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Turkish Adaptation Study of the Trust in Science and Scientists Scale: Validity and Reliability Study

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Abstract

In this study, the scale of "Instrument to Measure Trust in Science and Scientists" developed by Nadelson et al. (2014) was adapted into Turkish, and it was aimed to perform the validity and reliability studies of the scale. The original scale consists of 5 point Likert-type, single factor, and 21 items. The study was carried out with 236 pre-service teachers selected according to the convenient sampling technique. Some steps were followed in the adaptation of the scale. Content validity, construct validity, convergent and divergent validity were tested and reliability analyses were made. After the adaptation, a 2-factor structure consisting of 10 items emerged. It was accepted that the scale, in which expert opinions were consulted, is a valid and reliable measurement tool. Thus, a measurement tool that can be used in studies of trust in science and scientists has been adapted to the Turkish language and brought to the literature.

Key Words

Scale adaptation • Science and scientist • Trust

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Emotions are of great importance in people's attitudes towards science and in their learning of science (Robinson et al., 2020). Likewise, emotions are involved in the relationship between the trustor and the trusted, and long-term interaction contributes to the formation of interpersonal interests and attachments (Rousseau et al., 1998). This is also true in the public's trust relationship with science and scientists, and different situations can be mentioned that affect this trust relationship. Because individuals' levels of trust towards science and scientists may vary emotionally, rational thoughts are at the forefront in the relationship of trust between scientists and the public (Larson et al., 2011). Trust in science and scientists can also vary according to personal, religious, and ideological views (Hamilton et al., 2015; McCright et al., 2013). In addition, ordinary people can establish a relationship of trust with science and scientists by considering the expertise, benevolence, and honesty of the scientist on a science-related issue (Hendriks et al., 2016; Mayer et al., 1995). The failure of scientists to carry out their studies in reliable ways may lead to the loss of public trust in science (Kennedy, 2008). Examples such as Diederik Stapel, working at Tilburg University, who imitated the data in many scientific articles he produced for 15-20 years and did not comply with ethical rules (Crocker & Cooper, 2011), can negatively affect the public's trust in science and scientists. Subjective decisions made on scientific issues such as genetically modified foods, hydraulic fracturing, vaccines, climate change, and applications of science away from objectivity and data-based decision-making may negatively affect trust in science and scientists (Nadelson et al., 2014). Hendriks et al. (2016) stated that the public's trust in science decreases when discussing specific issues such as nuclear energy and genetically modified foods. Because although people try to make personal and social meanings by associating their scientific ideas with their lived experiences, they can stay out of science without alienating themselves from their social contexts (Feinstein, 2011). However, when personal issues are discussed, individuals' perspectives towards science and scientists may change. For example, an individual who is sick may have increased interest and trust in science and scientists on issues related to health or an individual struggling with drought on issues related to climate change (Rousseau et al., 1998).

Although it is difficult to build, restore and maintain trust between scientists and the public, establishing a sense of trust is an important social task (Irzik & Kurtulmus, 2021). Trust in science and scientists can be achieved through science education. There is a widespread view that science education is necessary for all people, including those who do not consider scientific and technical careers (Feinstein, 2011). The reason for this is the thought that behaviors and attitudes developed through education at an early age can affect individuals' future lives and perceptions (Blalock et al., 2008; Boyd et al., 2006; Nieswandt, 2007). Perceptions towards science and scientists can affect individuals and societies. For example, people who do not trust science and believe that the vaccine harms people may endanger the health of the public (Dyer & Hall, 2019; Tvrdy, 2021). As a matter of fact, it is stated that educated individuals are more likely to trust scientists about solutions to climate change or vaccines (Hamilton et al., 2015; Sleeth-Keppler et al., 2017). There are other factors that affect the issue of trust in science and scientists. For example, Keelan et al. (2010) argue that the public has different views on the benefits or harms of vaccines. It is stated that trust in vaccines varies and individuals who can approach situations objectively are more likely to trust vaccines and scientists (Larson et al., 2011). A high level of public confidence in science and scientists is very important in terms of being able to read and understand scientific information correctly (Hendriks et al., 2016).

