ADAPTATION STUDY OF MOTIVATION TOWARD SCIENCE LEARNING QUESTIONNAIRE FOR ACADEMICALLY ADVANCED SCIENCE STUDENTS

.

Mustafa Serdar Köksal
Inonu University, TURKEY

Abstract. In this study, the purpose is to adapt "Motivation toward science learning questionnaire" for academically advanced science students. The survey method was used for the study and examination of reliability and validity of the scores on the instrument was conducted after the data collection. The study was conducted on 75 advanced science students. The "principle component analysis" with "varimax rotation" was used at the beginning of the study. Then, considering high communalities and loading of the majority of the items on one factor, confirmatory factor analysis with "maximum likelihood method" on one-factor solution was conducted. The results of the study showed that the adapted instrument was valid and reliable to use for the measurements of motivation toward science learning in the context of advanced science classrooms.
Keywords: advanced science students, motivation, science learning

Introduction

Science is a major contributor for our lives with many important innovations in its basic disciplines; biology, physics and chemistry. Scientific contributions as the product of science processes changed many factors which were important for our life. For instance, we have effective cure approaches to many diseases in current time, new more effective chemicals for cleaning; again we can see and use nano-scale matters and microorganisms for medical and technological purposes. But harmful recombinant foods, harms of mobile phones, new psychological diseases related to computers are found in another side of science for our lives. However solutions of these problems are researched and produced only by science. With pros and cons, learning science for daily life is an inevitable need in today's world. Learning science begins at elementary grades and continues for a life-long time. High school science lessons are the most important contexts for learning science before the end of the formal education. Science learning in high schools includes many factors which are determinants of learning quality and process. These can be classified as affective and cognitive factors. For the cognitive domain, information processing, reasoning ability and academic achievement are the frequently emphasized constructs (Köksal & Yel, 2007; Lawson, 2006; Lawson et al., 2007; Schunk, 2000; Yumuşak et al., 2007). Under the affective title, frequently emphasized factors in the science education literature are attitude, self-efficacy, anxiety and motivation (Baldwin et al., Ebert-May & Burns, 1999; Ekici, 2005; Glynn & Koballa, 2006; Mallow, 2006; Osborne et al., 2003; Savran & Çakıroğlu, 2001; Uzuntiryaki & Çapa Aydın, 2008; Yumuşak et al., 2007). As an affective factor, giving more importance to motivation in science learning over the other affective factors regarding to science learning was suggested by researchers (Osborne et al., 2003). Motivation is defined as the process which instigates and sustains a goal directed activity (Pintrich & Schunk, 2002). There are many studies in which relationship of motivation with educationally important outcomes are presented. Tuan et al. (2005) showed that motivation scores of 1407 junior high school students were correlated to their scores on science attitude and achievement. Again, existence of more effort and perseverance of students with higher motivation was also showed by studies as a positive effect of motivation on educationally important outcomes (Wolters & Rosenthal, 2000). On the importance of motivation, Palmer (2005) stated that motivation also played a significant role in construction of knowledge and process of conceptual change. Moreover, Pintrich & DeGroot (1990) showed relationship between motivational factors and cognitive constructs such as strategy use and meta-cognition. Similar to the results of Pintrich & DeGroot (1990), Köksal & Tasdelen (2007) also showed relationship between motivational factors including self-efficacy and task value and use of rehearsal and organization as cognitive strategies. Again, Glyn & Koballa (2006) presented that science motivation is correlated with interest in science, number of courses taken and science grades. Correlation of motivational factors with both other affective factors and cognitive variables provides an important place to study motivational situations of students toward science learning.

