

Adaptation of Statistics Anxiety Scale to Turkish: Validity and Reliability Study

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Abstract: The aim of this study is to adapt the Statistics Anxiety Scale (SAS) developed by Vigil-Colet et al. (2008) to Turkish. This study is expected to fill an important gap in the literature since no valid and reliable specific statistics anxiety scale developed or adapted in Turkish for undergraduate students in the literature is available. The sample consists of a total of 439 university students, 258 women and 181 men, studying at Düzce University. The construct validity of the Turkish form of SAS was examined by EFA and DFA. Also, for the criterion validity, a different statistics anxiety scale whose validity and reliability tested was used. As a result of EFA, a three-dimensional structure was obtained as in the structure of the original scale. According to the CFA results, which is the second analysis for construct validity, all fit index results of the model were at an acceptable level. Thus, the CFA results supported the three-factor structure obtained from EFA findings. As a result of the reliability analysis, the Cronbach's Alpha internal coefficients of the SAS and its subscales and, the Guttman and Spearman-Brown internal consistency coefficients of Split-Half Reliability methods were quite high and above the limit of 0.70. For item discrimination, items have good discrimination by obtaining all values above 0.30 lower limit in the results. When the results of the study are evaluated as a whole, the SAS form adapted to Turkish can be used as a guiding scale to measure the statistics anxiety of undergraduate students.

1. INTRODUCTION

Statistics is a discipline that is very important today as it was in the past. Although there are many reasons for this, some of them are its being a necessary tool for scientific research (Neşe et al., 2019), used for logical inference, critical thinking and right decision (Joe, 2005; Chew, 2016), and to promote in technology and knowledge. Along with these, Basic statistics information is used for many situations in daily life including forecasting weather and growth, crime and unemployment rates, the spread of a disease, keeping various reports as political elections, etc. (Chew, 2016; Paul et al., 2018). The use of statistics techniques especially in big data, data science and various artificial intelligence techniques, which are important components of artificial intelligence, increases the importance of statistics. However, many people are not statistically literate and lack the ability to perform statistics evaluation (Utts,

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2003; Earp, 2007). In addition, it is stated in various studies that Statistics plays an important role in students' academic careers (Young & Nelson (1994); Parker et al., 1999; Collins & Onwuegbuzie, 2007; Neşe et al., 2019). For these reasons, statistics course is both very important and it is offered as a compulsory course in many programs of universities in both social sciences and natural sciences. For example, all the business program, one of the social sciences fields, at the graduate level is required to take at least one statistics course in Turkey. Similarly, research methods course includes a substantial proportion of statistics is offered among compulsory courses in almost all programs at the undergraduate and graduate education in Turkey. In addition, measurement and evaluation in education courses, which include a certain level of statistics and are included in all programs in education faculties, are among the compulsory courses. The important role of statistics and statistics related subjects in the curriculum in Turkey as it is visible in the curricula of other countries. For example, Stoloff et al. (2009) states that taking at least one statistics course is mandatory in 98% of psychology programs, which is one of the social sciences programs, in the USA Chew (2016), while this rate is 100% in Singapore and Australia.

Although statistics is a compulsory course in many undergraduate programs, due to its quantitative and mathematical based structure, it can create a risky perception and cause anxiety in the minds of students who do not have a numerical background (e.g. social sciences). Even, statistics and statistics-based courses are positioned as a negative situation by graduate students (Collins & Onwuegbuzie, 2007). For this reason, students may exhibit academic procrastination behavior, which can be defined as delaying preparation to an exam, doing homework and other academic obligations for various reasons (Roberts & Bilderbeck, 1980). Moreover, being a known fact that personal characteristics play a role in the academic performance of students, this situation is supported in many studies (Furnham & Chamorro-Premuzic, 2004; Vigil-Colet, 2008; Zhou, 2015; Hazrati-Viari et al.; Sari et al., 2017). Anxiety, one of the personal characteristics, is a forward-looking mood and is defined as an emotional state associated with preparedness for possible upcoming negative events (Spielberger, 1983; Barlow, 2002). Although it is stated that moderate anxiety has a positive effect on the individual (Donnelly, 2009), high levels of anxiety can negatively affect the social, work, psychological, family and educational life of the individual (Zahrakar, 2008). High level of anxiety in education life may occur more especially in some lessons. Since statistics, which is one of these courses, creates anxiety for many students, it is specifically addressed in the literature and is called "statistics anxiety".

