JOURNAL OF BALTIC SCIENCE EDUCATION

ISSN 1648-3898 /Print/
ISSN 2538-7138 /Online/

VALIDITY AND RELIABILITY ANALYSES FOR THE NATURE OF SCIENCE INSTRUMENT SECONDARY (NOSI-S)

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Abstract. *This research aims to adapt The Nature of Science Instrument Elementary Scale (NOSI-E) developed by Peoples (2012) into Turkish for secondary school students and to analyse the psychometric properties of the scale setting out from the fact that it is a necessity of science education aimed to achieve for students/prospective teachers to have adequate understanding of the nature of science. The validity analyses for the scale were performed with Confirmatory Factor Analysis (CFA) and Cronbach alpha (α) coefficients were calculated for reliability. Following CFA, it was taken for granted that the fit indices for the model met the goodness of fit criterion. On examining the fit indices, the scale was regarded to attain construct validity due to the fact that the χ2/df ratio (1.42) was below 3, that the RMSEA value was at the level of .04 and that the NNFI and CFI (>.90) values were at acceptable levels. On the other hand, a coefficients, which were the internal consistency coefficients calculated for the reliability analysis of the scale, were found to range between .631 and .775, and for the overall scale was calculated as .814. These reliability index values were considered to be at acceptable levels.*

Keywords: *nature of science, NOSI-S, instrument reliability, secondary school students, instrument validity.*

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Introduction

Science literacy individuals are the individuals who are knowledgeable about the Nature of Science (NOS), how scientific knowledge is generated and the connections between science, technology and society (Shamos, 1995). Individuals with science literacy are the individuals who can apply scientific knowledge and concepts to diverse situations and who can use the language of science in interpreting, generating and evaluating oral and written texts (Palinscar, Anderson & David, 1993). The main component of science literacy is NOS (AAAS, 1989, 1993; Bybee, 1997; NRC, 1996; NSTA, 1982). Developing adequate understanding of NOS in students is one of the aims of science education (Kimball, 1967-68). NSTA (1982) claims that an adequate understanding of NOS necessitates understanding the experimental and changeable nature of scientific knowledge, and perceiving the central role of inquiry and theory in science.

NOS is defined in its general sense as epistemology, as the sociology of science, as the values or beliefs inherent in the development of science or of scientific knowledge as a way of knowing (Lederman, 1992). The concept of NOS is dynamic and it has changed along with the evolution of science and of systematic thinking about science. The specific meaning of NOS is controversial (Abd-El-Khalick & Lederman, 2000a). This situation stems from the complex and sophisticated nature of NOS (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002).

Science for All Americans (AAAS, 1990) reports that three aspects are available in NOS: (I) seeing the world as comprehensible and understanding that science cannot answer all questions, (II) understanding the nature of scientific inquiry (understanding that inquiry in science is based on reasoning and that it is experimental but that it involves suggesting imagination

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

and explanations), (III) understanding the social and political aspect of science. The National Science Education Standards (NRC, 1996) lays emphasis on the historical, changeable, experimental, reasonable and proven nature of scientific claims. It also mentions the effects of personal, social and cultural beliefs in addition to scepticism in generating scientific knowledge. According to Lederman, Add-El Khalick, Bell and Schwartz (2002), scientific knowledge is not certain but experimental, it is dependent on theories, it is partially the product of human inference, imagination and creativity and it is culture-dependent. Three other important aspects of NOS are the distinction between observation and inference, lack of universal methods to do science, and the correlations between scientific theories and laws. According to Liang et al (2009), (I) the development of scientific knowledge involves observations and inferences, (II) scientific knowledge is changeable and is open to change, (III) scientific theories and laws are distinct scientific knowledge, (IV) scientific knowledge is socially and culturally dependent, (V) the development of scientific knowledge involves imagination and creativity, and (VI) the development of scientific knowledge involves using different scientific methods.

Research has demonstrated that students' and teachers' views of NOS were not consistent with contemporary views of science (Abd-El-Khalick & Lederman, 2006b; Duschl, 1990; Lederman, 1992; Ryan & Aikenhead, 1992). According to Abd-El-Khalick and Lederman (2006b), an examination of the efforts to develop students' views of NOS through science method courses and through in-service training makes it clear that it is difficult to imagine allocating more time to address NOS in those contents. The reason for this is that the goals of those courses or curricula intended to attain are too many. It is impossible to change and develop teachers' views concerning NOS in a few hours, days or weeks.