Motivation and its importance for science learning were recognized by science education researchers in a short time and different studies for measurement of motivation were done. Instrument development studies conducted for motivation include a large number of studies from different fields (Pintrich & DeGroot, 1990; Bozanoğlu, 2004). But, the number of the studies on instrument development on motivation toward learning in particular subjects such as science is not large enough to study on motivation of different students from traditional students although there are some examples of the studies conducted with traditional students. Kempa & Diaz (1990) developed the "Students' Motivational Traits in Science" instrument to determine motivational situations of the students. Again, Gllyn & Koballa (2006) conducted validation and development studies of "Science Motivation Questionnaire" for learning science in college settings. As one of the science motivation questionnaire development studies presenting conceiving instrument development process with a large sample of traditional students at the lower age than college, Tuan et al.(2005)'s study provided current and comprehensive questionnaire for measuring motivation toward science learning. They conducted validation and reliability studies of "Students' Motivation toward Science Learning Questionnaire" with a large group of students and reached strong evidence for reliability and validity of the instrument. Then, Yılmaz & Çavaş (2007) adapted the questionnaire into Turkish for elementary students by finding conceiving evidence on factor structure, validity and reliability. Therefore, the questionnaire was validated and found reliable for further use with the similar samples. But, the original development and adaptation studies of such a strong questionnaire were conducted with traditional students. There are students who deserve to take attention for study and are different than traditional students in terms of their different characteristics and experiences. Advanced science students as an important group for science motivation studies deserve an attention for assessment and evaluation of motivation as well as traditional students. They have important characteristics and experiences on science content and science. These students are selected by national content examinations for the programs in which they are enrolled. In addition, these students are enrolled in more courses on science and are more experienced with science content than traditional students. These students have more probability of being in a status to make important decisions for other people. Some studies on motivational differences of them from traditional students showed importance of study on motivation of them for their difference from traditional students. For instance, Gottfried and Gottfried (1996) studied on academic intrinsic motivation of the students at the age range from 9 to 13 and the authors showed that advanced children had significantly higher academic intrinsic motivation across all subject areas including science and school in general. Again, Vallerand et al. (1994) studied with grade 4, 5 and 6 students and they found that advanced students saw themselves as more competent and intrinsically motivated toward activities in school than traditional students. But, these studies were not specifically related to motivation toward learning science. Therefore, academically advanced science students are very important group for studying motivation in science learning. Therefore, there is a need to develop or adapt a motivation instrument to measure motivation of this group on learning science. The studies of Tuan et al. (2005) and Yılmaz & Çavaş (2007) on "Motivation toward Science Learning" questionnaire provided conceiving evidence of validity and reliability for traditional students. The strong evidence and large scale samples of the studies on the questionnaire added power for persuasiveness of the studies to use the questionnaire for advanced science students in this study. Therefore, it was thought that adaptation of the questionnaire for advanced science studies might provide an important point for determination of and studying on science learning motivation of academically advanced science students.

Method

In the study, survey approach as a quantitative research method was used. The study was conducted with 75 ninth grade "science high school" students. Science high schools have been selecting the students by considering their scores in nation-wide examination and have been including advanced and dense science courses. At the same time, the students are in the top 2% of all test takers. Ninth grade was selected for its importance for standing in beginning point to determine entering characteristics of advanced science classrooms for various purposes. Thirty seven (49.3%) of the students were female whereas 38 (50.7%) of them were male. Nearly all of them were at the age of 14 (f=67) while there was one student at the age of 15 and were seven students at 16 age.

In this study, both confirmatory and exploratory factor analyses were done for testing construct validity. Then, convergent validity analysis was also performed. Following these analysis, Cronbach alfa was also calculated for reliability.

Instrument

The original instrument was developed by Tuan et al. (2005). The questionnaire has six factors including "active learning strategies", "science learning value", "self-efficacy", "performance goal", "achievement goal" and "learning environment stimulation". The original scale has 35 items; 9 negative and 26 positive. The format used for the questionnaire was five-scale Likert type. The questionnaire was adapted into Turkish for elementary students at grade 6, 7 and 8 by Yılmaz & Çavaş (2007). The scores on original questionnaire and its Turkish version had high reliability coefficients for internal consistency (.87 for Turkish version, .89 for the original questionnaire). The basic aim of the instrument was to measure motivational states of the students on learning science. Turkish and original versions of the instruments had the same factor structure. Turkish version provided same factor structure of the original instrument with 33 items; 7 negative and 26 positive items. The items of the questionnaire can be seen in Table 1.

