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TURKISH STUDY OF INVENTORY OF STUDENT EVALUATION ACCEPTANCE (ISEA) SCALE

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Abstract:
This study aimed to adapt the ISEA (Inventory of Student Evolution Acceptance) developed by Nadelson and Southerland (2012) to Turkish students by undertaking the required validity and reliability studies on the scale. Subsequent to obtaining permit from the authors of the scale, scale items were translated into Turkish by the researchers. Translation validity was investigated with the help of translation agreement rating forms checked by English and Turkish linguistics experts. After ensuring language validity, the Turkish form was given to 632 senior high school students. Varimax orthogonal rotation on oblique axes was used in factor analysis to assign factors in the scale. Analysis results provided a three factor scale with 22 items. The Cronbach's alpha internal consistency coefficient was found and the test-retest method was used to analyze the reliability of the ISEA scale: a Cronbach's alpha value for the whole scale was identified to be 0,79 while values of 0,80, 0,70 and 0,697 were found for the first, second and third factors respectively. The Spearman-Brown split-halves reliability value was calculated as 0,847 and the test-retest reliability coefficient was 0,76.

Keywords: theory of evolution, recognition of evolution theory, high school students

1. Introduction

The theory of evolution was born when Charles Darwin explained the evolution of species via natural selection in 1859 in his book "On the Origin of Species'. Darwin combined the theory of natural selection with Mendel's studies on heredity in his theory of modern evolutionary synthesis. In his article titled "Nothing in Biology Makes Sense Except in the Light of Evolution", Dobzhansky (1973) expressed that evolution is a central theory that acts as the key and/or framework for the biological sciences. The theory of evolution is crucial since it associates the scientific data obtained in various

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scientific fields that investigate different time periods and events and that focus on different rules of nature by using different methods. Although astronomy, physics, bio-chemistry, geology, paleontology, bio-geography, biology, anthropology and several other scientific areas are quite distinct from one another, the theory of evolution synthesizes and associates all these sciences as a unifying theory.

Starting with the 21st century, the modern theory of evolution explains how mutations and natural selection have created evolutionary changes. Although teaching evolution has been stressed in the educational reforms of the last 20 years, studies still point to misconceptions on the part of both students and even teachers (Evans, 2008; Gregory, 2009; Nehm & Schonfeld, 2007). For instance, it was found that students explain evolutionary changes with the help of Lamarck's theory which states that the acquired characteristics result in evolution, the organs that are often used develop while the ones that are not used die down (Bishop & Anderson, 1990; Jensen & Finley, 1996), they perceive selection value as being healthy and strong (Bishop & Anderson, 1990; Gregory, 2009) and they explain evolutionary changes at the individual level (Gregory, 2009). In addition to studies on misconceptions, other studies in recent years have predominantly focused on cognitive biases (Evans, 2008; Sinatra, Brem & Evans, 2008). In this context, studies on cognitive sciences have revealed three main cognitive biases that complicit understanding of evolutionary concepts and cause misconceptions: essentialist, theological and intentional biases. Theological biases are related to the realization of evolutionary changes based on a specific purpose. Intentional biases are cognitive biases which assume that evolutionary changes are controlled cognitively. Essentialist biases are based on the trend that ignores variations in the population by classifying species in specific categories.

Some scientists and researchers emphasized that one of the most important reasons why the theory of evolution is not highly accepted is related to misconceptions regarding the concept of "theory" (Bloom, 1989; Brickhouse, Dagher, Letts & Shipman, 2000; Dagher & BouJaoude, 1997; Dagher, Brickhouse, Shipman & Letts, 2004; Graf, Tekkaya, Kılıç & Özcan, 2011; Gregory & Ellis, 2009; Kılıç & Tekkaya, 2011; Lawson, 1995; National Research Council [NRC], 1998; Norris & Phillips, 1994; Prinou, Halkia & Skordoulis, 2008; Taşkın, Çobanoğlu, Apaydın, Çobanoğlu & Yılmaz, 2008). Different methods were used to remove the negativity associated with the concept of "theory". Lewontin (1981), an evolutionary biologist in Harvard University, stated that "evolution is a reality, not a theory" and defended the position that individuals who do not accept evolution cannot comprehend the natural world. He went so far as to say that an individual who denies the theory of evolution may even deny the fact that the earth revolves around the sun. Lewontin's use of the analogy based on the reality of the earth revolving around the sun to prove the same scientific basis for evolution is an indicator that shows how scientists made efforts to assign factuality to the concept.