Griffiths and Barman, (1995); Horner and Rubba, (1978); Larochelle and Desautels, (1991); Lederman and O'Malley, (1990); Mackay, (1971); Rubba, (1977) exhibited that students had naïve thoughts about the experimental, changeable, inferential, creative and imaginary nature of scientific knowledge- which were the important aspects of NOS. Bora, Aslan and Çakıroğlu (2006); Erdoğan, Çakıroğlu and Tekkaya (2006) investigated prospective science teachers', science teachers' and high school students' views on NOS and found that the participants had naïve views on the changeability of scientific knowledge, the definition of science, the nature of scientific models and on the properties of hypotheses, theories and laws. According to Ryan and Aikenhead (1992), most of the teachers and students have misconceptions about NOS and they believe that scientists follow a universal scientific method because scientific method yields valid and accurate results. Sorgo et al (2014) stressed that the understandings of NOS should be improved immediately in all countries. Sert Çıbık (2016) attracted attention to the importance of developing strategies in teaching the content of NOS and its' importance to teachers who raise the next generations. Köksal and Tunç Şahin (2014) demonstrated that students had misunderstandings about the changeability of NOS, its neutrality, the development of scientific knowledge in social and cultural structure, the hierarchical relations between hypotheses, theories and laws, the definition of science, and the place of imagination and creativity in science.

Research Focus

Having examined the literature taking into account all the above-mentioned studies, it was shown that students'/prospective teachers' having an adequate understanding of NOS was a necessity that science education aims to attain, but they did not have understanding at adequate levels. Therefore, scales/questionnaires are needed to develop students'/prospective teachers' views/ perceptions of NOS primarily for use in assessment. The fact that the scales used in the literature were rather old-fashioned (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002) made it necessary to adapt NOSI-E scale into Turkish and thus to obtain a valid and reliable scale of NOSI-S. Accordingly, this research aimed to adapt the The Nature of Science Instrument Elementary Scale (NOSI-E) developed by Peoples (2012) into Turkish for secondary schools and to analyse the psychometric properties of the scale. Secondary school students in particular were used as the sample in adapting the scale which had been originally developed for elementary school education into Turkish. The reason for this was that the level of knowledge in items constituting the scale overlapped with the gains in secondary school education in Turkey. In other words, the knowledge level of the items in the original scale was overlapped with the knowledge level of the subjects included in secondary school curriculum in Turkey. Moreover, it was aimed to adapt the original scale into Turkish for using as a reliable and valiable measurement tool in the future studies about NOS which will be conducted at secondary school level in Turkey. There are no tools available with the appropriate psychometric properties to determine NOS views of secondary school students.

Methodology of Research

The quantitative method was used in this research. The scale application process was conducted in 2015-2016 academic year. The scale was adapted into Turkish in three phases: (I) translation process of the items in NOSI-E, (II) pilot study of the NOSI-S and (III) the validity and reliability analyses of NOSI-S.

Sample of Research

A total of 261 secondary school students were included in the research. 137 female and 123 male participants took part in the research. One student did not answer the question about gender. The students were in the age range of 13 and 15, with an average age of 15.73 (SD=.99). Secondary school students enrolled in two different state schools those instructional programs were determined by Ministry of National Education participated in the research. The socio-economic status of the students was at medium level. Also, their school achievement was at high level by considering to their regional properties.

