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Research

Study of Developing Stereotyped Thoughts Scale Toward Science Courses [1]

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Abstract:

The study aims to develop a scale for determining the stereotyped thoughts of primary school classroom and elementary science teacher candidates toward science courses. Descriptive survey model, one of the quantitative research patterns, is used since the study follows the process of scale development. In sample determination, first stratified sampling and then easily accessible sampling method are used. The study groups consist of 611 pre-service teachers, wherein 302 was for Exploratory Factor Analysis (EFA) while 309 was for Confirmatory Factor Analysis (CFA). For the validity of the scale, the number of content validity rate (CVR) was determined in line with the opinions of 14 experts and the scale items were arranged. For the construct validity of the scale, EFA was performed and total item correlation and item factor loadings were found to be at the desired level. As a result of the validity-reliability analysis of the study by adopting a Likert-type scale development model, a 28-item scale structure with Cronbach alpha internal consistency coefficient .81, consisting of five factors, was obtained, which explains 58.63% of the total variance.

Keywords: Science courses, stereotyped thoughts, scale development, teacher candidates, validity and reliability

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1 This article is derived from Bayram Irmak's master thesis entitled "Development and implementation of stereotyped thought scale for science courses" conducted under the supervison Mutlu Pınar Demirci Güler.

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INTRODUCTION

Science lessons are aimed to prepare a person for life and for attaining the capacity to produce solutions by making sense of the difficulties that will arise in his/her lifetime. Important skills from science are gained via participation of a person in the process of structuring the knowledge according to method of reasoning and habits, by doing and living, doing research, and continuing studies in science processes. A student, who decides to get a bachelor's degree in science in Turkey's education system, receives 14 years of science education starting from the 3rd grade in primary school to his/her final year of bachelor's degree., despite such a long education period, it can be seen that many factors, such as the following, are in place:unorganized educational approaches that lack the requirements of modern times,intensive science education and curriculum,inadequate readiness of teachers in line with certain qualification levels or teachers' lack of knowledge and skills,inadequate use of learning-teaching method and technical and measurement-evaluation methods in terms of impact,overcrowded classes, and lack of materials used to transfer information (Baş, 2015; Keser, 2005) are described as the reasons of student's failures in science courses.

When the reasons for the failure in science education are examined in terms of teachers; it was found that teachers are not prepared to teach science education content areas, teachers who have more experience in science education perceive themselves superior than new graduates and are not open to innovation, teachers do not trust themselves in the field of science and technology, teachers have regarded themselves as inadequate in scientific process steps during the science education, and teachers' insufficient conceptual knowledge in the process of learning and teaching (Baş, 2015; Radford, DeTure & Doran, 1992; Carin & Sund, 1989; Downing & Filer, 1999). If the reasons for the failure in science education are analyzed from student sources; it may be stated that it is not correct to consider only the absence of scientific awareness as a predictor of the failure of students in science lesson (Watter, Ginns, Neumann & Schweitzer, 1994), but also affective variables that influence individuals' science literacy levels (Zor, 2020). The most significant variables influencing involvement in the course are: the attitudes of the students toward science, their degree of enthusiasm, motivation and communication. (OECD, 2016; Osborne, Simon & Collins, 2003; Schibeci, 1984; Baş, 2015; Zorluoğlu, Olgun & Kızılaslan, 2020). The concepts of communication and non-communication come out as influences impacting individuals' accurate interpretation of the process and their self-expression in the process of involvement in the lesson (Demiray, 2008; Özkul, 2020).

Communication can be defined as the process of transmitting information and common understanding from one person to another (Keyton, 2011). A problem in any one of these elements can reduce communication effectiveness (Keyton, 2011) and cause lack of communication. Lack of communication is defined as not being able to receive the message to be transmitted or getting it wrong (Hanks, 1999). There are many factors that cause lack

of communication. These factors, are expressed as process barriers, physical barriers, semantic barriers, and psychosocial barriers (Eisenberg, 2010) and the thoughts of the people who communicate (Dökmen, 1997). The thoughts of the individuals are the sources that direct the emotions and behaviors of the person, that is to say, directing the life of the individual. The main reason that constitutes the final situation is the thought patterns of an individual. Thought patterns are mostly expressed as stereotypes in daily life (Orhon, 2013) and stereotyped thought was drawn up as perceptions and thoughts about the person, nation, or culture that are often wrongly formed, simplified, and generalized (Berkant & Baysal, 2020). Thoughts that shape the emotions and behaviors within certain patterns that are not functional in individuals (Baş, Tay & Işık Tertemiz, 2021), and he defined these thoughts as stereotypes (Pretzer & Beck, 2004). Stereotypes are "*widely-accepted, culturally shared beliefs describing personal traits and characteristics of groups of individuals*" (Ramasubramanian, 2011), and often distorted "pictures in our heads" which refer to phenomena and people (Lipmann,1922). Stereotypes are sometimes overgeneralized, inaccurate, and resistant to new information, but can sometimes be accurate (David,2013). A person can embrace a stereotype to avoid humiliation such as failing a task and blaming it on a stereotype (Burkley, Hart, 2008) and enable them to "*make sense of their worldly encounters*" (Hager, 2010: 127). Stereotypes can affect self-evaluations and lead to self-stereotyping (Cox, Abramson & Lyn, 2012), Correll (2001, 2004) such that men assess their own task ability higher than women performing at the same level found that specific stereotypes (*e.g., the stereotype that women have lower mathematical ability*).