Studies regarding teaching of evolution emphasized the religious beliefs as the basic determinants behind positive or negative student attitudes towards evolution or their acceptance or denial of the theory (Bergman, 1979; Sinatra, Southerland, McConaughy & Demastes, 2003; Somel, Somel, Tan & Kence, 2006). Although there are

numerous scientific studies on evolution and although it is regarded as the most comprehensive and the most basic theory of biology by the scientific community, it is not possible to claim that the public has similar approaches to the theory of evolution. According to the results of an international study conducted by Miller et al. in 2006, Turkey is the last in a list of 34 countries with a 25% ratio of individuals who embrace the theory. The USA is the second from the last right before Turkey in the list. In another comprehensive study undertaken in Lebanon by Dagher and BouJaoude (1997), 50% of the students were found to reject the theory of evolution. According to the same study, 82% of Christian and 35% of Muslim students accepted the theory of evolution. Teachers, who are the primary human element in the teaching of evolution, have influential religious beliefs both in acceptance or denial of the theory and in teaching the ideas related to the theory. Based on these studies, atheist or agnostic teachers show wider acceptance of the theory compared to Muslim and Christian teachers whereas Christian teachers are more accepting compared to Muslim teachers (Asghar, Wiles & Alters, 2007; Clement, Quessada, Laurent & Carvalho, 2008; Moore, 2007; Trani, 2004). Researchers who argue that teachers will accept the theory of evolution regardless of their beliefs when they comprehend the nature of science and the theory of evolution imply that the theory is not sufficiently comprehended by teachers (Rice, Olson & Colbert, 2010; Trani, 2004).

The fact that the theory of evolution has gained more and more priority in the biological sciences and the paradoxical public resistance to the theory has resulted in focusing on the problems related to teaching, learning and adopting the theory (Alters & Nelson, 2002; Nelson, 2008; Akerson et. al, 2009; Van Dijk, 2009). Generally these problems are caused by students' and teachers' misunderstandings regarding the nature of science, belief systems from their past or from their environments and techniques that are based on conceptual learning (Deniz et. al., 2008; Peker et. al., 2009). Researchers focused on misconceptions or inadequacies based on lack of understanding or miscomprehending the fundamental concepts or processes about genetics and evolution especially during teaching and learning of evolution, problems caused by lack of understanding of the nature of science and problems caused by student beliefs. Studies on teaching the theory of evolution do not solely focus on creationism as the only factor that affects student acceptance of the theory, however, conflict between the theory and individual beliefs as an explanation of rejection of the theory was analyzed comprehensively in the literature (Apaydın & Sürmeli, 2009; Alters & Alters, 2001; Aroua, Coquide & Abbes, 2009; Bishop & Anderson, 1990; Mino & Espinosa, 2009; Mino & Espinosa, 2010; Osif, 1997; Reiss, 2009; Shipman, Brickhouse, Dagher & Letts, 2002; Woods & Sharmann, 2001). Many studies have been undertaken to identify attitudes towards the theory of evolution, to remove negative aspects and design better teaching in the field. Studies generally focus on student learning in the field of evolution, their attitudes towards theory of evolution, their acceptance of the theory and beliefs, teacher comprehension and their teaching intentions (Hermann, 2007). Studies show that articles published in the field of training in evolution have increased incrementally. The

number of publications for the periods of 1980-1989, 1990-1999 and 2000-2007 are 19, 35 and 103 respectively (Rice, 2007).The number of publications is still increasing.

It is specified in the studies that evolution is among the important topics of the biology curriculum that is difficult to comprehend and teach (Beardsley, 2004; Bishop & Anderson, 1990). Related research points to the fact that teacher candidates and teachers are having difficulty in understanding the topic of evolution and have misconceptions (Asghar, Wiles & Alters, 2007; Deniz, Donelly, & Yılmaz, 2008; Graf & Soran, 2011; Kim & Nehm, 2010; Smith, 2010; Van Dijk & Reydon, 2010). This fact affects student ideas about the acceptance of evolution. The studies undertaken so far have generally targeted teachers and teacher candidates. Adding a scale to the national literature to identify senior high school students' views in this matter is highly important. The current study aims to adapt evolution acceptance of the scale developed by Nadelson and Southerland (2012) to Turkish students.

2. Method

2.1 Working Group

The study was conducted with a total of 632 students from three state high schools that attend school or are graduates who prepare for the university entrance exam in the Kahramanmaraş center in Turkey. A total of 38% of the students attended School A (N = 240), 20,3% attended School B (N = 128) and 20,6%went to School C (N = 130) whereas 21,2% attended the Preparatory Course A (N=134). About 54% of the students in the study were females (N = 338) and 47% were males (N = 294). Approximately 25% of the students (N = 156) described themselves as secular-social democrats, 22% (N = 137) as religious, 18% (N = 117) as nationalistic and 35% (N = 222) expressed no philosophy of life. Only 70 students participated in test-retest analysis of the study.