Statistics anxiety is a type of situational anxiety and is defined as an emotion that occurs when faced with statistics in any form or time (when a statistics lesson is taken, a statistics analysis or interpretation is required, etc.) (Zeidner, 1991; Onwuegbuzie et al., 1997). This situation prevents learning and negatively affects academic performance as well as creates various psychological problems (Onwuegbuzie & Daley, 1999). Such problems caused by statistics anxiety attracted the attention of researchers and led to the development of various scales to measure statistics anxiety. However, it is stated that some scales developed for statistics anxiety contain items related to attitude towards statistics lesson (For example, STARS) and some of them include items related to mathematics anxiety (For example, Zanakis & Valenzi, 1997), and it is emphasized that the distinction between them should be made (Nasser, 2004; Grajzel, 2019). Unlike statistics anxiety, attitude towards statistics is a multidimensional phenomenon that shows students' learned tendencies to respond positively or negatively to statistics (Emmioğlu & Çapa -Aydın, 2012), while mathematics anxiety is generally a negative emotional reaction to mathematics and defined as a state of tension and discomfort caused by problems (Hembree, 1990). Although it was mostly associated with mathematics anxiety in the past (For example, Zanakis & Valenzi, 1997) and the statistics anxiety scale was first developed based on mathematics anxiety (Pretorius & Norman, 1992), these three concepts, which are clearly

seen to have different meanings by definition, should be distinguished from each other to measure them correctly. Apart from that, Vigil-Colet et al. (2008) stated that to reveal the relationship between academic performance and anxiety more clearly, a specific anxiety scale should be used for the variable aimed to be measured. Supporting this, the work of Rindermann and Neubauer (2001) and Ferrando et al. (1999) found that test anxiety scale is more related to academic performance than a general anxiety scale.

When the literature on statistics anxiety is examined, it is seen that the literature focuses on the relationship between statistics anxiety and academic performance. Accordingly, statistics anxiety can damage students' thinking abilities, thus causing a decrease in learning and academic performance. To put it more clearly, it has been revealed by various researchers that statistics anxiety causes psychological problems such as depression and panic as well as various physical problems such as muscle pain and headache (Onwuegbuzie et al., 1997), decreases focus (Chiesi, Prime, & Marquez, 2011), and causes distraction. (Fitzgerald, Jurs, & Hudson, 1996). It has been found as a result of various studies that such problems caused by statistics anxiety specifically affect statistics success negatively (Hanna & Dempster, 2009) and cause low academic success (Baloglu, 2001; Gal & Ginsburg, 1994; Fitzgerald, Jurs, & Hudson, 1996). In some other studies, statistics anxiety was found to have an indirect negative effect on performance (Chiesi, Prime, & Marquez, 2011). In addition, another negative situation created by statistics anxiety is that it causes academic procrastination. As a matter of fact, a student who took the statistics course for the first time and failed or passed the statistics course with difficulty may prefer academic procrastination in order not to face statistics again. Supporting this, Alexander and Onwuegbuzie (2007) and Vahedi et al. (2012) found that students displayed the behavior of delaying writing the statistics term report, studying for the exam and performing weekly homework.

The second focus of the literature is on the relationship between statistics anxiety and attitude towards statistics, and the relationship between statistics anxiety and mathematics anxiety. Accordingly, many researchers argue that there is a negative relationship between Statistics Anxiety and attitude towards statistics lesson (Chiesi et al., 2011; Mji & Onwuegbuzie, 2004; Watson et al., 2003; Zanakis & Valenzi, 1997). Accordingly, Chiese and Primi (2010) concluded and pointed out a two-way relationship that high statistics anxiety reduced attitude towards statistics, and low attitude towards statistics resulted in high statistics anxiety. When examining the studies on the relationship between statistics anxiety and mathematics anxiety, it was found that students who mostly have a poor mathematics background or take a limited number of mathematics lessons have higher statistics anxiety compared to other students (Baloglu & Zelhart, 2004; Zeidner, 1991; Primi & Chiesi, 2018). On the other hand, there are some studies that have been found to have high statistics anxiety, although mathematics anxiety is low (For example, Onwuegbuzie et al., 1997). However, a few such results in the literature do not cast doubt on the positive correlation between mathematics anxiety and statistics anxiety, which is generally accepted and proved by many studies.