Table 1. The items of the instrument in the original questionnaire

Items
1. Whether the science content is difficult or easy, I am sure that I can understand it.
2. I am not confident about understanding difficult science concepts.(-)
3. I am sure that I can do well on science tests.

4. No matter how much effort I put in, I cannot learn science.(-)
5. When science activities are too difficult, I give up or only do the easy parts.(-)
6. During science activities, I prefer to ask other people for the answer rather than think for myself. (-)
7. When I find the science content difficult, I do not try to learn it (-)
8. When learning new science concepts, I attempt to understand them.
9. When learning new science concepts, I connect them to my previous experiences.
10. When I do not understand a science concept, I find relevant resources that will help me.
11. When I do not understand a science concept, I would discuss with the teacher or other students to clarify my understanding.
12. During the learning processes, I attempt to make connections between the concepts that I learn.
13. When I make a mistake, I try to find out why.
14. When I meet science concepts that I do not understand, I still try to learn them.
15. When new science concepts that I have learned conflict with my previous understanding, I try to understand why.
16. I think that learning science is important because I can use it in my daily life.
17. I think that learning science is important because it stimulates my thinking.
18. In science, I think that it is important to learn to solve problems.
19. In science, I think it is important to participate in inquiry activities.
20. It is important to have the opportunity to satisfy my own curiosity when learning science.
21. I participate in science courses to get a good grade. (-)
22. I participate in science courses to perform better than other students. (-)
23. I participate in science courses so that other students think that I'm smart.(-)
24. I participate in science courses so that the teacher pays attention to me.(-)
25. During a science course, I feel most fulfilled when I attain a good score in a test.
26. I feel most fulfilled when I feel confident about the content in a science course.
27. During a science course, I feel most fulfilled when I am able to solve a difficult problem.
28. During a science course, I feel most fulfilled when the teacher accepts my ideas.
29. During a science course, I feel most fulfilled when other students accept my ideas.
30. I am willing to participate in this science course because the content is exciting and changeable.
31. I am willing to participate in this science course because the teacher uses a variety of teaching methods.
32. I am willing to participate in this science course because the teacher does not put a lot of pressure on me.
33. I am willing to participate in this science course because the teacher pays attention to me.
34. I am willing to participate in this science course because it is challenging.
35. I am willing to participate in this science course because the students are involved in discussions.

Results

The results of the analyses to provide evidence for validity and reliability of the instrument will be presented under this title.

Convergent validity

To gain evidence for convergent validity of the scores on the instrument, scores on attitude towards science scale were used in this study. The attitude scale was developed by Geban et al. and included 15 items. The scores on the scale were examined for validity and reliability with the advanced science students again. The scale was investigated by "principle component analysis" approach with varimax rotation. This way was found appropriate since the group of the study was very different from the group that was included in the original scale development study. Before the analysis, the scores on negative statements were converted to appropriate scaling for whole instrument. According to initial analysis in terms of factorability of the scores, data was found as appropriate to go further in factor analysis (Kolmogorov Simirnov Z= .67 *p*= .76, KMO=.88, Barlett's Test =412,85, *p*= .00, *df*=55). KMO was higher then .50 and Barlett test result was significant as expected (Sharma, 1996; Tavşancıl, 2002). The results of the factor analysis showed that item 2, 3 and 14 loaded on two factors with high factor loadings at the same time (.59 and .54 for item 2, . 46 and .47 for item 3 and .45 and .46 for item 14). So, the analysis was conducted by eliminating these items. After the elimination, the analysis was run again and it was found that item 15 loaded on two factors with factor loading values of .43 and .53. So, the item 15 was also eliminated. Then, the third run of analysis showed that item 7 constructed one factor without any other items (Factor loading = .95). Therefore, elimination of it was found appropriate due to the insufficient number of the items to measure related attitude factor. Eventually, Cronbach alpha coefficient was found as .90 after all eliminations. The results related to the scores of the students on attitude scale can be seen in the following tables.