2.2 Data Collection Tool

The original ISEA scale was developed by Nadelson and Southerland (2012). During the scale development process, statements in the scale were generated as a result of a literature review and 15-20 minute face to face interviews with 30 high school and college students. Pilot scale items were prepared using an open-ended written survey with statements based on responses obtained during face to face interviews. These pilot items were given to more than 75 high school and college students and data were obtained regarding the attitudes towards and perceptions about evolution. A Likert type scale composed of three sub-scales (microevolution, macroevolution, human evolution) was generated following these pilot implementations. Content validity was reviewed by an 8-person team composed of biology teachers, science teacher educators and college biology faculty. A total of 56 items were obtained in the first ISEA scale and 32 items were removed as a result of content, exploratory, confirmatory and reliability analyses to generate a 5-point Likert type ISEA scale (ranging from strongly disagree, disagree, undecided, agree to strongly agree) with 24 items. The Cronbach's alpha reliability coefficient of the scale was found to be 0,96; and the Cronbach's alpha

reliability coefficients for the sub-scales were calculated as follows: macroevolution 0,92; microevolution 0,96; human evolution 0,93.

2.3 Translation Process

A Turkish adaptation process of the ISEA scale followed specific phases. Firstly, the scale was translated into Turkish by three instructors from the School of Foreign Languages who had a good command of both languages and the forms were translated back to English one week later. Consistency between the two translations was investigated by the instructors. The instructors examined the translated scale in terms of meaning and grammar and the pilot Turkish form was generated after the necessary adjustments. This pilot form was sent to 12 academicians in the field via e-mail to rate their ideas on conformity of the translation to the original using a rating scale from 1 (does not conform at all) to 10 (fully conforms to the original). According to data obtained from Kendall's Concordance (W) Analysis ($W = 0,086$; χ^2 (23) = 23,774; $p = 0,416 > 0,05$) lack of conformity was identified among the experts regarding the congruency of the Turkish-English form. Statements that were incomprehensible or incoherent were reviewed in line with expert views. Following this phase, the pilot Turkish form was sent to three more experts who completed their doctorate degrees abroad to translate the form to English and the form was compared with the original. Experts who translated the form and the researchers were thus satisfied that the form conformed to the original form. After the scale was examined in terms of language, wording and typos by a linguist, the scale was ready to implement validity and reliability studies.

In this phase, construct validity was examined for the validity studies of the ISEA scale. Exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were undertaken to present construct validity. While CFA, which is based on a theoretical base, is used to evaluate the degree of overlap between the data and the factors that are formed by different variables, EFA was undertaken to generate a few identifiable and meaningful constructs from many items (variables) that can be explained by the combination of these items (Büyüköztürk, 2010).

EFA was used in this study to determine the construct of the original form on Turkish students and CFA was used to examine whether the factor structure of the original form was validated on Turkish students (Büyüköztürk et al., 2004). Multiple Correspondence Indices were used for CFA analysis and Chi-Square Goodness, comparative fit index (CFI), incremental fit index (IFI), Goodness of fit index (GFI), relative fit index (RFI), normed fit index (NFI), root mean square residuals, RMR and root mean square error of approximation (RMSEA) goodness of fit indices were examined. In goodness of fit indices, $p > 0,90$ was utilized for CFI, IFI, GFI, RFI, NFI and $p < 0,05$ was utilized for RMR and RMSEA (Hu & Bentler, 1999). Internal consistency (Cronbach's alpha) and test-retest analysis were used to determine the reliability of the ISEA scale and corrected item-total correlations and t-test were preferred for item analysis to examine the significance of the differences between means of groups of 27%.

3. Findings

3.1 Construct Validity

A. Exploratory factor analysis

Firstly, the correlation matrix (R matrix) was examined to decide whether the data were fit for factor analysis: a high ratio of significant relationships was identified which pointed to the fact that the data were fit for factor analysis. Later, sampling adequacy ((Kaiser-Meyer-Olkin Measure of Sampling Adequacy Analysis) and Barlett Sphericity analyses were undertaken and KMO Sampling Adequacy Coefficient was found to be 0,870 and Bartlett Sphericity testχ^2value was calculated as 3673,149 (p = 0,000 < 0,01) (Table 1).

Table 1: KMO and Bartlett's test results

Kaiser-Meyer-Olkin (KMO)test		0,870
Bartlett test of sphericity	Chi-square(χ^2)	3673,149
	df	276
	p	0,000

In order for data to be fit for factor analysis, KMO value should be higher than 0,60' and the Barlett test should be significant (Pallant, 2007). Since the KMO value was 0,870, Barlett Sphericity test was significant and the majority of correlation coefficient values were 0,30 and above in this study, the data were found fir for factor analysis (Hutcheson & Sofroniou, 1999).

The original form was composed of three sub dimensions titled microevolution, macroevolution, and human evolution. Therefore, factor analysis results in principal component analysis were limited to three factors. Table 2 presents the factor loadings of the scale and the variance ratios they explain.