Beck (1979) classified the identified stereotypes in seven sub-dimensions: arbitrary inferences, selective abstraction, over-generalization, exaggeration/underestimation, personalization, labeling and mislabeling, and polarization.

There are different studies in the literature on the classification of stereotypes (Beck, 1979; Burn, 1980; Blackburn, 2011; Dökmen, 1997; Köroğlu, 2012; Özer, 2013). General concepts encountered in these studies are as follows:

•***Over-Generalization*:** The individual creates general beliefs and thoughts by looking at only one event.•***Black or White* / *All or None* / *Polarization***: It involves thinking and interpreting every situation and event as "*all or none*" or looking at things on the verge of "*black and white*".•***Personalization* / *Emotional Explanation***: It is the relationship of the individual with himself/herself in matters or incidents for which he/she is not responsible.•***Absolutism* / *Have To/Must Rules* / *Should-Have Logic:***It is a type of thought mostly stereotyped by normative individuals. They feel unhappy when they go beyond these rules. •***Sacrifice Mobilization* / *Excessive Sacrifice:*** The individual tries to change/sacrifice himself/herself for someone else. •***Exaggeration* / *Hellfire Preaching* / *Enlargement* / *Focusing on Negative Thinking* / *Competence:*** The individual gives more importance to a situation or event than it should be. •***Underestimating* / *Ignoring the Positive***: The individual gives less importance to a situation or event than it should be. •***Arbitrary Inferences* / *Jumping to Conclusions* / *Fortune Telling:*** The individual tends to conclude without any evidence. •***Selective Abstraction* / *Mind Reading:*** When an individual is evaluating an event, he/she pays attention to minor details and concludes by

taking this detail as a guide. •***Labelling and Mislabeling / Stigma***: It involves defining/qualifying an individual according to his/her past mistakes.

Stereotypes of individuals can be positive or negative. While positive stereotypes generally cause fewer communication problems among individuals, negative stereotypes cause more problems for individuals (Pretzer & Beck, 2004). In this sense, addressing negative stereotypes has become essential for the solution of problems. In this context, the communication that students have with their peers, as well as with their teachers, is effective in the natural development of self-esteem and self-expression competencies. Monitoring the success of individuals who can express themselves during lessons is more difficult and complex than those who cannot. At this point, it is mandatory to establish a classroom environment which is democratic and open to communication in the course of the lesson to ensure healthy communication for the teacher and peers (Edwards, 1997; Şimşek, 2003).

Purpose of the research

This research was analyzed according to the framework of cognitive therapy founded on the stereotyped thought patterns of Beck (1997). In this context, this research is a significant study in terms of identifying stereotypes that arise from the factors that cause failure in science courses. The study is scale development and identifying pre-service teachers stereotypes at university level with the developed scale.

METHODS

This study is a scale development study aiming to develop the stereotyped thinking scale for science lessons in pre-service teachers.

Research model

Descriptive survey model, one of the quantitative research patterns, is used since the study follows the process of scale development.

Research universe and sampling

The universe of the research consists of two different study groups, including pre-service teachers studying in the fields of classroom education and science education in the 2018-2019 academic year at Kırşehir Ahi Evran University and Mersin University Education Faculties. Data from the first study group is used for Exploratory Factor Analysis (EFA), while data from the second study group is used for Confirmatory Factor Analysis (CFA).

More than one study group has been created by considering multiple elements in the formation of the study groups, and multiple sampling methods has been adopted in the creation of these study groups. In this context, stratified sampling, a probabilistic sampling method, is used. The second stage of the sample selection aimed to create study groups with similar characteristics by using convenience sampling method for working groups where EFA and CFA are applied (Büyüköztürk et al., 2018: 94).

The first study group consists of 302 pre-service teachers studying at Kırşehir Ahi Evran University; 232 are female while 70 are male. The group is formed through the

homogeneous sampling method and convenience sampling method. Two-hundred twenty-four pre-service teachers of this group are classroom education teachers and 78 of them are pre-service science teachers. According to Tabachnick and Fidel (2015), the number of samples required for exploratory factor analysis should be at least 300 participants. In this study, the sample size can be considered as a good level, since data were obtained from 302 people for exploratory factor analysis. The second study group is formed through the homogenous sampling and convenience sampling method. The group consists of 309 pre-service teachers studying at Mersin University, wherein 246 are female and 63 are male. Two-hundred pre-service teachers of this group are classroom education teachers and 109 of them are pre-service science teachers.

Development of the data collection tool

Various questions must be answered, and some decisions must be taken before starting the measurement tool development process (Cohen & Swerdlik, 2005). The process of developing a Stereotyped Thought Scale for Science Courses was started by scanning the relevant literature (Erkuş, 2007; McGartland et al., 2003; Torgerson, 1958; Yurdugül, 2005). Based on the sources reached, the first phase was developed within the scope of YÖK/World Bank National Education Development Project (YÖK, 1997); twelve transactional step called "*determining the structure, examining related researches, determining their size, deciding the question format, producing questions in accordance with the format, getting expert opinion on questions, calculating coverage validity indessiges, reviewing questions, implementing EFA, reviewing questions and finalizing testing, analyzing CFA application and test data, and factor structure reporting*" were put to work.