It is necessary for the public to trust in science and scientists, to protect and maintain this trust, and to solve the problems of trust. In order to develop trust in science and scientists and to solve the problems of trust, there is a need to document these conditions. Nadelson et al. (2014) developed a trust scale for science and scientists in line with this need. When the relevant literature is examined, there is no national scale developed or adapted to Turkish that measures the public's trust levels towards science and scientists. In this respect, it is seen that there is a need for a scale developed or adapted to Turkish by ensuring its validity and reliability.

Rationale and Purpose of the Study

In this study, Nadelson et al. (2014) in the study titled "I Just Don't Trust Them: The Development and Validation of an Assessment Instrument to Measure Trust in Science and Scientists", it is aimed to determine the psychometric properties of the scale by adapting it to Turkish.

Instrument to Measure Trust in Science and Scientists

Nadelson et al. (2014) were developed a scale to measure the level of trust in science and scientists titled "Instrument to Measure Trust in Science and Scientists". The scale was developed by a team of scientists from six different disciplines (a geoscientist, a chemist, a biologist, a biochemist, a sociologist, and a mathematician). The original scale consists of 21 items and the 5-point Likert-type (1=strongly disagree…5=strongly agree). In the first stage, the data were analyzed and after reviewing, necessary changes were made. Then, the data collected for the second stage were analyzed and the Cronbach's alpha value of the scale was reported as .84.

For another verification of the validity of the scale, correlation analysis was performed by using personal characteristics thought to be related to trust in science and scientists, and the level of trust. As a result of the analysis, it was reported that trust in science is related to religiosity, and as religiosity increases, trust decreases. In addition, it was stated that trust in science is related to political philosophy. It was concluded that liberals trust science and scientists more than conservatives. Finally, it was stated that there is a positive relationship between the trust in science and scientists and the number of science courses and grade level at the university level. These associations found confirmed the validity of the scale (Nadelson et al., 2014).

Method

Research Design

In this study, scale adaptation was made. Therefore, it was tried to reach a large sample representing the universe. In this context, the survey model was adopted in the study. In the survey model, the current situation is tried to be revealed and a general picture is drawn about the existing situation (Sezgin Selçuk, 2019). Since a measurement tool was adapted to be used in studies to be carried out with preservice teachers, the survey model was found to be appropriate in the study.

Participants

In this study, in which a scale adaptation was made, a sample was created for exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). In the study, in which the convenience sampling technique was used

(Büyüköztürk et al., 2008), the data were collected from a total of 236 preservice teachers studying at the education faculty of a large university located in the Central Anatolia Region. In this context, demographic information about the sample of the study is presented in Table 1.

Table 1

Demographic Information of the Sample Group

Participants		
Gender	*f*	%
Female	171	72,5
Male	65	27,5
Total	236	100

Research Instruments

In this study, in which the scale was adapted, the data were collected with the help of a personal information form and a questionnaire containing the scale items. In the questionnaire, the genders of the pre-service teachers were asked, and then Turkish equivalents of the scale items were included. The questionnaire form was applied to the preservice teachers in the online environment. Preservice teachers used 10-15 minutes for the application.

Ethical Permissions of Research

For the adaptation of the scale, Louis Nadelson was first contacted via e-post, and permission to use the scale was requested. The ethics committee application was made in line with the permission obtained from the researcher. In this context, the form regarding the ethics committee permission, dated 15.03.2022 and decision number 25, obtained from the Selcuk University Faculty of Education Ethics Committee, was delivered to the preservice teachers who voluntarily agreed to participate in the research.