Another focus of the literature is the relationship between statistics anxiety and socio-demographic characteristics. In this direction, the relationship of statistics anxiety with the following demographic characteristics was particularly emphasized; gender, age, mathematics background, social class, ethnicity, personality type, reading ability (Onwuegbuzie & Wilson, 2003; Collins & Onwuegbuzie 2007). One of the most studied socio-demographic features in relation to statistics anxiety is gender. Benson and Bandalos (1989) found that girls have a higher level of statistics anxiety than boys. However, in a similar study, although statistics anxiety of girls was higher than boys, no difference was found between these two groups in terms of statistics success (Bradley & Wygant, 1998). There are also a bunch studies examining the relationship between statistics anxiety and mathematics background, one of the socio-

demographic characteristics. Accordingly, Malik (2015), Becker and Bzhetai (2018) and Grajzel (2019) found that a strong mathematics background has a decreasing effect on statistics anxiety, and in the opposite case, it has an increasing effect. However, there are a few studies that conclude that there is no relationship between mathematics background and statistics anxiety (For example, Sutarso, 1992).

In the past, statistics anxiety, which was mostly associated with mathematics anxiety and measured within that framework, resulted in the development of scales named directly with the statistics anxiety scale over time. For this purpose, the first scale included in the literature under the name of statistics anxiety is Statistics Anxiety Rating Scale (STARS), developed by Cruise et al. (1985). Afterwards, it can be listed as Statistics Anxiety Inventory developed by Zeidner (1991), Statistics Anxiety Scale developed by Köklü (1996), Statistics Anxiety Measure developed by (Earp, 2007), Statistics Anxiety Scale (SAS) developed by Vigil-Colet et al. (2008), and Statistics Anxiety Scale developed by Faber et al. (2018). Although STARS is the most widely used Statistics Anxiety Scale whose psychometric properties have been studied various studies as Baloğlu (2002), Hanna et al. (2008), Chew et al. (2018), this scale has been criticized for having different structures other than anxiety (attitude towards statistics) and being quite long (Vigil-Colet et al., 2008; Chew & Dillon, 2014; Grajzel, 2019). Therefore, Vigil-Colet et al. (2008) developed a shorter scale and specifically measuring statistics anxiety whose sub-dimensions taken from the STARS.

In addition, until recently, there were no other scales other than the scale developed by Köklü (1996), which was developed in Turkish directly to measure statistical anxiety. However, it has been determined that the scale developed by Köklü (1996) is neither in the archive of the journal in which the study was published nor in Google Scholar etc. databases. On the other hand, as a result of the literature review conducted within the scope of this study and as stated by Güler et al. (2019), although there are Turkish studies (for example Baloğlu & Zelhart, 2004) using STARS, no studies have been found that adapt this scale to Turkish. Apart from that, in the Turkish literature, there is an adapted scale (adapted by Güler et al., 2019) to measure graduate students' statistics anxiety. However, although this scale measures the statistics anxiety of undergraduate students to a certain extent, it cannot be able to measure comprehensively since it was developed for graduate students.

Finally, it has just been noticed due recently published that Bektaş et al. (2021) adapted the SAS of Vigil-Colet et al. (2008) to Turkish. Our study includes some advantages over the study of Bektaş et al. (2021). Firstly, we also apply confirmatory factor analysis, which is a crucial analysis for testing the construct validity of the scale, as it was performed on many developed scales. Furthermore, there was no item lost in the scale we adapted but in theirs were. Therefore, it is aimed to fill an important gap by introducing a different reliable and validated scale for measuring Statistics Anxiety to the Turkish literature with this adaptation study. In addition, with this adaptation study, a scale that could both directly measure statistics anxiety and be considered relatively short to the STARS etc. scales would be introduced to the Turkish literature.

2. METHOD

This study, which aims to adapt Statistics Anxiety Scale developed by Vigil-Colet et.al (2008) into Turkish, is a quantitative descriptive research. Detailed information on participants, data collection tools, adaptation process of the scale to Turkish, data collection Process and analysis are presented below.