In this context, a comprehensive study of international and national literature was conducted to develop a valid and reliable measurement tool to be used in determining the stereotyped thoughts of pre-service teachers for science courses, and a scale was drafted from a large pool of 128 articles. Care has been taken to create items to include all dimensions of stereotyped thoughts. It was decided that the scale to be developed for the study should be prepared in Likert-type rating scale developed by Likert (1932), which is used more frequently and more widely than other scales in measuring many personality traits in social sciences (Oppenheim, 1979; Judd, Eliot, & Kidder, 1991; Fraenkel & Wallen, 2003; Sommer & Sommer, 2002: as cited in Tezbaşaran, 2008). Considering the age level of the pre-service teachers, the scale was prepared in a 5-point Likert type (Adelson & McCoach, 2010; Bourke & Frampton, 1992). An 85-point draft form was prepared with the elimination of items that are similar between expressions and are estimated to have repeated, low relationships. This draft form, which was created during the development of the Stereotyped Thought Scale for Science Courses for the content validity study of the research was presented to a total of 14 field experts, including seven teachers and seven academicians specializing in educational sciences, measurement and evaluation, psychological counseling and guidance, and Turkish language. The process of creating a pool of matter is defined as a process in which behaviors are measured in terms of inclusion with the universe (DeVellis, 2016). As a result of the expert opinion study conducted with the forms presented to the experts, the substances receiving negative opinions were

removed from the scale; the number of articles of the draft vehicle was reduced to 67 and they were prepared for pre-application.

Ethical considerations

In this study, all rules stated to be followed within the scope of "Higher Education Institutions Scientific Research and Publication Ethics Directive" were followed. None of the actions stated under the title "Actions Against Scientific Research and Publication Ethics", which is the second part of the directive, were not taken.

FINDINGS AND CONCLUSION

Validity and Reliability Studies

Within the scope of validity studies, view validity, and scope validity for interpretive validity, validator factor analysis and explanatory factor analysis using structural equality modeling for structure validity were looked at. Within the scope of trust studies, Kaiser-Mayer-Olkin (KMO) and Bartlett Test result for consistency, Kuder-Richardson (KR) trust coefficients and Cronbach alpha Confidence coefficient were looked at for internal consistency.

Exploratory Factor Analysis (EFA)

In scale development studies, the data set to be analyzed for exploratory factors should have a normal distribution (Özdamar, 2016). Otherwise, correlation-based relationships that allow factor analysis will not emerge (Can, 2017). In this context, the normality distribution of the data set was examined first.

After examining the distribution of normality, exploratory factor analysis was performed. Exploratory factor analysis is a type of statistical analysis that aims to combine variables of similar nature and explain this measurement with fewer factors in order to determine the theoretical constructs in which the variables in the data set are constructed and to what extent these theoretical structures represent variables (Büyüköztürk, 2018; Henson & Roberts, 2006).

In the study, during the exploratory factor analysis performed on the data obtained from 302 pre-service teachers, 232 females and 70 males in total, it was observed that the factor values were at least .40, and the difference between two factors was at least .10 during the distribution of an item to more than one factor (Büyüköztürk, 2018; Tabachnick & Fidell, 2015). After which, 67 items were subjected to Principal Component Analysis. Since sub-factors were thought to be related to each other within the framework of the concept of stereotyped thoughts, Direct Oblimin rotation method was used (Can, 2017; Çokluk, Şekercioğlu & Büyüköztürk, 2018).

As a result of the analysis in the study, the KMO value is 0.891, and as a result of Bartlett's Test of Sphericity, chi-square value is 4050,533 ($p < .001$). Bartlett's significance value indicates that the data is derived from a multivariate normal distribution (Thompson, 2004; Hair et al., 2013: 34; Morgan et al., 2011: 51). In light of the above information, it can

be said that the data set used in this study is suitable for exploratory factor analysis (Büyüköztürk, 2018). After checking the KMO and Bartlett Sphericity tests, an exploratory factor analysis was performed. The Scree Plot chart, which gives the eigenvalue and factor numbers, is given below and is used for identifying the number of factors.

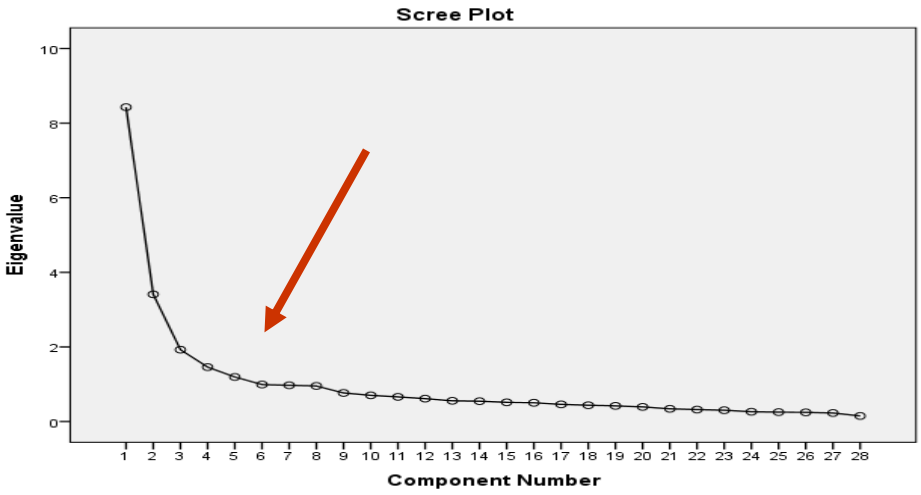

Figure 1. Scree Plot Chart Showing the Dimensions of the Scale.