.

Table 2. Communalities of the items in attitude scale

	Communalities	
	Initial	Extraction
Item1	1	.80
Item4	1	.59
Item5	1	.73
Item6	1	.60
Item8	1	.64
Item9	1	.35
Item10	1	.68
Item11	1	.83
Item12	1	.69
Item13	1	.62
KMO	**Barlett's Value (df=45)**	***p* for Barlett test**
.87	399.67	.00

Table 3. Rotated component matrix

	Components	
	Factor 1	Factor 2
Item1	.80	
Item4	.74	
Item13	.79	
Item6	.76	
Item9	.59	
Item12	.80	
Item10		.78
Item11		.79
Item5		.73
Item8		.70
Cronbach Alpha	.88	.80
	.90	
Eigenvalues	5,33	1,21

The results showed a two-factor solution with explanation of 65.40 % of total variance related to the structure measured (F1= 37.84% Eigenvalue$_{F1}$=5.33, F2=27.57%, Eigenvalue$_{F2}$= 1.21). Eigenvalue above 1 is accepted as appropriate (Büyüköztürk, 2002). The names of the factors were assigned as "liking factor" for the first one and "expectation and importance" for the second factor. Two of item examples from the attitude scale are "I like to solve problems about the subjects of science course" and "I am bored when I study on science subjects". The Scree plot test result can also be seen in Fig. 1.

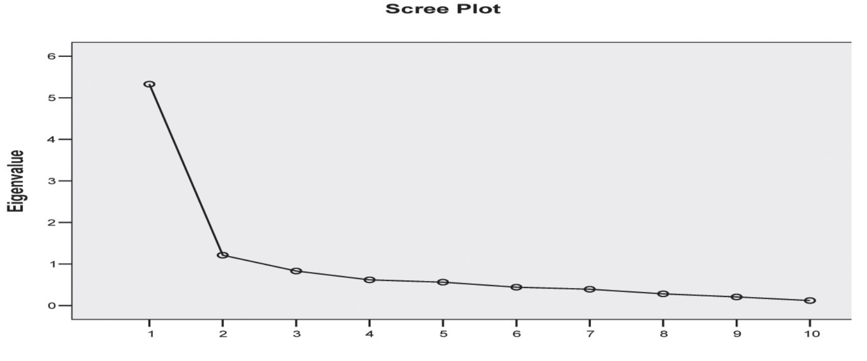

Fig. 1. The results of Scree plot test for the scores on the attitude scale

After the construct validation and reliability of the test scores for the group, convergent validity of the motivation questionnaire was investigated by using the attitude scale, because attitude toward science is positively related to motivation toward science learning (Tuan et al., 2005). Pearson-product moment correlation value between scores on the instruments as an evidence for convergent validity of the motivation instrument showed a significant positive correlation as expected (r=.62, N= 71, *p*=.00). It is accepted as an evidence for convergent validity.

Construct validity

To gather evidence on construct validity of the scores of advanced science students on the instrument, "principle component analysis" approach was used with "varimax rotation" technique at the beginning of the study since the sample of the study was very different from the students used for original development and adaptation studies of the instrument. At the beginning, normality was tested by using Kolmogorov Simirnov Z test and the result of the test approved normality of the scores on the motivation questionnaire (Kolmogorov Simirnov Z=1.27, *p*= .08). Then, the principle component analysis provided the information that the scores on the majority of items presented high communalities (> .55). Correlation matrix was investigated for pattern in data. It was seen that all of the correlation values were significant at .05. The results showed that there were seven-factor solutions for the scores and the solution explained 72% of total variance. But, great majority of the items loaded on the first factor. With high communalities and loading of majority of items on one factor, it was concluded that one-factor solution might be appropriate for the data set. Then, it was thought that following such a way might provide practical advantages to use the instrument and analyze the scores coming from it in advanced science classrooms. Therefore, confirmatory factor analysis was conducted.