2.1. Participants

The sample of the study consists of 439 undergraduate students who are studying at the Faculty of Business Administration of Düzce University and enrolled in the Statistics course in Fall 2019. In this context, data were collected from the students of Business Administration, International Trade and Health Management departments of the Faculty of Business Administration using the random sampling method. In this regard, a questionnaire was shared in social media course groups in which all students participated, within the framework of the ethics committee's permission. The average age of the participants was 21.18 and the standard deviation was 1.13. The characteristics of the participants' department and gender variables are given in Table 1.

Table 1. *Frequencies of the Participants by Department and Gender.*

Department	Frequency	Percentage (%)	Gender	Frequency	Percentage (%)
Business Administration	188	42.6	Female	260	59.0
International Trade	137	31.1	Male	181	41.0
Health Management	116	26.3	Female	260	59.0

2.2. Data Collection Tools

Statistics Anxiety Scale-SAS (Vigil-Colet et al., 2008): In order to purify statistics anxiety from the different structures as included in SARS scales and thus measure it more specifically and accurately, Vigil-Colet et al. (2008) developed a Statistics Anxiety Scale (SAS). This scale includes a total of 24 items and has a three-dimensional structure. In this scale, the participants were asked to state their opinions on a 5-point Likert-type scale ranging from 1 = No Anxiety (*Absolutely Disagree*) to 5 = Considerable Anxiety (*Strongly Agree*). The dimensions of this scale are Exam Anxiety-EA, Interpretation Anxiety-IA and Anxiety to Ask for Help-AAH. One of the sample items in the Exam Anxiety dimension is " Studying for an examination in a statistics course ". One of the items in the Interpretation Anxiety dimension is " Interpreting the meaning of a table in a journal article". One of the items in the Asking Anxiety dimension is " Going to ask my statistics teacher for individual help with material I am having difficulty understanding". Vigil-Colet et al. (2008) used three dimensions and 11 questions from the STARS scale while developing SAS. The remaining 13 questions were originally obtained from faculty members who teach statistics. In Table 2, questions in each dimension of original scale are given.

Table 2. *Subscales of SAS and Corresponding Items.*

Subscales	Items
Examination anxiety	1*, 4, 9*, 11*, 13, 14*, 15, 20
Interpretation anxiety	2*, 6*, 8, 10*, 16, 18*, 19, 22*
Asking for help anxiety	3*, 5, 7, 12, 17*, 21, 23, 24

Note: *=Items obtained from the STAR

The validity of SAS has been proved in Spain, Italy, Australia, Singapore, Bangladesh, and the USA and adapted into these languages. Accordingly, the internal consistency coefficient results obtained in these adapted studies are given in Table 3.

Table 3. Internal Consistency Coefficients Obtained from SAS in Various Studies.

Studies	Examination anxiety	Interpretation anxiety	Asking for help anxiety	Total Score
Vigil-Colet et al. (2008)	0.87	0.82	0.92	0.91
Chiesi et al. (2011)	I	0.87	0.84	0.92
	S	0.91	0.83	0.93
Chew and Dillon (2014)	0.90	0.89	0.95	0.93
O'Bryant (2017)	0.90	0.82	0.92	0.93
Paul et al. (2018)	0.78	0.73	0.82	0.87
Grajzel (2019)	0.91	0.84	0.95	0.94

Note. I=Italy, S=Spain

Statistics Anxiety Scale-SAS (Faber et al., 2018): Faber et al. (2018) developed a statistics anxiety scale, aiming to measure the statistic anxiety of graduate students. This scale includes 17 items in total and has a three-dimensional structure. In this scale, participants were asked to state their opinions on a 4-point Likert-type scale such as 1 = *Strongly Disagree*, 2 = *Somewhat Agree*, 3 = *Strongly Agree* and 4 = *Fully Agree*. The dimensions of this scale and the number of items in the dimensions are Worry (8 items), Avoidance (4 items), and Emotionality (5 items). One of the sample items in the worry dimension is "Despite careful preparation for a statistics exam, I would worry about not passing it". One of the items in the avoidance dimension is "If I could, I would rather take two other courses than do one statistics course". One of the items in the emotionality dimension is "I would be very uncomfortable if I had to work on a statistical problem". This scale was adapted to Turkish by Güler et al. (2019). The Turkish Internal Consistency Coefficients of the scale were 0.91 for the worry dimension, 0.83 for the avoidance dimension, 0.91 for the emotionality dimension, and 0.96 for the overall scale.