When the Scree Plot Graph is examined, the graph curve becomes horizontal after 5 declines. This situation suggests that the SSTS has 5 factors. Also, when the total variance table is examined, the variance values of the factors following 5 factors have approximate and low values.

The oblimin axis rotation method is frequently used in scale studies in social sciences (Cohen, Manion & Morrison, 2007). This rotation technique is performed to ensure the independence, easier interpretation and significance of the factors obtained in EFA (Büyüköztürk, 2018). Following the rotation technique, it is observed that it has a 5-factor structure with eigenvalue greater than 1. While determining the items of the scale, the eigenvalues should be at least 1 and the load values of the items should be at least .40. It is also noted that the items are included in a single factor and there is at least .10 difference between the factors in the two factors. As a result of factor analysis, on a scale of 67 items, 39 items in total are removed from the scale since 31 of the items (I1, I8, I10-I13, I18-I21, I30, I32-I35, I41, I42, I44-I50, I56-I61, I66) have low factor load, 8 of them (I5, I6, I23, I24, I27, I37, I39, I67)are located under more than one factor, as a result it was decided to exclude these items from the scale (Lawshe, 1975).

Table 1

Factor Structure of Items, Variance Levels and Item Total Correlation Values

Items	1.Factor	2.Factor	3.Factor	4.Factor	5.Factor	T.I.Cor.
I-43. I am always tensed when I need to solve science questions general exams.	.805					.591
I-40. Science is very difficult, so I think I do not want to deal with science topics.	.709					.649
I-38. When I do something wrong in science lessons, I think I will be ashamed.	.634					.613
I-22. Fear of not being able to succeed in science lessons is always a cause of unhappiness for me.	.632					.457
I-9. I can never understand science courses.	.626					.736
I-25. Science course exams are difficult.	.616					.404
I-29. Whenever I want to learn new information about science, I immediately get bored and look for other things.	.611					.468
I-7. I believe that I can't be successful in science lessons even though I work for it.	.596					.709
I-28. I always think that I will repeat the same mistake in science lessons.	.579					.631
I-26. Questions never came from the well-studied topics	.495					.520
I-53. Those who can experiment in science classes are more popular.		.858				.737
I-51. Those who are successful in science lessons are more popular than the others.		.744				.634
I-52. Those who can relate science subjects to daily life are more sophisticated.		.667				.539
I-54. Faculty members who teach science courses in the laboratory are more ambitious in their field.		.598				.618
I-2. Science lecturer teaches lessons with hardworking students.			.814			.598
I-17. I fail because I am not appreciated in science lessons.			.702			.644
I-36. When the science lecturer says that I can do, I think he makes fun of me.			.666			.662
I-55. Male students are more successful in science lessons and courses.			.657			.596
I-14. Since I am afraid of not delivering the result, I cannot experiment in science.			.656			.743
I-31. When science courses become concrete, then everyone can understand easily.			.501			.582
I-62. A student is either successful or unsuccessful in science lessons.				.688		.532
I-65. I must get high scores from the exams to teach science subjects in the future.				.672		.568
I-64. I must know all the terms in an experiment to understand it.				.532		.505
I-63. If I do not get the first place in science exams, I will be unsuccessful.				.452		.525
I-15. My lecturer is also responsible for the low scores I get in science lessons.					.682	.492
I-3. I cannot be successful in this course unless the teaching method changes.					.652	.562

I-4. I cannot be successful in this course unless the science course is taught in a laboratory environment.	.617	.598
I-16. The difficult subjects make me think that learning this course is very difficult.	.523	.503

* Old item numbers are given in parentheses.

In the consequence of the exploratory factor analysis performed to determine the factor structure of the scale, structure consisting of five dimensions and 28 items is formed either by removing the items with factor load below .40 or items with approximate loads in two dimensions. As a result of the principal components analysis, it is seen that there are five factors with eigenvalues greater than one. When these factors are examined, the eigenvalue of the 1st factor is 8.427, the 2nd factor is 3.410, the 3rd factor is 1.926, the 4th factor is 1.459 and finally, the 5th factor is 1.195. The entire five-factor structure explains 58.63% of the total variance (Kline, 2005; Büyüköztürk, 2018). Another result is the total correlation coefficients of the items. When these results are analyzed, the total-item correlation of the items is between 0.404 and 0.743. Öner (1997) suggests that the total-item correlation related to the total item correlation should be above 0.30. In the research, item discrimination levels of scale items were examined after performing exploratory factor analysis for scale items. In order to determine the internal consistency of the scale items, the t-test of the lower 27% and upper 27% groups of the data belonging to the exploratory factor analysis study group was performed, and according to the results, there was a significant difference between the lower 27% and upper 27% groups of the 18 items in the scale ($p<0.05$). According to these results, the item discrimination levels of the scale items were appropriate (Büyüköztürk, 2002). When the current study results are examined, the item-total correlation scores of the scale are in the desired interval.