Table 4. Communalities of the scores on the items in seven-factor solution

	Initial	Extraction
mot1	1	.74
mot2	1	.76
mot3	1	.70
mot4	1	.69
mot5	1	.60
mot6	1	.59
mot7	1	.60
mot8	1	.80
mot9	1	.69
mot10	1	.71
mot11	1	.72

mot12	1	.73
mot13	1	.69
mot14	1	.76
mot15	1	.70
mot16	1	.77
mot17	1	.73
mot18	1	.55
mot19	1	.67
mot20	1	.68
mot21	1	.74
mot22	1	.74
mot23	1	.73
mot24	1	.77
mot25	1	.80
mot26	1	.83
mot27	1	.78
mot28	1	.84
mot29	1	.84
mot30	1	.75
mot31	1	.72
mot32	1	.78
mot33	1	.62

For the confirmatory factor analysis, "maximum likelihood" technique with "direct oblimin" rotation was used since all items were considered as correlated with each other as seen in communalities. The results of the analysis showed that 15 items presented communalities below .40 in confirmatory factor analysis for one-factor solution (see Table 5). Before the elimination of the items, values on factorability of scores were found as appropriate (KMO=.84, Barlett's value=1810.55, p=.00). KMO was higher then .50 and Barlett test result was significant as expected (Sharma, 1996; Tavşancıl, 2002). Total variance explained was found as % 37.32. After the elimination, the analysis was run again.

Table 5. Communalities for one-factor solution in confirmatory factor analysis

	Initial	Extraction
mot1	.73	.15*
mot2	.65	.00*
mot3	.65	.11*
mot4	.76	.54
mot5	.63	.16*

mot6	.71	.26*
mot7	.65	.45
mot8	.89	.70
mot9	.72	.53
mot10	.76	.59
mot11	.88	.67
mot12	.77	.45
mot13	.75	.66
mot14	.86	.73
mot15	.79	.60
mot16	.84	.68
mot17	.65	.37*
mot18	.70	.42
mot19	.74	.51
mot20	.57	.01*
mot21	.79	.21*
mot22	.68	.02*
mot23	.76	.33*
mot24	.84	.62
mot25	.82	.45
mot26	.86	.42
mot27	.77	.29*
mot28	.80	.30*
mot29	.78	.22*
mot30	.59	.03*
mot31	.63	.00*
mot32	.78	.43
mot33	.73	.42
* Communalities below .40		

The factorability of the scores were investigated by examining KMO and Barlett's sphericty test and it was found that data were factorable (KMO=.93, Barlett's value=1021.97, p=.00). KMO was higher then .50 and Barlett test result was significant as expected (Sharma, 1996; Tavşancıl, 2002). The results of the confirmatory factor analysis showed that one-factor solution was provided with 18 items under the title of "motivation toward science learning". Communalities can be seen in Table 6.

Table 6. Communalities of item scores in one-factor solution

	Initial	Extraction
mot4	.62	.53
mot7	.52	.43

mot8	.82	.70
mot9	.67	.54
mot10	.67	.59
mot11	.79	.68
mot12	.61	.46
mot13	.69	.66
mot14	.78	.74
mot15	.73	.60
mot16	.79	.67
mot18	.51	.40
mot19	.61	.51
mot24	.78	.63
mot25	.72	.45
mot26	.67	.41
mot32	.63	.41
mot33	.61	.40

The one-factor solution explained 54.56% of the total variance with 18 items. The "scree plot" for the confirmatory factor analysis result can be seen in Fig. 2.