2.3. The Adaptation Process of the Scale to Turkish

The scale adaptation process generally consists of the following; obtaining the necessary permission from the authors for the adaptation of the scale, adapting the scale to the target language, piloting the adapted scale, performing validity analysis of the adapted scale, and finally performing the reliability analysis of the adapted scale.

a) Obtaining permissions for adapting the scale: Primarily adapting the SAS scale to Turkish culture, Andreu Vigil-Colet, one of the authors who developed the original scale, was contacted via e-mail. The adaptation process was started after the e-mail reported by Urbano Lorenzo-Seva, the one of the other authors in the study, stated that they approved and welcomed the adaptation of the scale to Turkish.

b) Adapting the scale to the relevant language: First, it should be known that two frequently confused concepts, "translation" and "adaptation", are different from each other. Translation is only one of the stages in the adaptation process and includes linguistic conversion from a language to a language. However, adaptation is a much more comprehensive concept and requires taking into account the cultural, psychological and linguistic differences of the scale to be adapted (International Test Commission-ITC, 2017). Two basic methods are used in the literature in the process of adapting the scale to the relevant language. These are forward and backward translation methods.

i) Forward translation: At this stage, one or more translators translate the relevant scale from its original language to the target language. Then, these translations are compared, and a form is created to reflect the common view. In this framework, the items of the scale were translated into Turkish by five experts, one in assessment and evaluation, one in psychological counseling and guidance, one in English and two in statistics. A common Turkish form was created by

comparing the scale items obtained from these experts. (At this stage, if there are items that do not comply with Turkish culture, write that you revise them. Benefit from Neşe Güler)

ii) *Back translation*: At this stage, the items of the scale translated into the target language are translated into the original language of the scale by other translators, and by comparing these translations, a form in the original language that reflects the common opinion of the translators is obtained. Then, the similarity of the scales is compared by comparing this form obtained in the original language with the back-translation method with the scale form in the original language. In this direction, the scale translated into Turkish was given to a group of three people who are experts in the language of the original scale and independent from the experts in the second stage, and these experts were asked to translate the scale from Turkish into the original language of the scale. Then, the original expressions of each item and the expressions resulting from this translation were compared one to one. As a result of the comparison, it was seen that the translation and the original scale were generally equivalent to each other and the translation process was completed. In this scale, five-point grading was adopted as in the original form, and the scale categories were named as 1 = No Anxiety (*Strongly Disagree*) and 5 = Considerable Anxiety (*Strongly Agree*).

c) *Pilot study of the adapted scale*: After this process, the scale was applied to a group of 35 people in the sample to get feedback on the comprehensibility of the translations. It is aimed to identify problematic questions by adding a question such as "If there are questions you have difficulty in understanding, please specify" at the end of the questionnaire. It was stated that there was no problem with any understanding in line with the feedbacks. In addition, in the pilot study, Cronbach's Alpha coefficient was .78 and item-total correlations were .33 (item 19) and .68 (item 14). In this context, the Turkish form of the SAS, which was prepared for application and given in Appendix-A, was created in order to test its psychometric properties (The fifth item of the scale was removed from the scale as it did not meet the conditions specified in the test of construct validity. Thus, the scale adapted to Turkish consists of 23 items).

2.4. Data Collection and Analysis

The data of the study were collected online between 07 December 2019 and 02 January 2021. In the study, within the framework of the psychometric properties of the measurements obtained with the Turkish form of the SAS; construct validity, criterion validity, internal consistency reliability and item discrimination were tested.

3. RESULT / FINDINGS

Please This part covers outputs of data analysis for the psychometric properties of the adapted form of the SAS. The findings of the statistical analyses for construct validity, reliability, criterion validity and discrimination is presented below under related headings.