Data Collection Tool

NOSI-E scale was developed by Peoples (2012) on the basis of Rasch Model so as to determine elementary school students' understanding of NOS based on science reform efforts in US. Peoples used the Rasch Model to provide the most reliable, interpretable and responsive Rasch – based measure to assess the elementary students' views of NOS for use in large-scale studies. The 28-item scale contained five constructs- namely, empirical, inventive, theory-laden, certainty and socially and culturally embedded. Peoples (2012) performed separate analyses for one-factor model where 28 items measured only one factor, for multidimensional model composed of five inter-related but separate dimensions and for the model with five independent unidimensional constructs. The researcher concluded that the multidimensional model with composed of five inter-related but separate dimensions was more valid and reliable. In the research, it was found that $\chi 2$ / df = 1.28, RMSEA= .029 and CFI=.96. Six items were available on the sub-dimension of empirical while five items were available on the sub-dimension of inventive, six items on the sub-dimension of theory-laden, six items on the sub-dimension of certainty, and five items on the sub-dimension of socially and culturally embedded. Cronbach alpha internal consistency coefficient was found as α= .84 for the overall scale, whereas it was found as .78 for the sub-dimension of empirical, .73 for the sub-dimension of inventive, .73 for the sub-dimension of theory-laden, .73 for the sub-dimension of certainty, and .74 for the sub-dimension of socially and culturally embedded. Table 1 shows the sub-dimensions of the scale NOSI-E.

Table 1. The Sub-dimensions of NOSI-E.

Sub-dimensions	Item no	Reliability Values
Empirical	6	.78
Inventive	5	.73
Theory-laden	6	.73
Certainty	6	.73
Socially & culturally embedded	5	.74
Total	28	.84

Process

The desire to adapt the NOSI-E scale developed by Peoples (2012) into Turkish for secondary school students was conveyed to the author via e-mail, and the permission required was obtained. The originally English scale was then translated into Turkish by experts who were competent in Turkish and English languages and the other two were experts in the field of NOS. By considering the points in common in both translations, the Turkish version of the scale was formed. The Turkish version was translated back into English again by a language expert. Having made the necessary corrections by experts in the field, the final shape was given to the Turkish version of the scale.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

The scale was then administered to a group of 30 secondary school students. After it was tested in terms of content and comprehensibility, the final shape was given to the scale.

Data Analysis

Kaiser-Meyer-Olkin index and Bartlett's Sphericity test were used in this research to determine the adequacy of sampling and to find whether or not the data fitted the factor analysis. CFA was performed in order to determine the construct validity of the scale. Cronbach alpha coefficient was calculated for reliability analysis. Field (2009) points out that data can be factorised if KMO is .50 and above. Besides, Bartlett's Sphericity Test should also be statistically significant for data to fit factor analysis. KMO and Bartlett's Sphericity Test results are shown in Table 2.

Table 2. The results of KMO and Bartlett's Sphericity Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	Bartlett's Test of Sphericity		
.778	Approx. Chi-Square	df	Sig.
	1609.757	378	p<.0001

Results of Research

This part of the research contains findings on the validity and reliability analyses in relation to the NOSI-S scale. The construct validity of the scale was tested by doing CFA analysis. Following the first CFA, the CER 2 item "*New theories in science should only be accepted when there is a lot of evidence to support them*" - which was on the sub-dimension of certainty- was removed from the scale (t=-.67). Having removed the CER 2 item from the scale, the t values and error parameters were examined for the model, and it was found that there were no problems. The fit indices obtained by removing the item from the scale are shown in Table 3.

Table 3. Model-Data Fit Values for the Data of NOSI-S.

Model-data fit indices (acceptable fit values)									
N	χ^2/df	RMSEA	SRMR	CFI	GFI	AGFI	NFI	NNFI	IFI
261	1.42	.04	.058	.95	.89	.86	.85	.94	.95

Accordingly, the indices of model fit for secondary school students satisfy the goodness of fit criterion. Commonly used fit indices are NNFI and CFI (>.90 indicates good fit), RMSEA (<.08 indicates acceptable fit), and another value used frequently is the χ^2 statistics (it is desired that the χ^2/df ratio is below 3 (which was 1.42 here) (Hoe, 2008). On examining the fit indices here, it may be said that the χ^2/df ratio is below 3 (which was 1.42 here) and that the model fits the data perfectly. Besides, since the RMSEA value below .08 was acceptable, the value of .04 found in this research also indicated that the model fitted the data (Schermelleh-Engel, Moosbrugger, & Müller, 2003). In addition to that, because the NNFI and CFI (>.90) had acceptable values, the scale was considered to have attained construct validity. The standardised values for the scale items are shown in Figure 1 below.