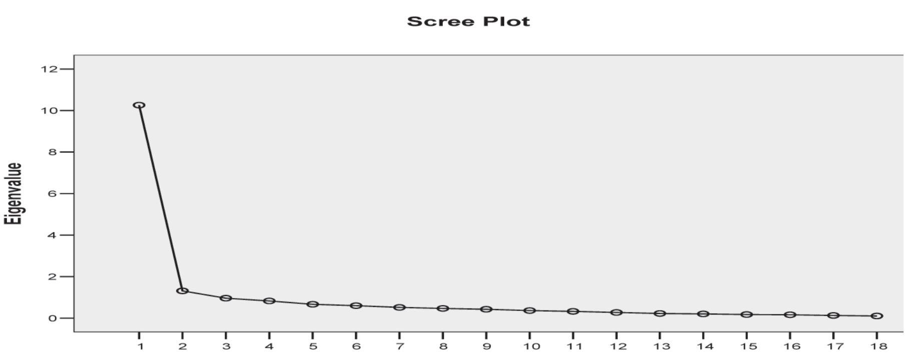

Fig. 2. The results of Scree plot test for the scores on the motivation toward science learning questionnaire

The factor loadings of the items in one-factor solution were above. 60 and 10.26 eigenvalue as expected since majority of the item scores presented high communalities at the beginning of the analysis. Comrey & Lee (1992) stated that factor loadings above .63 can be categorized as "very good" and "excellent". The factor loadings of the items can be seen in the Table 7.

Table 7. Factor loading of the scores on the items in one-factor solution

Items	Factor
Mot4	.73
Mot7	.70
Mot8	.84
Mot9	.74
Mot10	.77
Mot11	.83
Mot12	.68
Mot13	.82
Mot14	.86
Mot15	.78
Mot16	.82
Mot18	.64
Mot19	.71
Mot24	.79
Mot25	.67
Mot26	.64
Mot32	.64
Mot33	.64

Reliability

The reliability of the test was analyzed by using Cronbach alpha value for internal consistency. The result of the analysis showed that alpha coefficient was .95 for the group of study. Considering the alpha value, it was concluded that the scores presented high internal consistency. In addition to the internal consistency analysis, difference in motivation toward science between female and male students was also investigated by independent-t test for finding supportive evidence for the results. Literature gives conflicting results on gender differences for motivation toward science learning (Azizoğlu & Çetin, 2009; Yaman & Öner, 2006). So, there is a need to show difference between students in terms of gender as one of the most studied variable in motivation literature. The results showed that there was no difference between females and males in terms of motivation toward science learning. Results can be seen in Table 8.

Table 8. Independent t-test results for gender differences

Gender	N	Mean	SD	t	df	*p*
Male	38	4.11	.67	.21	73	.84
Female	37	4.15	.90			

Conclusion

The scores of advanced science students on motivation toward science learning questionnaire were found as reliable and valid to use for further aims in studying with advanced science students. The one-factor solution found in this study added another importance for practical use of the instrument in advanced science classrooms. By using the instrument; teachers might gather and analyze data easily since it has Likert structure and one-factor solution might provide easiness for statistical procedures. The data on the questionnaire was found as correlated with scores on attitude toward science as a school subject. This result showed efficacy of the instrument in terms of convergent validity. The literature also showed the same results for convergent validity (Tuan et al., 2005). Use of the instrument might provide many opportunities to study important variables considered continuously for monitoring achievement in advanced science classrooms. The instrument might be used to study associated variables of motivation in advanced science classrooms. For example, motivation was shown to be correlated with achievement, cognitive strategy use and meta-cognitive strategy use beside other affective variables (Pintrich & DeGroot, 1990; Glynn & Koballa, 2006; Köksal & Taşdelen, 2007). These factors are important determinants of the outcomes in science education. In advanced science classrooms, lack of such an instrument is a restrictive statement to study such variables in Turkish context of advanced science classroms. As another side of the study, differences in characteristics of the advanced science students from traditional students were shown in the study with different factor structure from the original questionnaire. It might be speculated that advanced science students are different from their traditional counterparts in terms of motivational states toward science learning.