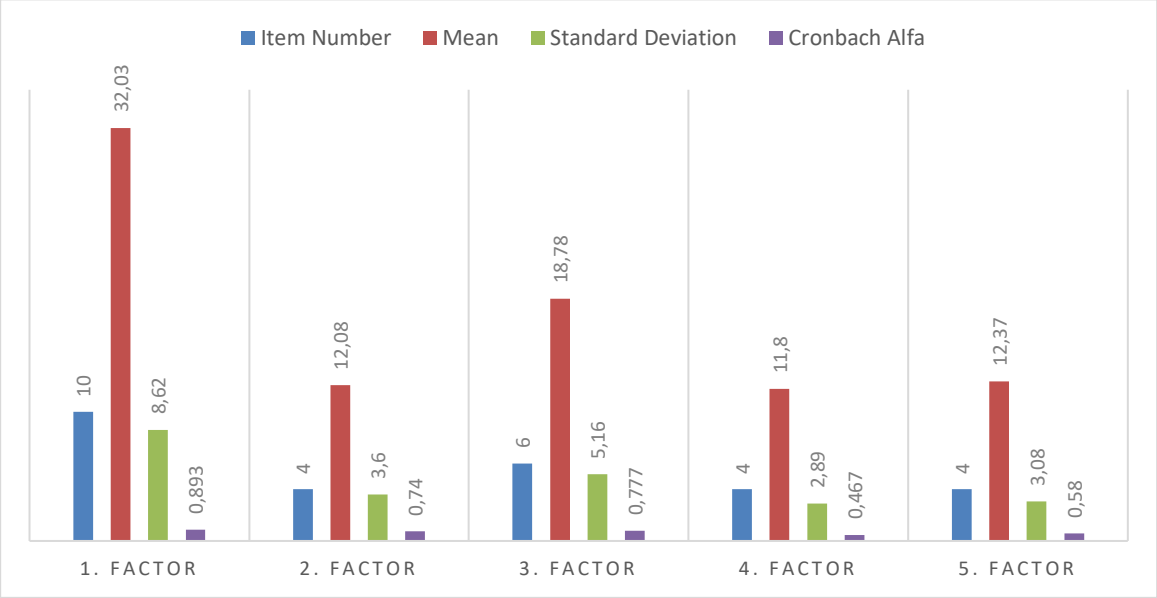

Figure 2. Item Numbers, Mean Scores, Standard Deviations and Cronbach Alpha Internal Consistency Coefficients of Factors

When Figure 2 is examined, the number of items in the scale, mean scores, standard deviations, and Cronbach alpha internal consistency coefficients are seen. It is observed that the mean of the 1st factor is 32.03 (SS = 8.62), the 2nd factor is 12.08 (SS = 3.60), the 3rd factor is 18.78 (SS = 5.16), the 4th factor is 11,80 (SS = 2.89), and 5th factor is 12.37 (SS = 3.08). Cronbach alpha internal consistency coefficients of the scale are .893, .740, .777, .467, and .580, respectively. The Cronbach Alpha interval can be expressed as 0.40 ≤ a <0.60 reliable, 0.60 ≤ a <0.90 quite reliable, and 0.90 ≤ a <1.00 highly reliable (Özdamar, 1999; Tavşancıl, 2006: 29). From this point of view, it has been observed that the measurements obtained from SSTS are at an acceptable level for many dimensions, but lower than the expected level for one dimension.

Confirmatory Factor Analysis (CFA)

While the factor structure of the data is determined based on factor loads without any particular preliminary expectations or experiments in EFA, CFA is based on testing a prediction that certain variables will predominantly be placed on predetermined factors based on a theory. Many fit indexes are used to demonstrate the adequacy of the model tested for compatibility in DFA. These are Chi-square fit test (Chi-square Goodness), Goodness of Fit Index (GFI), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Normed Fit Index (NFI), Relative Fit Index (RFI), Incremental Fit Index (IFI), and Adjusted Goodness of Fit Index (AGFI) (Seçer, 2017: 189).

Table 2

Confirmatory Factor Analysis Results

Index	Excellent	Acceptable	Research Findings	Results
$X^{2/df}$	0 – 3	3 – 5	2.68	Excellent
RMSEA	.00 – .05	.05 – .08	.07	Acceptable
SRMR	.00 – .05	.05 – .10	.08	Acceptable
CFI	.95 – 1.00	.90 – .95	.93	Acceptable

It is suggested that the value of $\chi 2$, which is obtained by dividing $\chi 2$ value by degree of freedom, should be below two, three, or five (Bollen, 1989). RMSEA index below .05 indicates excellent data fit, whereas RMSEA index between .05 and .08 indicates acceptable data fit. Models with RMSEA ≥ .10 are rejected due to poor model-data fit. Besides, it is recommended that the CFI value is .90 and above (Hu & Bentler, 1999). Standardized Root Mean Square Residual (SRMR) value is requested to be under .10 (Kline, 2005). Other indices do not need to be used and reported (Brown, 2006; Kline, 2005). According to the results obtained, confirmatory factor analysis and confirmatory factor analysis results are confirmed.