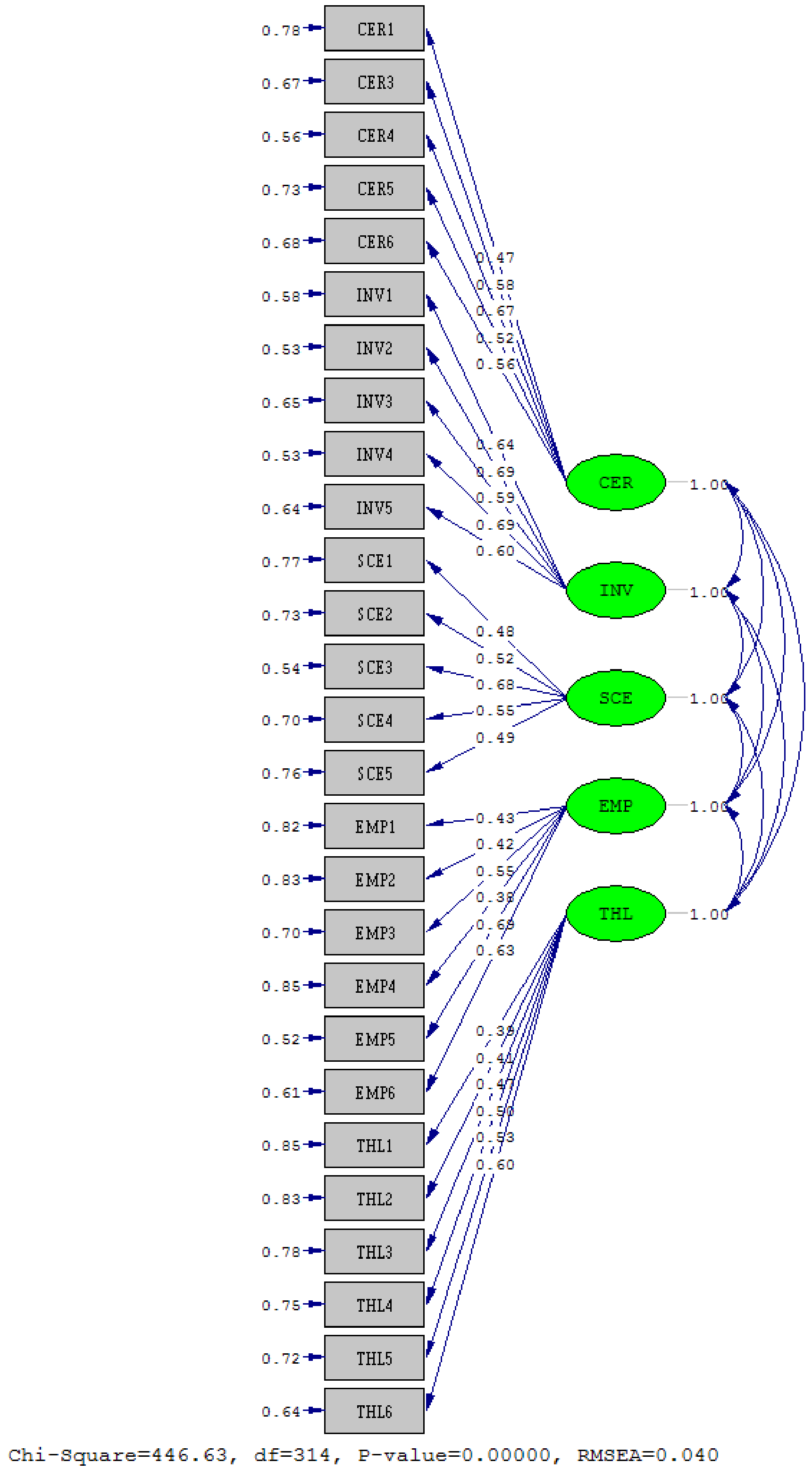

Figure 1: **Confirmatory factor analysis standard coefficients for the NOSI-S scale.**

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

A close examination of Figure 1 makes it clear that the standard coefficients are significant. Table 4 shows the error variances and α coefficients for the scale items.

Table 4. The λ_x, δ, t and α values obtained with CFA analysis.