In addition, non-significant motivational difference for science learning between females and males is also in consistent with the literature (Azizoğlu & Çetin, 2009; Meece & Jones, 1996). Meece and Jones (1996) showed that differences for motivation in science learning are related to achievement level of students rather than gender. Therefore, achievement level differences among students groups will provide different pattern for gender difference in motivation toward science learning. Studying motivation toward science learning by grouping strategies as low, middle and high achievers is a need in Turkish context of advanced science classrooms.

In spite of evidence on reliability and validity of the scores coming from the instrument, explaining some limitations is worth to consider in further researches. The most important limitation of the study is the number of the participants although Karasar (1995) finds 50 as appropriate to study on questionnaire development in preliminary phase. It should be considered to use the instrument and adaptation study with advanced science students by including more participants is an open issue to study. As the other limitation, data collector ability should also be considered for further study. Data to be gained by the instrument should be gathered by teachers in advanced classrooms since the practical importance for using the instrument in classrooms is related to teacher who will use it for educational purposes, so use of the instrument by teachers should also be studied to increase practical use of it. Again, the instrument items are limited to 18 items, so this is another point to consider for measuring motivation toward science learning.

NOTES

1. Geban, O, Ertepınar, H., Yılmaz, G., Atlan, A. & Şahpaz, F. (1994) The effect of computer assisted learning on students' achievement and attitudes. *Proceedings First National Science Education Symposium*. Buca Faculty of Education, Izmir, Turkey.

REFERENCES

Azizioğlu, N. & Çetin, G. (2009). 6 ve 7. sınıf öğrencilerinin öğrenme stilleri, fen dersine yönelik tutumları ve motivasyonları arasındaki ilişki [Relationship between learning styles, attitude toward science and motivation of sixth and seventh graders]. *Kastamonu Eğitim Dergisi, 17,* 171–182.

Baldwin, L.A., Ebert-May, D. & Burns, D.L. (1999), The development of a college biology self-efficacy instrument for nonmajors. *Science Educatian, 83,* 397-408.

Bozanoğlu, İ. (2004). Akademik Güdülenme Ölçeği: Geliştirmesi, Geçerliği, Güvenirliği [Academic motivation scale: development, validity and reliability]. *Ankara Üniversitesi Eğitim Bilimleri Fakültesi Dergisi*, *37 (2),* 83–89.

Büyüköztürk, Ş. (2002). Faktör analizi: Temel kavramlar ve ölçek geliştirmede kullanımı [Factor analysis: basic concepts and its use in scale development]. *Eğitim Yönetimi Dergisi*, *32*, 470- 483.

Comrey, A.L. & Lee, H.B. (1992). *A first course in factor analysis*. Hillsdale: Lawrence Erlbaum.

Ekici, G. (2005). The validity and reliability of the biology self-efficacy instrument. *Hacettepe University J. Education*, *29,* 85–94.

Glynn, S.M., & Koballa, T.R. (2006). Motivation to learn in college science (pp.25-32). In: Mintzes, J.J. & Leonard, W.H. (Eds.). *Handbook of college science teaching: theory, research, practice.* Arlington: NSTA Press.

Gottfried, A.E. & Gottfried, A.W. (1996). A longitudinal study of academic intrinsic motivation in intellectually gifted children: childhood through adolescence. *Gifted Child Quarterly, 40*, 179–183.

Karasar, N. (1995). *Bilimsel Araştırma Yöntemi: Kavramlar, İlkeler ve Teknikler [Scientific research methods: concepts, principles and technique]*. Ankara: 3A Araştırma Eğitim Danışmanlık Ltd. Şti.

Kempa, R.F. & Diaz, M. (1990). Motivational traits and preferences for different instructional modes in science. *Intern. J. Sci. Educ., 12,* 195–203.

Köksal, M.S. & Taşdelen, Ö. (2007). An analysis of scores of prospective biology teachers on the factors of MSLQ. *11th EARLI JURE Conference*. 8–11 July 2008. Katholieke Universiteit, Leuven, Belgium.

