale was 0.87 for the first factor and 0.68 for the

second factor, with a total coefficient of 0.79. The Cronbach's alpha coefficient of .70 and higher, which is used as a subscale of the reliability of test scores, is generally considered adequate for the reliability of the test scores [19]

The value found in the study indicates that the reliability of the scale is high.

Table II: Factor Loads and Explanatory Variances Obtained by DFA

Item No	λ	SE	t	R^2
Item2	0.96	0.08	11.33	0.92
Item4	0.93	0.14	11.37	0.86
Item7	0.93	0.14	11.32	0.86
Item13	0.66	0.56	9.26	0.44
Item18	0.66	0.56	9.27	0.44
Item20	0.79	0.38	10.43	0.62
Item23	0.73	0.47	9.88	0.53
Item25	0.94	0.12	11.42	0.88
Item29	0.72	0.48	9.84	0.52
Item30	0.85	0.28	10.86	0.72
Item31	0.63	0.60	10.75	0.40
Item32	0.80	0.36	11.30	0.64
Item34	0.88	0.23	11.47	0.77
Item35	0.68	0.54	35.92	0.46
Item36	0.74	0.46	11.14	0.54
Item37	0.80	0.36	11.30	0.64
Item38	0.58	0.66	10.53	0.34
Item39	0.85	0.28	11.41	0.72
Item40	0.55	0.70	10.39	0.30
Item41	0.65	0.58	10.81	0.42
Item42	0.67	0.55	10.92	0.45
Item45	0.70	0.51	11.00	0.49
Item46	0.64	0.59	10.76	0.41
Item47	0.57	0.68	10.31	0.32
Item48	0.55	0.70	10.39	0.30
Item49	0.71	0.50	11.03	0.50
Item50	0.80	0.36	11.28	0.64

IV. CONCLUSION

In order to measure the motivation of middle school students to science lessons in the study, “Science Motivation Scale” was developed. Explanatory and confirmatory factor analyzes were performed in the process of testing the construct validity of the scale according to the data obtained from the scale.

Exploratory factor analysis was first performed in the development of a tool for measuring the motivation of students in science class. In order to be able to perform this analysis, we first looked at the KMO test that tested the adequacy of the study group. The KMO value was found to be .887. According to [19] , it was concluded that because this value is greater than .70, factor analysis can be done on this data. Secondly, since the data obtained from the Bartlett Sphericty test showed a significant difference, it was found to be suitable for factor analysis.

When the entire scale consisting of 27 items is considered, the scale shows a two-factor structure. The first of these factors has created the dimension of "internal motivation" related to science lesson. There are a total of 17 items on this dimension. The second is; has created the "external motivation" dimension for science lessons and is composed of 10 items. The load values of the 27 items in the scale range from 0.35 to 0.66. The two factors on the scale account for 32.492% of the total variance. Accordingly, it can be said that the structural validity of the Science Lesson Motivation Scale is high.

The model fit of the values and structure obtained was examined by confirmatory factor analysis. GFI = 0.87, AGFI = 0.85, CFI = 0.95, NFI = 0.88, RMSEA = 0.050 and IFI = 0.95 were obtained from the compliance indices calculated in the study. Taking these values into consideration, it can be argued that a two-factor structure obtained as a result of confirmatory factor analysis has a good model..

The reliability of the scale was examined by the Cronbach Alpha coefficient, which was calculated based on the test retest and the internal consistency of the items. The Cronbach Alpha internal consistency reliability coefficient of the scale was 0.87 for the first factor and 0.68 for the second factor, with a total coefficient of 0.79. The Cronbach's alpha coefficient used as a subcriterion of the reliability of test scores .70 and higher are generally considered sufficient for the reliability of test scores [19] The value found in the study indicates that the reliability of the scale is high.

The developed scale is a tool with validity and reliability according to the analyzes made. The scale can be used as a scale to measure the motivation of middle school students towards science courses in the summer.

It is thought that the factors that affect student motivation in science course can be used to demonstrate motivation elements that affect the course related, notes, academic achievements and failures, course aims and tendencies.

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APPENDIX-1

M2. Ailemin olumsuz tepkisinden çekindiğim için fen bilimleri dersine çalışırım.
M4. Arkadaşlarımın fen bilimlerinde benden daha başarılı olmaları kendimi kötü hissetmeme neden olur.
M7. Yapılan aile ziyaretleri fen bilimleri dersine hazırlanmamı olumsuz etkiler.
M13. Fen bilimleri öğretmeni sınıftaki bazı öğrencilere ayrıcalık tanıdığı için fen dersini çalışmak istemem.
M18. Öğretmen derse hazırlıksız geldiği zaman derse katılmak istemem
M20. Anlamadığım yerleri ders akışını bozmaktan çekindiğim için sormam.
M23. Fen bilimlerinden düşük not alınca ders çalışma isteğim azalır.
M25. Fen bilimleri öğretmenimden övgü dolu sözler duymak için fen bilimlerine daha fazla zaman ayırırım.
M29. Sınıf mevcudu kalabalık olduğu zaman öğretmenimi ve kullanılan materyalleri görmekte zorlandığımdan dolayı derse çalışmak istemem.
M30. Ders esnasında sınıfta oluşan gürültüden dolayı öğretmeni dinleyemediğim için derse karşı ilgim azalır.
M31. Fen bilimleri dersine aktif olarak katıldığım için başarılı olacağıma inanıyorum.
M32. Fen bilimleri projelerinde başarılı olduğum için kendime güveniyorum.
M34. Fen bilimleri dersi kişisel hedeflerimle bağlantılıdır.
M35. Fen bilimlerinde öğrendiklerim günlük yaşamda karşıma çıktığı için fen dersi amaçlarıma hizmet eder.
M36. Sınavlarda başarılı olabilmek için fen bilimleri dersini çalışırım.
M37. Kendimle gurur duyabilmek için fen bilimleri dersinde başarılı olmalıyım.
M38. Fen bilimleri dersine nasıl çalışmam gerektiğini biliyorum.
M39. Fen bilimleri dersinde hangi konularda yetersiz olduğumun farkındayım.
M40. Fen bilimleri dersinde başarılı olduğum konuları biliyorum.
M41. Fen bilimleri dersinde yapılan etkinliklerde kendimi yeterli hissediyorum.
M42. Fen bilimleri dersinde başarılı olacağıma inanıyorum.
M45. Öğrendiğim fen konularını yorumlayabilirim.
M46. Fen bilimleri dersinde eski ve yeni bilgilerim arasında ilişki kurabilirim.
M47. Fen dersinde öğrendiklerimle günlük hayat arasında bağlantı kurabilirim.
M48. Fen dersinde öğrendiklerim hakkında değerlendirme yapabilirim.
M49. Fen bilimleri etkinliklerini kendim yapabildiğim zaman mutlu olurum.
M50. Derste öğrendiklerimi deneylerle uygulamama fırsat verdiklerinde fen bilimleri dersinden zevk alırım.