Table 2: I-SEA Scale factor load values

Rotated Component Matrix(a)

	Component		
Item No	**Factor 1**	**Factor 2**	**Factor 3**
Q7	,703		
Q3	,668		
Q5	,656		
Q11	,653		
Q10	,645		
Q1	,604		
Q8	,588		
Q14	,480		
Q17	,469		
Q4	,459		,301
Q24	,413		,334
Q12		,680	
Q18		,677	
Q15		,649	

Q19		,626	
Q22		,603	
Q9		,552	
Q6		,536	
Q13		,458	
Q2		,446	
Q20			,753
Q23			,737
Q21			,664
Q16			,386
	%20,046	**%14,122**	**%7,132**

Table 2 shows microevolution as a sub dimension obtained as a result of Varimax analysis, result. This sub dimension consists of nine statements. Factor load values of the items in the sub dimension change between 0,469 and 0,703. Results of EFA show that the second sub dimension is composed of nine statements and factor load values of the items in the sub dimension varied between 0,446 and 0,680. The third sub dimension consists of four statements with factor load values between 0,386 and 0,753. As a result of EFA analysis, statements 4 and 24 which distort the factor structure of the scale and provide high load values were excluded from the scale. Therefore, a total of 22 items can be said to ensure construct validity in the Turkish form. Eigenvalues of the factors were 4,811; 3,389 and 1,712 respectively. These three factors were found to explain 41,30% of the variance. Factor structure was defined as having three factors based on the eigenvalues. This can also be observed in scree plot graphic drawn according to eigenvalues (Figure 1). The graphic shows a curve after the third factor which helps explaining the scale as having three factors.

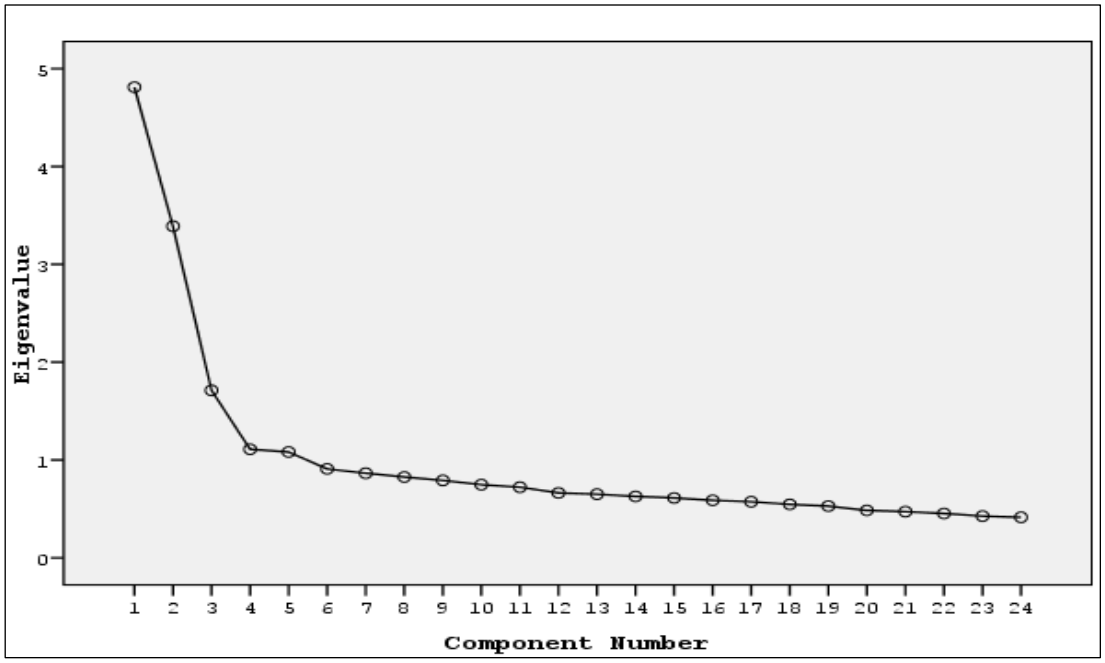

Figure 1: Scree Plot Graphic based on Eigenvalues

B. Confirmatory Factor Analysis

The ISEA scale was regarded as valid due to sufficient percentage in explaining the total variance and sufficiently high load values in the three factors which pointed to the ability to of the scale to measure what it set out to measure. CFA was also conducted on the scale on which EFA was already implemented. Figure 1 presents the factor loads of the model.