Adaptation Process of the Scale

The responsible author was contacted on behalf of the researchers who developed the scale and permission to adapt the scale was obtained. The corresponding author has informed us about the issues to be considered regarding adaptation in the e-post. After this stage, the translation process of the scale into Turkish was started. First of all, scale items were translated separately by 2 researchers in this study. After the translation, the researchers came together and tried to reach a common view on the translated scale items. In line with the opinion that emerged, the Turkish translation of the scale was prepared. Meanwhile, the scale was sent to 2 independent English teachers and they were asked to translate. Comparing the incoming translations with the translations made by the researchers, they were sent to an expert with a doctorate in science education and a good command of English, and they were asked to express their opinions in order to reach the appropriate expressions among the translations. It was decided that the form from the expert was the final form for translation into Turkish. Then, this form was sent to a specialist in English Language and Literature and a science educator who completed his doctorate abroad for back translation, and they were asked to translate it into English. It has been observed that there are small differences between the

incoming translations in terms of meaning not to cause differences. At this point, the researchers of the study made the decision together and the sentences in the final form were clarified. Before applying the items in the scale, a specialist who has a doctorate in Turkish teaching was asked to read it and review it for language, grammar, and expression disorders. In line with the feedback and suggestions of the expert, the final version of the scale items was created and transferred to the online environment, and delivered to the preservice teachers.

Data Analysis

In this study, in which the scale adaptation was made, some analyzes were carried out. In this context, descriptive analyzes and EFA and CFA were conducted. In descriptive analyzes, missing data and whether the data showed normal distribution were discussed. Then the assumptions for the EFA were checked. The relevant literature mentions a specific sample size for EFA. Accordingly, some literature states that the number of participants/items should be over 15 (Stevens, 2009) and some literature states that the number of participants should be five or 10 times the number of items (Field, 2000; Tabachnick & Fidell, 2001). With the stated sample size, the hidden structure of the scale is tried to be revealed (Tavşancıl, 2006). In this context, a total of 236 preservice teachers participated in the study. Since the latent structure was revealed in the scale adaptation process after EFA and CFA, convergent and divergent validity was tried to ensure construct validity.

SPSS 27.0 for EFA and AMOS 27.0 for DFA were used for data analysis. Chi-Square fit test (χ^2/Sd), goodness fit index (GFI), adjusted fit index (AGFI), comparative fit index (CFI), normized fit index (NFI), recommended by Marcoulides and Schumacher (2001) at the point of determining the model fit of the scale) and unnormed fit index (NNFI) and root mean square errors (RMSEA- Root Mean Square Error of Approximation) values were taken into account. χ^2/Sd < 2, p > .05, .85<AGFI<.99, .90<GFI <.99, .90< CFI<.99, .90<TLI<.99, .005<RMSEA < .009 values were considered as model fit index values (Dimitrov, 2012; Özdamar, 2017). At the point of deciding the reliability of the scale, the Cronbach alpha value was examined.

Results

Descriptive Analyzes and Exploratory Factor Analysis

The data collected for the adaptation study of the trust scale for science and scientists were first evaluated in terms of their suitability for EFA. At this stage, Kaiser Meyer Olkin (KMO) coefficient and Barlett sphericity test results were examined. In the examination, it was seen that the KMO value was .838 and the Barlett test was significant at the p<0.01 level (χ^2=722,750, df= 45, p=.00). Based on the relevant review, it has been seen that the amount of data collected is very good (Field, 2000), so EFA can be performed.

After moving to the EFA stage, the direct oblimin rotation option under the principal components analysis was preferred as the rotation technique (Kieffer, 1998), and the factor structure with an eigenvalue greater than 1 was taken into account (Zwick & Velicer, 1986). Then, it was checked whether the anti-image values of the items were above .50 (Hair et al., 2010), and the criterion of the contribution of each item to the common variance was .30 and above (Büyüköztürk, 2004). Before examining the total variance values for EFA, it was examined whether the difference between the correlation coefficients of the model and the actual correlation coefficients of the items was

above .05. In the meantime, it was observed that 38% of the values obtained exceeded the specified value and therefore remained below the 50% limit recommended in the literature (Field, 2000), and analysis table analysis was started.