3.1. Construct Validity

For construct validity, exploratory factor analysis (EFA) was performed initially and then factors found by exploratory factor analysis were checked by confirmatory factor analysis (CFA). First, in the EFA results, the suitability of the data for factor analysis was examined. In this direction, Kaiser Meyer Olkin (KMO) coefficient and Bartlett test results were examined. The KMO value exceeded the lower limit of .60 (Büyüköztürk, 2010) and was obtained as .94. This result indicates that the sample size is sufficient for factor analysis, and even very good. In addition, Bartlett test detects whether there are high correlations between variables and checks compliance with factor analysis. While the correlation between the obtained factors is desired to be minimum, the intra-factor correlation value should be maximum (Eş & Durak, 2018). In the analysis, Bartlett test was found statistically significant ($\chi^2 = 6362.336$, $sd = 253$, $p < .001$). These results show that the data are suitable for factor analysis. Later, EFA analysis

was done and the principal axis factor method was preferred in the analysis (Tan, 1999). In EFA, the value of .32 was obtained as the determining criterion based on Tabachnick and Fidell (2007) as the lower limit of factor loads. The total explained variances and eigenvalues obtained as a result of EFA are given in Table 4.

Table 4. *Explained Variance and Eigenvalues as a Result of EFA.*

Components	Eigenvalues	Explained Variance (%)	Total Explained Variance (%)
1	9.434	22.030	22.030
2	3.516	21.652	43.683
3	1.363	18.546	62.229

Table 4 shows that three factors with eigenvalues greater than 1 were formed as a result of EFA. The first factor explains 22.03% of the total variance, the second factor explains 21.652% of the total variance, and the third factor explains 18.546%. The cumulative amount of variance explained by the eigenvalues is 62.23% of the total variance. It can be said that this value is quite good (Karagoz, 2016). The structure of the components obtained as a result of EFA is presented in Table 5.

Table 5. *Components Matrix for the Turkish Form of SAS, obtained from EFA.*

Items	Components		
	1	2	3
Item-9	.830		
Item-15	.830		
Item-13	.810		
Item-14	.768		
Item-20	.756		
Item-4	.736		
Item-1	.702		
Item-11	.674		
Item-23		.823	
Item-17		.822	
Item-21		.810	
Item-12		.748	
Item-7		.715	
Item-3		.672	
Item-24		.660	
Item-6			.756
Item-10			.720
Item-22			.716
Item-2			.672
Item-18			.615
Item-16			.556
Item-8			.541
Item-19			.532

Extraction Method: Principal axis factoring

Table 5 shows that the scale consists of 23 items and 3 dimensions. Since the factor load of item-5 was obtained less than .32 as a result of EFA, this item was removed from the factor analysis. The structure obtained from the Turkish form as a result of EFA is very similar to the structure in the original language of the scale. The first factor consists of items numbered 1, 4, 9, 11, 13, 14, 15 and 20. The factor loads of these items ranged from .830 (item 9) to .674 (item 11). The second factor consists of 3, 7, 12, 17, 21, 23, and 24 items. The factor loads of these

items ranged from .823 (item 23) to .660 (item 24). The third factor is composed of items 2, 6, 8, 10, 16, 18, 19, and 22. The factor loads of these items ranged from .756 (item 6) to .532 (item 19). The dimensions obtained by considering the meaning of the items in the factors, as in the original scale, has been named respectively factor 1: exam anxiety (EA,) factor 2: asking for help anxiety (AAH), factor 3: interpretation anxiety (IA).

The structure obtained in the exploratory factor analysis was controlled by confirmatory factor analysis. Accordingly, the construct validity analysis was made with the confirmatory factor analysis and the obtained model fit indices are given in Table 6.

Table 6. Result of CFA Fit Indices for three-Factor Structure.

		Fit Indices						
χ^2	df	χ^2/df	GFI	IFI	TLI	CFI	RMSEA	SRMR
743.950	220	3.382	0.865	0.916	0.903	0.916	0.073	0.0639
		(≤ 5)	(≥ 0.85)	(≥ 0.90)	(≥ 0.90)	(≥ 0.90)	(<0.08)	(<0.08)

The fit values show that the data fit the model well. In addition, the diagram showing the model fit and factor loadings obtained as a result of CFA is given in Figure 1.

Figure 1. CFA Results of the Three-Dimensional Structure of the Turkish Form of SAS.