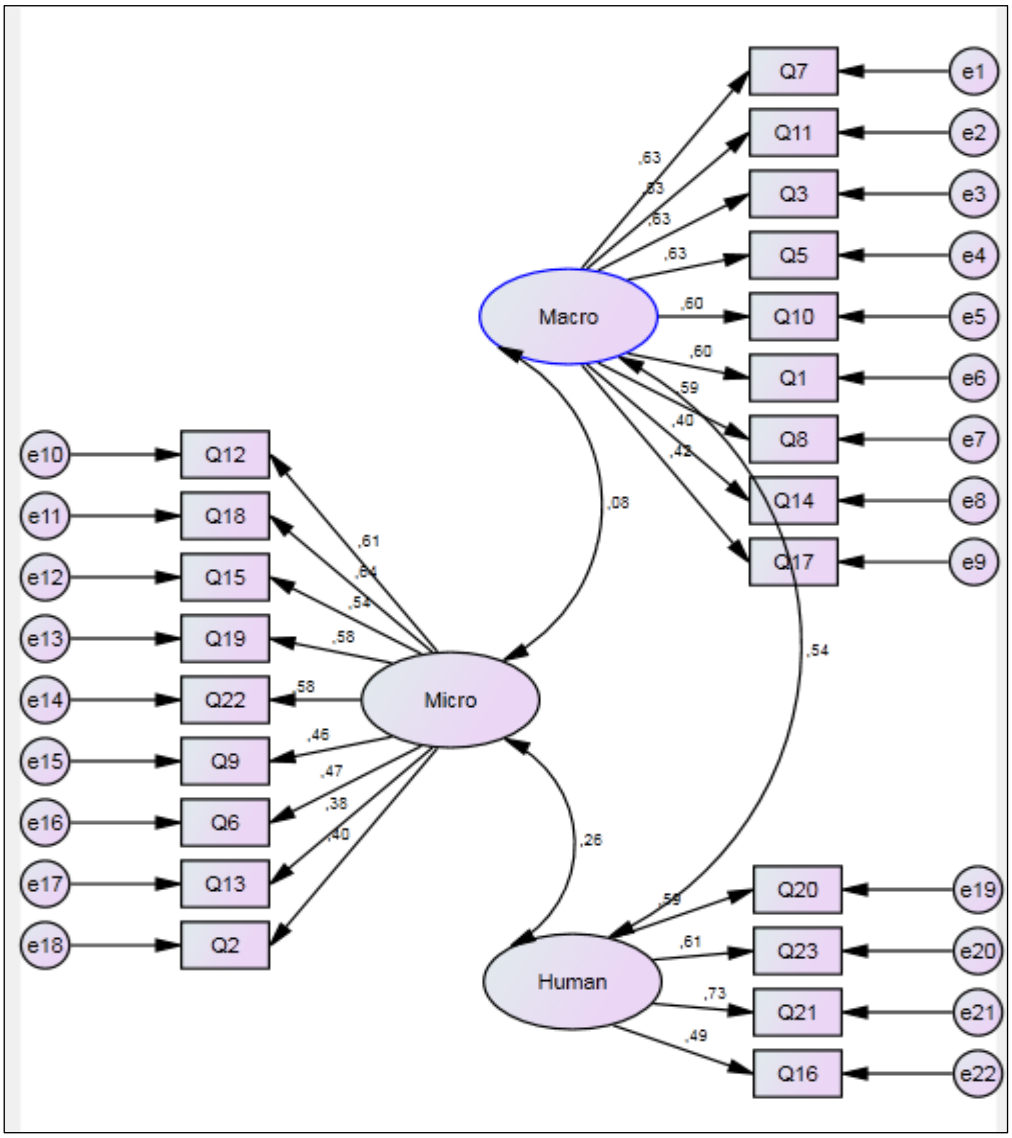

Figure 2: CFA Diagram

The AMOS program was used to employ CFA on the single factor of the ISEA scale obtained by EFA. While CFA pointed to the fact that all items corresponded to the three factor structure, the obtained model fit indices presented good values as well. Table 3 presents the findings regarding the CFA results for I-SEA scale.

Table 3: I-SEA Goodness-of-fit index values

CMIN (χ^2)	df	*p*	RMR	GFI	AGFI	RMSEA	CMIN/df
705,689	253	0,000	0,09	0,91	0,88	0,06	3,25

Since the CMIN/df ratio calculated as a result of the analysis was smaller than 5.0 (Kline, 2005), and GFI value was higher than .90 (Miles & Shevlin, 1998), RMSEA value was lower than .07 (Steiger, 2007), the small RMR value which is close to 0 (Tabachnik & Fidell, 2007), GFI values higher than .85, AGFI values higher than .85, they are regarded as acceptable lower limits for model-data fit (Anderson & Gerbing, 1984; Marsh, Balla & McDonald, 1988). Accordingly, Table 3 presents RMR = 0,09 < .10; GFI = 0,91 > .85; AGFI = 0,88 > .85; RMSEA = 0,06 < .07 and CMIN/df = 3,25 < 5,0. Values about model-data fit show good fit between the model and the data, the findings obtained from EFA is validated by CFA and therefore the scale has construct validity.

C. Reliability Analysis

The Cronbach's alpha internal consistency coefficient and test-retest method were used to analyze the reliability of the ISEA scale. The Cronbach's alpha value was found to be 0,79 for the whole scale and the Cronbach's alpha values for the factors were as follows: 0,80 for the first factor, 0,70 for the second factor and 0,697 for the third factor. Spearman-Brown split-halves reliability value was calculated as 0,847 and the test-retest test reliability coefficient was found as 0,76.