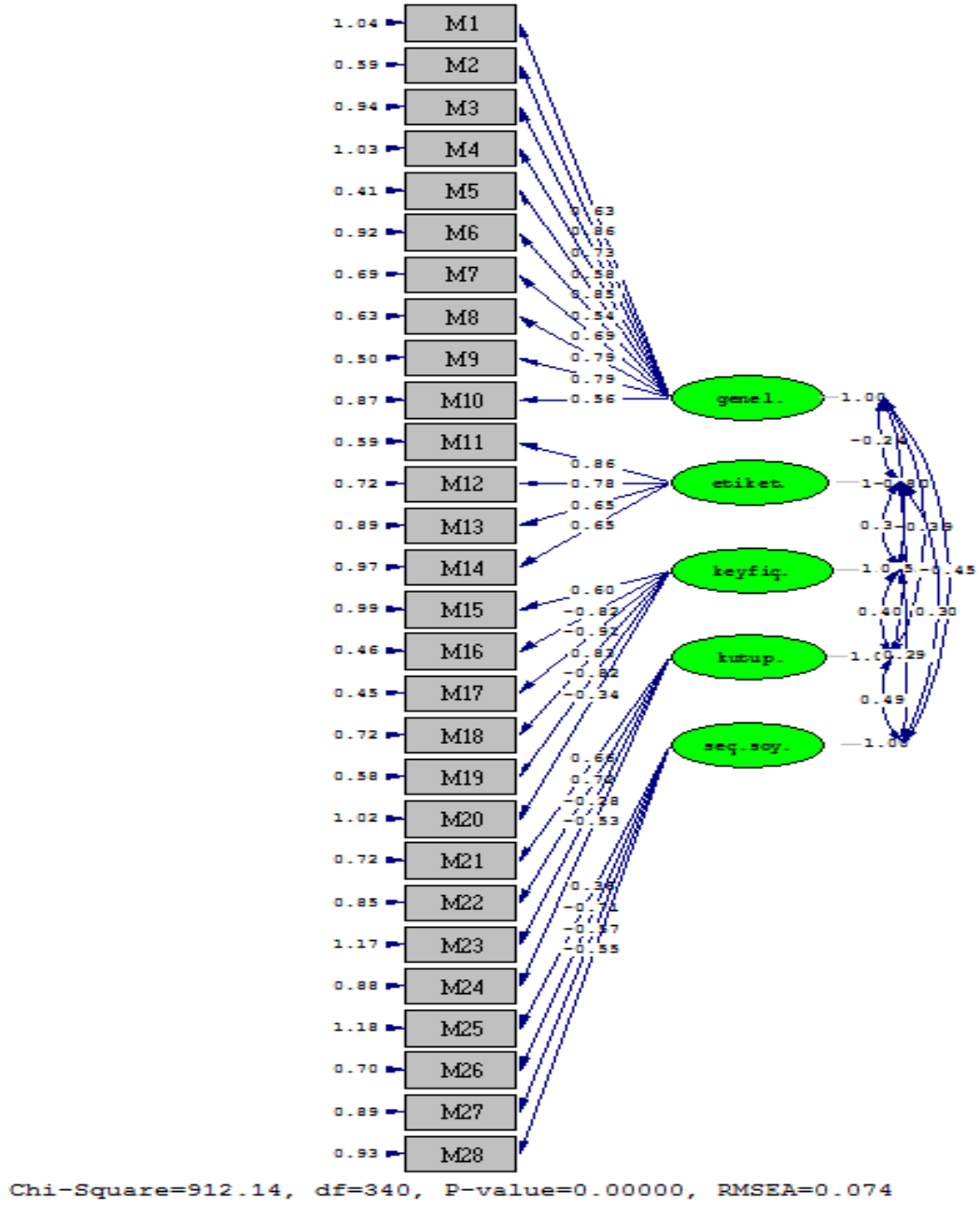

Figure 3. Confirmatory Factor Analysis Path Diagram

When Figure 3 is examined, the absence of red arrow in t values demonstrates that all items are significant at the level of .07. It was determined that the factor load values were over 30. A review of standard factor loadings for analysis shows that factor loads for all items are higher than 30 (Seçer, 2017). Also, X2 = 912.14, df = 340, X2 / df = 2.68. According to Sümer (2000), the fact that this ratio is below three indicates that it is in an excellent fit.

The Reliability of the Stereotype Scale Toward Science Courses

There are several ways to estimate reliability. One of these is the Cronbach's alpha reliability coefficient, which indicates the consistency of the single measurement without the need for multiple applications (Can, 2017). In this study, the internal consistency process is performed for the reliability of SSTS, and the obtained values are shown in Table 3.

Table 3

Internal Consistency Reliability Coefficients of SSTS

SSTS and Sub-dimensions	Cronbach's Alpha
SSTS	.819
Over Generalization	.893
Labelling	.740
Arbitrary Inference	.777
Polarization	.467
Selective Arbitration	.580

As seen in Table 3, the Cronbach Alpha internal consistency coefficient was examined for the reliability analysis of the scale consisting of 28 items and five sub-factors, and its value was found to be .81. In this context, the reliability of the scale is high (Büyüköztürk et al., 2018). The internal consistency coefficients are found as .893 for the first dimension, .740 for the second dimension, .777 for the third dimension, .467 for the fourth dimension, and .580 for the fifth dimension. It is observed that the measurements from the SSTS are acceptable for many dimensions; however, it is lower than the expected level for one dimension, and the internal consistency coefficients of the factors of "Polarization" and "Selective Arbitration" are at an acceptable level because they are higher than .40 (Tavşancıl, 2006).