Sub-dimensions	Items no	λ_x	δ	t	α
Certainty	CER1	.47	.78	6.78	.68
	CER3	.58	.67	8.51	
	CER4	.67	.56	9.94	
	CER5	.52	.73	7.57	
	CER6	.56	.68	8.26	
Inventive	INV1	.64	.58	10.36	.775
	INV2	.69	.53	11.17	
	INV3	.59	.65	9.39	
	INV4	.69	.53	11.16	
	INV5	.60	.64	9.46	
Socially & culturally embedded	SCE1	.48	.77	6.81	.667
	SCE2	.52	.73	7.56	
	SCE3	.68	.54	9.95	
	SCE4	.55	.70	7.91	
	SCE5	.49	.76	7.09	
Empirical	EMP1	.43	.82	6.36	.674
	EMP2	.42	.83	6.20	
	EMP3	.55	.70	8.47	
	EMP4	.38	.85	5.67	
	EMP5	.69	.52	11.05	
	EMP6	.63	.61	9.81	
Theory-laden	THL1	.39	.85	5.64	.631
	THL2	.41	.83	5.86	
	THL3	.47	.78	6.81	
	THL4	.50	.75	7.36	
	THL5	.53	.72	7.88	
	THL6	.60	.64	8.97	

Factor loads (λ), error variances (δ) and t values for each item can be seen in Table 4. Accordingly, it is clear that the t values are significant and the factor loads range between .38 and .69. Because the factor load was measured as -.05 and the t value was measured as -.67 for item CER 2, the item was removed from the scale. α coefficients, which were the internal consistency coefficients, were also calculated for the scale reliability. It was found that the reliability coefficients ranged between .631 and .775. Nunnally (1978) suggests as a general rule that reliability coefficient is .70. Yet, O'Rourke, Hatcher and Stepanski (2005) point out that the values below .70 are usually sufficient and even state that social scientists also report values below .60. It was also seen in the literature that reliability coefficients in scales developed for NOS fell below .70 and that even the values fell to .34 (Chen, 2006; Hacıeminoğlu, Yılmaz-Tüzün, & Ertepınar, 2014; Liang et al. 2008; Tsai & Liu 2005). Considering those scales, it may be said that the reliability index for the NOSI-S scale is at the acceptable level. α coefficient for the overall scale was found as α= .814. Correlation coefficients were analysed to see whether or not the factors in the scale were independent of each other and whether or not each factor measured a different construct. Table 5 shows the correlation coefficients.

Table 5. Correlation Matrix of Independent Variables of NOSI-S.

	CER	INV	SCE	EMP	THL
CER	1.00				
INV	.31 (t=3.98)	1.00			
SCE	.16 (t=1.88)	.19 (t=2.25)	1.00		
EMP	.36 (t=4.53)	.41 (t=5.72)	.48 (t=6.48)	1.00	
THL	.43 (t=5.38)	.43 (t= 5.66)	.38 (t=4.51)	.72 (t=11.63)	1.00

Table 5 shows the correlations between five sub-dimensions in the scale as well as the t values. On examining the values, it was found that the correlations between CER and SCE sub-dimensions were not significant (r=.16 t=1.88, p>.05). The correlations between the other sub-dimensions, however, were found to be positive and significant. Moreover, on examining the correlations between sub-dimensions, the highest correlation was found between THL and EMP sub-dimensions (r=.72).