Table 2

Factor Loading Values for the Scale and Item Analysis

Items	Factor Load Values		Item Total Correlation	Independent Samples t-Test Comparison of Lower and Upper 27%
	Factor 1	**Factor 2**		
M12	.671		.464	7.007
M14	.482		.313	4.912
M15	.679		.566	8.439
M21	.792		.651	8.434
M5		.499	.314	3.638
M6		.801	.643	8.432
M7		.645	.458	8.020
M9		.737	.549	8.005
M10		.850	.723	7.570
M11		.791	.627	9.124
Eigenvalue	3.919	1.387		
Explained Rate of Variance (%)	39.192	13.872		

In Table 2, independent samples t-test results of the answers given in the lower and upper groups according to the factor loading values, item-total correlation values , and the responses to the items are presented. It was observed that the factor loads of the scale collected under two factors ranged between .482 and .792 for the first factor, between .499 and .850 for the second factor, and the total variance ratio explained was approximately 53%. Considering the item-total correlation values that make up the scale, it was seen that these values ranged between .449 and .790. It was observed that the factor load values reached were above .45, the item-total correlations were above .30, and the items with less overlap between factor loads were excluded from the study (Büyüköztürk, 2004).

All these values obtained show that the items that make up the scale have integrity and competence within themselves. Finally, the scores obtained for each item that makes up the scale were ranked from largest to smallest,

and the lower 27% and upper 27% slices were determined. The response rate of the answers given to these slices and the items by the lower and upper groups was discussed. In other words, the power of the items to distinguish between those in the lower group and those in the upper group was tried to be determined. As a result of the analysis, it was seen that there was a significant difference (p<.01) between the lower and upper groups that made up the scale.

Confirmatory Factor Analysis

In the first stage of the study, CFA was performed for the scale. The resulting structure is presented in Fig. 1.

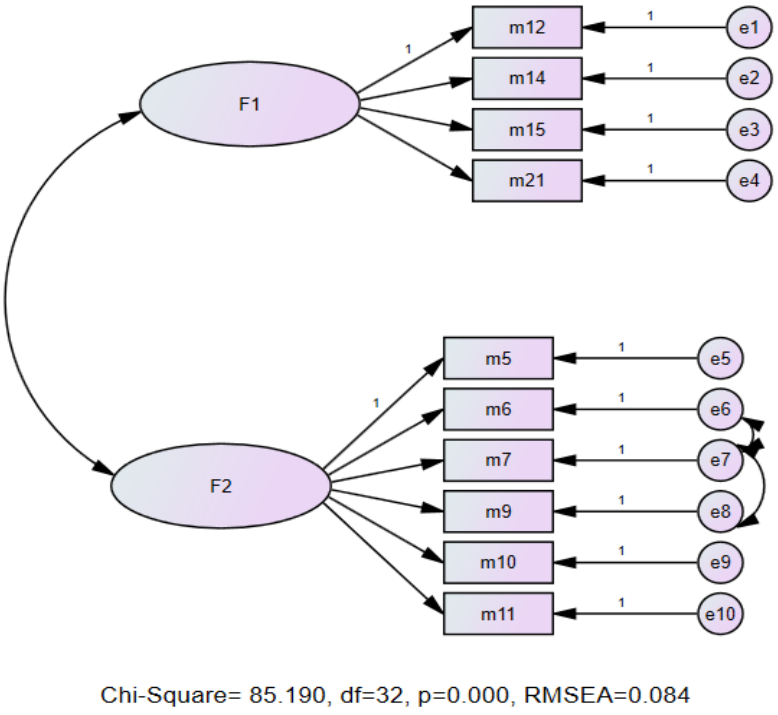

Figure 1. DFA Results

When Fig. 1 is examined, it is seen that the scale has a 2-factor structure, and covariance was formed between the 6th-7th and 8th items. When the values of the resulting structure are examined; χ^2/Sd= 2.662, AGFI = .886, RMR= .062, GFI =.934, CFI =.923, TLI =.892, RMSEA =.084, and these values were found to be in good agreement (Dimitrov, 2012; Kline , 2005). In the next step, the construct validity and reliability analysis of the items forming the scale were made.