Table 4 presents the values regarding the differences in item scores of the upper and lower 27% groups for corrected item-total correlations.

Table 4: I-SEA Scale Corrected Item-Total Correlations

Factor	Item no	r_{jx}	t
Micro	Q7	0,40	12,37**
	Q3	0,26	10,4**
	Q5	0,48	16,22**
	Q11	0,46	16,14**
	Q10	0,46	14,92**
	Q1	0,48	17,04**
	Q8	0,41	13,27**
	Q14	0,20	6,28**
	Q17	0,19	6,35**
Macro	Q12	0,41	10,6**
	Q18	0,40	9,17**
	Q15	0,35	8,56**
	Q19	0,31	6,95**
	Q22	0,24	4,82**
	Q9	0,29	7,37**
	Q6	0,18	4,33**
	Q13	0,21	4,4**
	Q2	0,21	3,9**
Human	Q20	0,35	9,76**
	Q23	0,28	8,94**
	Q21	0,35	10,5**
	Q16	0,48	15,41**

p < .001

Table 4 shows that the item-total correlations for all items in the scale changed between 0,18 and 0,48 and t values (sd = 340) are between 3,90 and 17,04 and significant (p< .001). These results present high item reliability for all items in the scale. Criterion validity of the ISEA was calculated by determining the correlation values between the scale and test scores taken as criteria and these values were as follows: 0,74 (p < .001) for Factor 1 (micro), 0,64 (p< 0.001) for factor 2 (macro) and 0,65 (p< 0.001) for Factor 3 (human).

4. Results and Suggestions

The current study aimed to adapt the ISEA (Inventory of Student Evolution Acceptance) scale developed by Nadelson and Southerland (2012) into Turkish by undertaking validity and reliability studies. The original form consisted of 24 items and three sub-dimensions: microevolution (8 items), macroevolution (8 items) and human evolution (8 items). Content validity of the scale was assessed by a team of eight individuals composed of biology teachers, science teacher educators and college biology faculty. The original ISEA scale with 24 statements was subjected to content, exploratory, confirmatory and reliability analyses which led to exclusion of 2 items and a 5-point Likert type scale with 22 items (ranging from strongly disagree, disagree, undecided, agree to strongly agree) as obtained (Appendix). The Cronbach's alpha reliability coefficient of the full scale was 0,79 with the following values for sub-dimensions: microevolution 0,80; macroevolution, 0,70; human evolution 0,69. The Spearman-Brown split-halves reliability value was found to be 0,847 and the test-retest test reliability coefficient was 0,76. It was observed that the item-total correlations changed between 0.386 and 0.753 in the adapted scale. Since the items with .30 and higher item-total correlations are better at distinguishing individuals in terms of measured characteristics (Büyüköztürk et. al., 2004), it can also be claimed that item-total correlations are sufficient for the current study. Findings from reliability and validity studies showed that the 22-item Turkish form of the scale was suitable to be used in Turkey, is reliable and valid and has linguistic equivalence just like the original form.

The scale adapted to Turkish in the current study can be safely used to identify high school students' views related to the acceptance of evolution. Further studies may include reliability and validity studies regarding different age groups. This study which aims to identify high school students' views regarding the acceptance of the theory of evolution can be used by science educators and researchers in the field of science

References

1. Akerson, L. V., Buzzelli, A. C. & Donnelly, A. L. (2009). On the nature of teaching nature of science: Preservice early childhood teachers' instruction in preschool and elementary settings. *Journal of Research in science Teaching*, *47*(2), 213- 233.