Technical Properties of the Stereotype Scale Toward Science Courses Suggestions

The Stereotype Scale Toward Science Courses, which aims to determine the stereotypes of pre-service teacher toward science courses (Beck, 1979), was prepared in five-point Likert type. Positive and negative items on the scale are scored as they are; in other words, negative items are not subject to rotation. Every item on the scale predicts stereotypes, whether they are positive or negative statements. The scale, consisting of 28 items, has five sub-dimensions. There are ten (10) identified items, between 1-10 in the first dimension called excessive generalization, four (4) items between 11-14 in the second dimension called labelling, six (6) items between 15-20 in the third dimension called arbitrary inference, four (4) items between 21-24 in the third dimension called polarization, and four (4) items between 25-28 in the third dimension called selective abstraction.

DISCUSSION AND SUGGESTIONS

Deciding on the measurement tool development process underwent a very difficult brainstorming. First of all, it has been observed that university students develop a negative attitude toward science courses, talk about the difficulty of science courses, constantly find an excuse for their level of success in science courses, and affect themselves and those

around them with irrational observations such as "I cannot succeed even if I study science courses." In addition, it was stated that the graduates of classroom education mostly hesitate to teach science lessons when they start working (Özdemir, 2006). If we look at countries in general, this situation is clearly seen in the success result table in international exams (TIMMS, 2011; 2015; 2019; PISA, 2015; 2018). Considering these situations, it is seen that the pre-service teachers, who will build the future, have some irrational and unrealistic stereotypes toward science classes. Studies have shown that students who have a positive attitude toward science classes have higher academic achievements (Altınok, 2005; Balım, Sucuoğlu & Aydın, 2009; Bloom, 1995; Demirbaş & Yağbasan, 2004; Dieck, 1997). For this reason, it is important to work to determine the stereotypes of pre-service teachers against science and to eliminate the negativities.

In the process of developing the scale, the steps of the process established within the scope of YÖK / World Bank National Education Development Project (YÖK, 1997) were followed.

The stereotyped thoughts and dimensions, which are the sub-principles of the Cognitive Behavioral Therapy Theory developed by Beck (1979) at the stage of determining the structure, form the basis of the study. Many national and international publications have been reached in the context of related research (Carels et al., 2015; Griffiths & Christensen, 2007; Levy et al., 2002; Park et al., 2019; Saxena, 2008; Sherman, 1996; Arkar, 1992; Ünal, 2015; Dağıstan, 2017; Dağıstan & Çalışkan, 2018; Nimbi et al., 2018; Van den Bos & Stapel, 2012; Macrae, Bodenhausen & Milne, 1998; Kodan, 2013). Macrae, Bodenhausen, and Milne (1998), in the study titled "Saying No to Unwanted Thoughts: Self-Focus and Regulation of Mental Life", revealed the situation of the reduction of stereotyped thoughts that increase in society with the model of self-regulation of cognitive and mental control mechanisms. The results of this study shed light on the writing process of this article.

Likert-type question format was determined for measurement. Considering the age level of pre-service teachers, it was decided to prepare the scale in five-Likert type (Adelson & McCoach, 2010). As stated by Erkuş (2007), a group of questioners' thoughts on the subject were taken as a prerequisite before starting to form questions in accordance with the format, and a wide item pool of 128 items was created by taking into account the age and education levels of the target audience, university students. A draft form consisting of 85 items was prepared by eliminating the items with similarity between the expressions, repetition, and low correlation. For the validity of the content, written opinions were received by sending a "substance expert opinion form" from 14 field experts. Subsequently, the content validity rate (CVR) and content validity index (CVI) were calculated, and items with a (CVR) value lower than 0.571 were excluded from the test (Lawshe, 1975; Demiralp & Kazu, 2012). In the light of expert opinion, the draft form with 85 items was reduced to 67 items; the form, which was ready for pre-application, was applied to 302 students in the first stage. Nunnally (1978, cited in DeVellis, 2016) suggests that 300 people are sufficient for the sample size. However, it is stated that the Kaiser-Mayer-Olkin test should be performed in deciding the