Discussion

This research aimed to adapt NOSI-E scale developed by Peoples (2012) into Turkish for secondary school students and to analyse the psychometric properties of the scale. Prior to data analysis, Kaiser-Meyer-Olkin (KMO) and Bartlett's Sphericity Test were performed so as to find whether the data fitted factor analysis. The fact that KMO sample fit test result was bigger than .50 and that Barlett's Sphericity Test was statistically significant (p<.001) indicated that the data set fitted factor analysis. Having seen the fit for factor analysis, CFA was performed so as to evaluate the construct validity of the scale. After the first CFA conducted for NOSI-S, the item CER 2 (t=-.67) on the sub-dimension of certainty was removed from the scale. With the second CFA, the t values and error parameters of the scale items were analysed and no problems were found. As it is clear from Table 3, the model fit indices for secondary school students were regarded to satisfy the goodness of fit criterion. Having examined the fit indices, due to the fact that the χ^2/df ratio was below 3 (1.42), that the RMSEA value was at the level of .04, and that the NNFI and CFI (>.90) had acceptable values, it was regarded that construct validity was attained. Figure 1 made it clear that standardised coefficients for the items were significant. Table 4 showed the factor loads (λ), error variances (δ) and t values for each item. Accordingly, the t values were significant and the factor loads ranged between .38 and .69. α coefficients, which were the internal consistency coefficient calculated for the scale reliability, was found to range between .631 and .775. The α coefficient for the overall scale was found as .814. Considering the scale development studies (Chen, 2006; Hacıeminoğlu, Yılmaz-Tüzün, & Ertepınar, 2014; Liang et al. 2008; Tsai & Liu 2005), it may be said that the reliability index for the NOSI-S scale is at the acceptable level. On examining the correlation coefficients between the factors in the scale, it could be said that the factors were independent of each other and that each factor measured a different construct.

Conclusion

In conclusion, scale adaptation is a process requiring special attention and care. Translating a scale into another language and removal of some items in the scale require detailed observations, experience and having good command of the subject of the scale as well as the culture into which the scale is adapted. In this context, item analyses were done in details in the process of adapting the NOSI-S into Turkish. It is essential that a scale is shown to be valid and reliable also for students who have grown up in a different culture and language other than the original. This situation, in a sense, is also the indicator of the fact that the scale is universal and that its items work very well at different levels of education.

ISSN 1648–3898 /Print/
ISSN 2538–7138 /Online/

References

Abd-El-Khalick, F., & Lederman, L.G. (2000b). The influence of history of science courses on students' views of nature of science. *Journal of Research in Science Teaching, 37* (10), 1057-1095.

Abd-El-Khalick, F., & Lederman, N. G. (2000a). Improving science teachers' conceptions of nature of science: A critical review of the literature. *International Journal of Science Education, 22* (7), 665-701.

American Association for the Advancement of Science (1989). *Project 2061. Science for All Americans*. Washington, DC: American Association for the Advancement of Science.

American Association for the Advancement of Science (1990). *Science for all Americans*. New York: Oxford University Press.

American Association for the Advancement of Science (1993). *Benchmarks for science literacy: A Project 2061 report*. New York: Oxford University Press.

Bora, N. D., Aslan, O., & Cakiroglu, J. (2006). *Investigating science teachers' and high school students' views on the nature of science in Turkey*. Paper presented at the annual meeting of the National Association for Research in Science Teaching, San Francisco, CA.

Bybee, R. W. (1997). *Achieving scientific literacy: From purposes to practices*. Portsmouth, NH: Heinemann.

Chen, S. (2006). Development of an instrument to assess views on nature of science and attitudes toward teaching science. *Science Education*, *90* (5), 803-819.

Duschl, R. A. (1990). *Restructuring science education: The importance of theories and their development*. Teachers College Press, New York.

Erdogan, R., Cakiroglu, J. & Tekkaya, C. (2006). Investigating Turkish pre-service science teachers' views of the nature of science. In C.V. Sunal & K. Mutua (Eds.), *Research on education in Africa, The Caribbean and the Middle East* (pp. 273–285). Greenwich: Information Age Publishing Inc.

Field, A. (2009). *Discovering statistics using SPSS (3rd ed.)*. London: Sage publications.

Griffiths, A. K., & Barman, C. R. (1995). High school students' views about the nature of science: Results from three countries. *School Science and Mathematics, 95*, 248-255.

Hacıeminoğlu, E., Yılmaz-Tüzün, Ö., & Ertepınar, H. (2014). Development and validation of nature of science instrument for elementary school students. *Education 3-13*, *42* (3), 258-283.

Hoe, S. L. (2008). Issues and procedures in adopting structural equation modeling technique. *Journal of Applied Quantitative Methods, 3* (1), 76-83.

Horner, J. K., & Rubba, P. A. (1978). The myth of absolute truth. *The Science Teacher, 45* (1), 29-30.

Kimball, M. E. (1967-68). Understanding the nature of science: A comparison of scientists and science teachers. *Journal of Research in Science Teaching, 5*, 110-120.