2. Alters, B. & Alters, S. (2001). Defending evolution: a guide to the creation/evolution controversy. City, MA: Jones and Barlett.
3. Alters, B. & Nelson, C.E. (2002). Perspective. *Teaching Evolution in Higher Education. Evolution, 56*(10), 1891-1901.
4. Apaydin, Z. & Surmeli, H. (2009). Undergraduate students' attitudes towards the theory of evolution. *Elementary Education Online*, *8*(3), 820-842.
5. Aroua, S., Coquide, M. & Abbes, S. (2009). Overcoming the effect of the socio-cultural context: impact of teaching evolution in Tunisia. *Evolution Education Outreach*, *2*, 474-478.
6. Asghar, A., Wiles, J. & Alters, B. (2007). Discovering international perspectives on biological evolution across religions and cultures. *International Journal of Diversity in Organizations, Communities and Nations*,*6*, 81–88.
7. Beardsley, P. (2004). Middle school student learning in evolution: Are current standards achievable? *The American Biology Teacher*, *Volume?* 604-612.
8. Bergman, J. (1979). Attitude of university students toward the teaching of creation and evolution in the schools. *Origins*, 6, 64-66.
9. Bishop, B., & Anderson, C. A. (1990). Student conceptions of natural selection and its role in evolution. *Journal of Research in Science Teaching,27*, 415–427.
10. Bloom, J. W. (1989). Preservice elementary teachers' conceptions of science: science, theories and evolution. *International Journal of Science Education*, *11*(4), 401-415.
11. Brickhouse, N. W., Dagher, Z. R., Letts W. J., & Shipman, H. L. (2000). Diversity of students' views about evidence, theory, and the interface between science and religion in an astronomy course. *Journal of Research in Science Teaching,37*(4), 340-362.
12. Büyüköztürk, Ş. (2010). Data analysis for social science hand book (11th edition), Ankara: PegemA Publishing.
13. Büyüköztürk, Ş., Akgün, Ö. E., Özkahveci, Ö., & Demirel, F. (2004). The validityand reliability study of the Turkish version of the motivated strategies for learningquestionnaire. *Educational Sciences: Theory & Practice, 4*(2), 231-239.
14. Clement, P., Quessada, M. P., Laurent, C. & Carvalho, G. (2008). Science and religion: evolutionism and creationism in education a survey of teachers' conceptions in 14 countries. XIII. IOSTE Symposium, The Use of Science and Technology Education for Peace and Sustainable Development. *Sunuldu*, Kuşadası/*:* Turkey Türkiye
15. Dagher, Z. R. & BouJaoude, S. (1997). Scientific views and religious beliefs of college students: The case of biological evolution. Journal of Research in Science Teaching, 34, 429 445.
16. Dagher, Z. R., Brickhouse, N., Shipman, H. & Letts, W. (2004). How some college students represent their understanding of scientific theories. *International Journal of Science Education, 26*, 735-755.
17. Darwin, C. (1859). On the origin of species by means of natural selection, or, the preservation of favoured races in the struggle for life. London: John, Murray.

18. Deniz, H., Donnelly A. L. & Yılmaz, I. (2008). Exploring the factors related to acceptance of evolutionary theory among Turkish preservice biology teachers: toward a more informative conceptual ecology for biological evolution. *Journal of Research in Science Teaching, 45*(4), 420- 443.
19. Dobzhansky, T. (1973). Nothing in biology makes sense except in the light of evolution. The *American Biology Teacher. 35*, 125-129.
20. Evans, E. M. (2008). Conceptual change and evolutionary biology: A developmental analysis. In S. Vosniadou (Ed.), *International Handbook of Research on Conceptual Change* (pp. 263–294). New York: Routledge.
21. Graf, D., & Soran, H. (2011). Einstellung und wissen von lehramtstudierenden zur evolution-ein vergleich zwischen Deutchland und der Turkei. Evolutionstheorie-Akzeptanz und Vermittlung im europäischen Vergleich, Tagungsband Einstellung und Wissen zu Evolution und Wissenschaft in Europa. Graf, D. (Hrsg.), Springer, (s. 141-161). Heidelberg.
22. Graf, D., Tekkaya, C., Kılıç, D.S., & Özcan, G. (2011). Research on pedagogical area knowledge, attitudes and pedagogical area concerns about evolution teaching of German and Turkish science teacher candidates. In Kaya, Z. (Ed.), 2nd International Conference on New Trends in Education and Their Implications. 418- 425. Antalya, Turkey.
23. Gregory, T. R. (2009). Understanding natural selection: Essential concepts and common misconceptions. *Evolution: Education and Outreach, 2,* 156-175.
24. Gregory, T. R. & Ellis, C.A.J. (2009). Conceptions of evolution among science graduate students. *BioScience, 59*(9), 792-799.
25. Hermann, R. S. (2007). Utilizing worldview theory to determine the factors influencing the understanding of evolutionary concepts. Ph.D. dissertation. Morgan State University.
26. Hu, L., & Bentler, P. M. (1999). Cut off criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*(1), 1-55.
27. Hutcheson, G. & Sofroniou, N. (1999). The multivariate social scientist. London: Sage Publications.
28. Jensen, M. S., & Finley, F. N. (1996). Changes in students' understanding of evolution resulting from different curricular and instructional strategies. *Journal of Research in Science Teaching, 33*(8), 879–900
29. Kılıç, D. S. & Tekkaya, C. (2011). Pre-service biology teachers´ pedagogical content knowledge, pedagogical content concerns, intensions and attitudes regarding evolution and their understanding of nature of science. World Conference on New Trends in Science Education, September 2011, İzmir, Turkey.
30. Kim, S. Y., & Nehm, R. H. (2011). A cross-cultural comparison of Korean and American science teachers' views of evolution and the nature of science. *International Journal of Science Education, 33*(2), 197-227.
31. Lawson, A. E. (1995). Science teaching of the development thinking. Belmont, CA: Wadsworth Publishing Company.