sample size for factor analysis; this test should give a value higher than .60 and the Bartlett test should be statistically significant (Büyüköztürk, 2018). In the current study, KMO value as a result of the analysis was 0.891. As a result of Bartlett's Test of Sphericity, the chi-square value was found to be 4050,533 ($p < .001$). The significance of Bartlett's value shows that the data come from multivariate normal distribution (Thompson, 2004). In the light of the above information, it can be said that the data set to be used in this study is suitable for exploratory factor analysis. It is seen that the item-total correlation values for all items in the scale vary between .404 and .743. According to Seçer (2017), the item factor load is recommended to be at least .30. As a result of the factor analysis, in the scale consisting of 67 items, a total of 39 items were excluded from the scale because 31 of the items had low factor loading and eight were under more than one factor. As a result of the analysis, a structure consisting of five dimensions and 28 items has been reached as a result of the factor analysis repeatedly performed by removing the items with a factor load of less than .40 and which are close to each other in two dimensions. As a result of the principal components analysis, it is seen that there are five factors with eigenvalues greater than one. When these factors are examined, it is seen that the eigenvalue of the 1st factor is 8.427, the eigenvalue of the 2nd factor is 3.410, the eigenvalue of the 3rd factor is 1.926, the eigenvalue of the 4th factor is 1.459, and the eigenvalue of the 5th factor is 1.195. In addition, Factor 1 made 30.09% of the total variance, Factor 2: 12.18%, Factor 3: 6.87%, Factor 4: 5.20% and Factor 5: 4%. It explains 26 of them. It is seen that the entire five-factor structure obtained explains 58.63% of the total variance. Kline (2005) states that the variance rate explained with the measurement tool should be at least 40%. It is seen that the scale explains 58.63% of the total variance and this value is above the specified limit. It shows that the five factors that make up the stereotyped thought scale for science have a correlational relationship with each other and the values are between .27 and .54. According to Seçer (2017), a correlation coefficient of .90 and above between each factor is not recommended, as it will indicate the multiple correlation problem. Therefore, the values obtained show that the scale does not have a multicollinearity problem.

As a result of the data obtained from the exploratory factor analyses, renaming was not required when the items under the factors were examined, and the Factor named by Beck (1979) as Overgeneralization, Labeling, Arbitrary Inference, Polarization, and Selective Abstraction sub-dimensions are used. The scale was finalized by testing the relationship of factors with one another with confirmatory factor analysis. In the confirmatory factor analysis results, the value of $\chi 2$ was found to be 2.68. In the confirmatory factor analysis results, it is recommended to be two, three, or less than five for the value obtained, by dividing the value of two by the degree of freedom (Bollen, 1989). As the research finding is below three, it is at an excellent level. RMSEA index was found .07. Having RMSEA index below .05 gives perfect data fit; being between .05 and .08 indicates an acceptable fit. Models with RMSEA ≥ .10 are rejected due to poor model data fit (Browne & Cudeck, 1993). The research findings are in the acceptable range. Also, CFI value is recommended to be .90 and

above (Hu & Bentler, 1999). SRMR value is required to be below .10 (Kline, 2005). In the research finding, CFI value is in the desired range with .93, while SRMR value is with .08. According to Brown (2006) and Byrne (2010), the fact that the RMSEA and SRMR values are zero or very close to zero reveals the perfection of the model. Other indices do not need to be used and reported (Brown, 2006; Kline, 2005).

When examined in the context of sub-dimensions of the scale, the opinions of the pre-service teachers regarding the Overgeneralization and Arbitrary Inference sub-dimensions are in the "I agree" range. It is seen that their views on the sub-dimensions of Labeling, Polarization, and Selective Abstraction correspond to the "indecisive" range. The range of indecision is a critical range that can tend to decrease and increase (Dağıstan, 2017). This situation points out that there may be an increase in the rational and unrealistic thoughts they form against the sciences in the sub-dimensions of Labeling, Polarization, and Selective Abstraction. Probably these are thoughts they carried unconsciously; these thoughts can push aside ideas and action and can generate stereotypical interests and reactions. As people do not tend to rush to test whether their firm thoughts are correct, they either ignore or reject information that contradicts their stereotypes (Dökmen, 1997).

In line with the findings obtained from this study, suggestions for future research and reducing stereotypes are listed. The stereotyped thinking interval of pre-service teachers and equivalent groups can be determined with “Stereotypical Thought Scale for Science Courses”. Class environment and course flow can be arranged accordingly. Pre-service teachers’ level of achievement can be increased by incorporating different studies in determining stereotypes of the related course to prevent stereotyped thoughts before they occur. Similar researches can be examined in line with different variables. While preparing science education programs, a system, which includes activities increasing science awareness and reducing stereotypes towards science from the moment teachers start science education, can be developed. Teachers and pre-service teachers can obtain information about stereotypes by providing short-term courses or seminars. While there are many qualified international studies on stereotypes in the literature, Turkey has limited studies related to the particular stereotypes. Hence, more studies can be done to enrich the relevant literature.

In the classroom, teachers who build a healthy communication framework for their students, so that they may observe the events from the viewpoints of the students, will not judge students’ views, will take into consideration their differences, and will display a flexible attitude. All these will improve the students' communication skills in the classroom so it can, therefore, be assumed that the said teachers should have a positive effect (Özkul, 2020) not a barieer.

When teacher and student are considered as a sender and a receiver, it can be said that the teacher-student relationship should be unbiased and empathic, away from stereotypes as shown in the communication cycle, so that the sender can act as a receiver and the receiver

can act as a sender. (Edwards, 1997). One of the frequently emphasized results in the literature is that healthy communication between students and teachers directly contributes to the development of self-expression skills and self-esteem in the favor of students and indirectly affects students' academic achievement, attitudes, and behaviors toward the course (Aspy & Roebuck, 1977; Brophy & Evertson, 1976; Ceyhan, 2006). In the definition of education made by Ertürk (1984), student-student communication is as effective as teacher-student communication for "the process of achieving the desired behavior change", and it is very important to ensure that the lessons are taught in a democratic classroom environment as a basis for the healthy formation of these interactions (Ceyhan, 2006).

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