Köksal, M. S. & Tunç Şahin, C. (2014). Understandings of advanced students on nature of science and their motivational status to learn nature of scıence: a Turkish case. *Journal of Baltic Science Education, 13* (1), 46–58.

Köksal, M. S. (2010). Discipline dependent understandings of graduate students in biology education department about the aspects of nature of science. *Education and Science, 35* (157), 68-83.

Larochelle, M. & Desautels, J. (1991). The epistemological turn in science education: The return of the actor. In Duit, R., Goldberg, F. & Niedderer, H. (Eds.), Research in physics learning: Theoretical issues and empirical studies (pp. 155-175). Kiel, ALL: Institute for Science Education.

Lederman, N. G. & O'Malley, M. (1990). Students' perceptions of tentativeness in science: development, use, and sources of change. *Science Education, 74*, 225-239.

Lederman, N. G. (1992). Students' and teachers' conceptions of the nature of science: A review of the research. *Journal of Research in Science Teaching, 29* (4), 331-359.

Lederman, N. G., Abd-El-Khalick, F., Bell, R. L., & Schwartz, R. S. (2002). Views of nature of science questionnaire: toward valid and meaningful assessment of learners' conceptions of nature of science. *Journal of Research in Science Teaching, 39* (6), 497-521.

Liang, L.L., Chen S., Chen X., Kaya O.N., Adams A.D., Macklin M., & Ebenezer, J. (2008). Assessing preservice elementary teachers' views on the nature of scientific knowledge: A dual-response instrument. *Asia-Pacific Forum on Science Learning and Teaching, 9 (*1). Retrieved from http://www.ied.edu.hk/apfslt/v9_issue1/liang/index.htm.

Mackay, L. D. (1971). Development of understanding about the nature of science. *Journal of Research in Science Teaching, 8*, 57-66.

National Research Council (1996). *National science education standards*. Washington, DC: National Academy Press.

National Science Teacher Association (1982). *Science - technology-society: Science education for the 1980s*. Position Paper. Washington, D.C.: Author.

Nunnally, J. (1978). *Psychometric theory.* New York: McGraw-Hill.

O'Rourke, N., Hatcher, L., & Stepanski E. J. (2005). *A step-by-step approach to using SAS for univariate and multivariate statistics* (Second Edition). Cary, NC: SAS Institute Inc.

Palincsar, A. S., Anderson, C. A., & David, Y. M. (1993). Pursuing scientific literacy in the middle grades through collaborative problem solving. *Elementary School Journal, 93* (5), 643-658.

Peoples, S. M. (2012). *The Nature of Science Instrument-Elementary (NOSI-E): Using Rasch principles to develop a theoretically grounded scale to measure elementary student understanding of the nature of science*. ProQuest LLC. 789 East Eisenhower Parkway, PO Box 1346, Ann Arbor, MI 48106.

Rubba, P. A. (1977). The development, field testing and validation of an instrument to assess secondary school students' understandings of the nature of scientific knowledge. Dissertations Abstracts International, 38, 5378A (University Microfilms No. 78-00,998).

Ryan, A. G., & Aikenhead, G. S. (1992). Students' preconceptions about the epistemology of science. *Science Education, 76* (6), 559-580.

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research-Online, 8* (2), 23-74.

Sert Çıbık, A. (2016). The effect of project-based history and nature of science practices on the change of nature of scientific knowledge. *International Journal of Environmental & Science Education, 11* (4), 453-472.

Shamos, M. (1995). *The myth of scientific literacy*. New Brunswick, NJ: Rutgers University Press.

Šorgo, A., Usak, M., Kubiatko, M., Fančovičova, J., Prokop, P., Puhek, M., Skoda, J. & Bahar, M. (2014). A cross-cultural study on freshmen's knowledge of genetıcs, evolution, and the nature of science. *Journal of Baltic Science Education, 13* (1), 6–18.

Tsai, C. C., & Liu, S. Y. (2005). Developing a multi- dimensional instrument for assessing students' epistemological views toward science. *International Journal of Science Education*, *27* (13), 1621-1638.

Received: *April 16, 2017* Accepted: *May 08, 2017*

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