Construct Validity and Reliability Analysis

Convergent and divergent validity methods were used to test the construct validity of the model revealed by CFA. At this stage, factor average variance extracted (AVE), composite reliability (CR), and Cronbach's alpha values were examined (Fornell & Larcker, 1981). The results obtained are summarized in Table 3.

Table 3

AVE, CR, and Cronbach's Alpha Values

Trust in Science and Scientist Scale	AVE	CR	Cronbach's Alpha
Trust in science	.914	.915	.658
Trust in scientist	.913	.916	.723

Table 3 presents the AVE, CR, and Cronbach's alpha values for the scale's construct validity and reliability analysis. Accordingly, it is seen that the AVE value is above .50 and the CR value is close to 1, thus ensuring the construct validity of the scale (Fornell & Larcker, 1981). In addition, it can be said that Cronbach's alpha values are .658 and .723 and therefore the measurement tool is reliable (Büyüköztürk, 2004). These results show that convergent validity is provided for the scale. The discriminant validity of the scale was also calculated in the study. Accordingly, the square root of the AVE values should be higher than the correlation between the factors. The discriminant validity values are presented in Table 4.

Table 4

Discriminant Validity

Factor	Trust in science	Trust in scientist
Trust in science	**.956**	
Trust in scientist	.595	**.955**

When the values in Table 4 are examined, it is seen that the square root of the AVE value is (.956) higher than the correlation value between factors (.595) for trust in science factor. Similarly, the value obtained from the factor of trust in scientists (.955) is found to be higher than the correlation value between factors. Thus, Fornell and Larcker's (1981) criterion was met.

Discussion, Conclusion & Suggestions

Negative attitudes towards science may cause a decrease in the number of scientists or weaken the public's trust in scientific knowledge and scientists (Gauchat, 2008). There are many reasons for the increase in negative attitudes towards science and scientists. Unethical behaviors in scientific studies, the role of scientists in issues such as climate change, genetically modified foods, vaccines, and nuclear weapons can negatively affect the public's trust in science and scientists (Crocker & Cooper, 2011; Kennedy, 2008). The level of trust towards science and scientists can be shaped according to the social groups or educational status of the individual, and changing personally

(Gauchat, 2012). It is an important issue to ensure the public's trust in science and scientists and to develop this trust. It was necessary to document the trust levels of the public in order to reveal whether this sense of trust varies according to individuals or social groups, or to reveal the role of education in this issue. In line with this need, Nadelson et al. (2014) developed the scale of trust in science and scientists. The scale developed in this study was adapted to Turkish.

As a result of the adaptation, a 2-factor structure emerged. Accordingly, these factors were named as "trust in science" and "trust in scientists", unlike the original. The eigenvalues of the resulting factors were found to be respectively 3.919 and 1.387. The explained total variance rate of the 2-factor scale is approximately 53%. The CR, AVE, and Cronbach's alpha values of the scale met the expectations. However, unlike the original structure, there has been a serious decrease in the number of items. This may be due to cultural and linguistic differences. however, a total of 11 items were removed from the scale in the analyses. This situation may also reduce the content validity of the scale. Against this risk, a total of 3 experts working in the field of science education and science or scientist were contacted and asked to give their opinions on the new scale structure that emerged. It was asked whether the items in the scale were actually sufficient to measure trust in science and scientists. Each of the 3 experts reported that the number of items was sufficient and that it was quite understandable in terms of Turkish. Therefore, it was accepted that the scale was successful in measuring the trust in science and scientists with this number of items. Based on this, trust in science and scientists can be measured in Turkey, especially during the pandemic period. With modeling studies, the factors affecting trust in science and scientists can be revealed or their predictors can be determined. In this context, the relations between the trust of different age groups in science and scientists and their ideological structures can be revealed.

Ethic

All procedures in this study involving human participants were carried out in accordance with the ethical standards of Selcuk University Faculty of Education Ethics Committee with date 15.03.2022 and number 25.

Author Contributions

All stages of the study were organized and conducted by the authors.

Conflict of Interest

The authors declare that they have no conflict of interest.

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