32. Lewontin, R. C. (1981). Evolution, creation debate: a time for truth. *Bioscience, 31*, 559.
33. Miller, J. D., Scott, E. J., & Okamoto, S. (2006). Science communication. Public acceptance of evolution. *Science, 313*(5788), 765-766.
34. Mino, G. & Espinosa, A. (2009). Acceptance of evolution increases with student academic level: A comparison between a secular and a religious college. *Evolution: Education and Outreach, 2,* 655-675.
35. Mino, G. & Espinosa, A. (2010). New England faculty and college students differ in their views about evolution, creationism intelligent design and religiosity, *Evolution: Education and Outreach, 4*(2), 323-342.
36. Moore, R. (2007). What are students taught about evolution? *Mcgill Journal of Education*, 42(2), 177-187.
37. Nadelson, L. S., & Southerland, S. (2012). A more fine-grained measure of students' acceptance of evolution: development of the inventory of student evolution acceptance—I-SEA. *International Journal of Science Education, 34*(11), 1637–1666.
38. National Research Council (NRC), (1998). Teaching about evolution and the nature of science. Washington, DC: National Academy Press.
39. Nehm, R. H., & Schonfeld, I. S. (2007). Does increasing biology teacher knowledge of evolution and the nature of science lead to greater preference for the teaching of evolution in schools? *Journal of Science Teacher Education, 18*(5), 699-723.
40. Nelson, E. G. (2008). Teaching evolution (and all of biology) more effectively: strategies for engagement, critical reasoning, and confronting misconceptions. *Integrative and Comparative Biology,48*(2), 213–225
41. Norris, S. & Phillips, L. (1994). Interpreting pragmatic meaning when reading popular reports of science. *Journal of Research in Science Teaching, 31*, 947-967.
42. Osif, B. (1997). Evolution and religious beliefs: A survey of Pennsylvania high school teachers. *The American Biology Teacher, 59*(9), 552-556.
43. Pallant, J. (2007). SPSS Survival Manual: A step by step guide to data analysis using SPSS (3rd edition). Sydney, Australia: Ligare Book Printer.
44. Peker, D., Cömert, G. G. & Kence, A. (2009). Three decades of anti-evolution campaign and its results: Turkish undergraduates' acceptance and understanding of the biological evolution theory. *Science and Education*, *Volume*, (Issue no.), Pages??
45. Prinou, L., Halkia, L. & Skordoulis, C. (2008). What conceptions do Greek school students form about biological evolution. *Evolution Education Outreach, 1*, 312-317.
46. Reiss, J. M. (2009). The relationship between evolutionary biology and religion. *Outlook on Evolution and Society*, doi:10.1111/j.1558-5646.2009.00714.x.
47. Rice, J. W. (2007). Evolution education at Iowa State University: student understanding and acceptance of evolution, creationism, and intelligent design. Ph.D. dissertation, Iowa State University.

48. Rice, J. W., Olson, K. J. & Colbert, J. T. (2010). University evolution education: The effect of evolution instruction on biology majors' content knowledge, attitude toward evolution and theistic position. *Evolution: Education and Outreach, 4*(1),137-144.
49. Shipman, H., Brickhouse, N., Dagher, Z. And Letts, W. (2002). Changes in students views of religion and science in a college astronomy course. *Science Education*, 86, 526-547.
50. Sinatra, G. M., Brem, S. K., Evans, E. M. (2008). Changing minds? Implications of conceptual change for teaching and learning about biological evolution. *Evolution: Education and Outreach,1*, 189 – 195.
51. Sinatra, G. M., Southerland, S. A., McConaughy, F. & Demastes, J. W. (2003). Intentions and beliefs in students understanding and acceptance of biological evolution. *Journal of Research in Science Teaching, 40*, 510-528.
52. Smith, M. U. (2010). Current status of research in teaching and learning evolution: II. Pedagogical İssues. *Science and Education, 19,* 539-571
53. Somel R. N., Somel M., Tan M. G., & Kence A. (2006). A brief view of teaching of the theory of evolution in Turkey. *Cumhuriyet Bilim Teknik*. *Volume*, 22
54. Taşkın, Ö., Çobanoğlu, E.O., Apaydın, Z., Çobanoğlu, İ.H. & Yılmaz, B. (2008). Undergraduate students' perception of theory concept. *Boğaziçi University Journal of Education, 25*(2), 35-51.
55. Trani, R. (2004). I won't teach evolution; It's against my religion. *The American Biology Teacher, 66*(6), 419-427.
56. Woods, C. S. & Scharmann, L. C. (2001). High school students' perceptions of evolutionary theory. *Electronic Journal of Science Education*, 6(2). http://wolfweb.unr.edu/homepage/crowther/ejse/woodsetal.html
57. Van Dijk M. E. (2009). Teachers' views on understanding evolutionary theory: A PCK-study in the framework of the erte-model. *Teaching and Teacher Education, 25*, 259-267
58. Van Dijk, E. M., & Reydon, T. A. C. (2010). A conceptual analysis of evolutionary theory for teacher education. *Science and Education, 19*, 655-677.