Köksal., M.S. & Yel, M. (2007). The effect of the instruction based on multiple intelligence theory on respiratory systems upon the attitudes of the 10th grade students towards the course, their academic success and the permanence of the teaching process. *Educational Sciences: Theory & Practice, 7,* 211–240.

Lawson, A.E. (2006**).** Developing scientific reasoning patterns in college biology (pp.109-118). In: Mintzes, J.J. & Leonard, W.H. (Eds.). *Handbook of college science teaching: theory, research, practice.* Arlington: NAST Press.

Lawson, A.E., Banks, D.L. & Logvin, M. (2007). Self-efficacy, reasoning ability, and achievement in college biology. *J. Res. Sci. Teaching*, *44,* 706–724.

Mallow, J.V. (2006). Science anxiety: research and action (pp.3-14). In: Mintzes, J.J. & Leonard, W.H. (Eds.). *Handbook of college science teaching: theory, research, practice.* Arlington: NSTA Press.

Meece, J.L. & Jones, M.G. (1996). Gender differences in motivation and strategy use in science: are girls rote learners? *J. Res. Sci. Teaching*, *33,* 393–406.

Osborne, J., Simon, S. & Collins, S. (2003). Attitudes towards science: a review of the literature and its implications, *Intern. J. Sci. Educ., 25,* 1049–1079.

Palmer, D. (2005). A motivational view of constructivist-informed teaching. *Intern. J. Sci. Educ*., *27,* 1853–1881.

Pintrich, P.R. & De Groot E. (1990). Motivational and self-regulated learning components of classroom academic performance. *J. Educ. Psychology, 82,* 33–50.

Pintrich, P.R. & Schunk, D.H. (2002). *Motivation in education: theory, research, and applications*. Upper Saddle River: Prentice Hall.

Savran, A. & Çakıroğlu, J. (2001). Preservice biology teachers perceived efficacy beliefs in teaching biology. *Hacettepe University J. Education, 21,* 105–112.

Schunk, D.H. (2000). *Learning theories: an educational perspective.* New Jersey: Prentice Hall.

Sharma, S. (1996). *Applied multivariate techniques*. New York: John Wiley.

Tavşancıl, E. (2002). *Tutumların Ölçülmesi ve SPSS ile Veri Analizi [Measurement of attitudes and data analysis with SPSS].* Ankara: Nobel Yayınları.

Tuan, H., Chin, C. & Sheh, S. (2005). The development of a questionnaire to measure students' motivation towards science learning. *Intern. J. Sci. Educ., 27,* 634-659.

Uzuntiryaki, E. & Çapa Aydın, Y. (2008). Development and validation of chemistry self-efficacy scale for college students. *Res. Sci. Educ., 39,* 539-551.

Vallerand, R.J., Gagne, F., Senecal, C. & Pelletier, L.G. (1994). A comparison of the school intrinsic motivation and perceived competence of gifted and regular students. *Gifted Child Quarterly, 38*, 172–175.

Wolters, C.A. & Rosenthal, H. (2000). The relation between students' motivational beliefs and their use of motivational regulation strategies. *Intern. J. Educ. Res.*, *37,* 801–820.

Yaman, S. & Öner, F. (2006). İlköğretim Öğrencilerinin Fen Bilgisi Dersine Bakış Açılarını Belirlemeye Yönelik Bir Araştırma [An investigation to determine views of elementary level students on science courses]. *Kastamonu Eğitim Dergisi*, *14,* 339–346.

Yılmaz, H. & Çavaş, P.H. (2007). Reliability and validity study of the students' motivation toward science learning (SMTSL) questionnaire. *Elementary Education Online*, *6,* 430–440.

Yumuşak, N., Sungur, S. & Çakıroğlu J. (2007). Turkish high school students' biology achievement in relation to academic self-regulation. *Educational Research & Evaluation*, *13,* 53–69.

✉ Dr. Serdar Koksal
Department of Elelentary Education,
Faculty of Education,
Inonu University
44280, Campus/Malatya, TURKEY
E-Mail: serdar.koksal@inonu.edu.tr