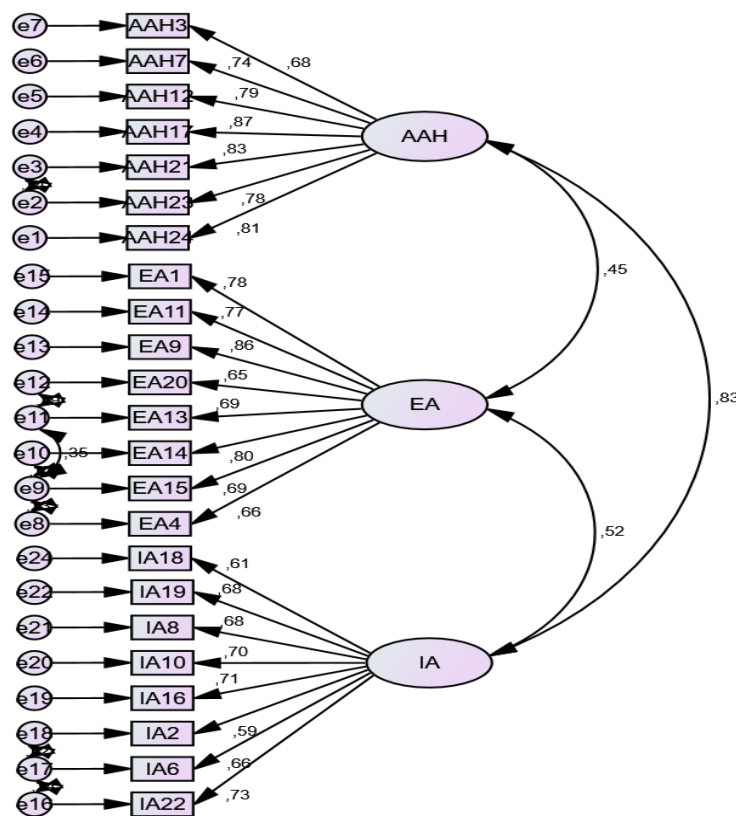


Figure 1 shows that the factor loads of the items in the asking for help anxiety (AAH) dimension ranged between .68 and .87, the factor loads of the items in the test anxiety (EA) dimension ranged between .65 and .86, and the factor loads of the items in the interpretation anxiety (IA) dimension ranged between .61 and .73. Also, Figure 1 shows that item-2 and 3 in AAH; item-8 and 9, item-9 and 10, item-9 and 11, item-11 and 12 in EA dimension; item-16 and 17, item-17 and 18 in the IA dimension were correlated each other and modified. The modified items were examined, and it was seen that the modifications made statistically were supported theoretically.

3.2. Criterion Related-Validity

The SAS scale developed by Faber et al. (2018) was used to test the criterion validity of the adapted Turkish form. The relationship between the SAS scale adapted to Turkish and the SAS scale of Faber et al. (2018) was determined by applying Pearson moments correlation analysis over the total score averages. In this direction, a positive relationship ($r = .73, p < .01$) was determined between the SAS scale adapted to Turkish and the SAS scale developed by Faber et al. This is a good level to ensure criterion validity. As a matter of fact, it can be said that the higher the level of correlation between the scales, the higher the criterion validity.

3.3. Reliability Analysis

A reliability analysis was performed by calculating the internal consistency coefficient both for the overall scale and the subscales. In addition, both Guttman and Spearman-Brown coefficients from Split-Half methods and Cronbach's Alpha were calculated as internal consistency coefficients. In this direction, the internal consistency coefficients for the overall and subscales of the Turkish form were calculated and presented in [Table 7](#).

Table 7. Internal Consistency Coefficients of Turkish Form of SAS and Three Subscales.

Scale and Subscales	Cronbach's Alpha	Split-Half Reliability	
		Guttman Coefficient	Spearman-Brown Coefficient
SAS	.934	.904	.905
AAH	.920	.899	.913
EA	.912	.873	.873
IA	.874	.830	.830

SAS= Statistics Anxiety Scale, AAH= sking for Help Anxiety, EA= Exam Anxiety, IA= Interpretation Anxiety

According to [Table 7](#), Cronbach's Alpha internal consistency coefficients were found between .874 and .934, Guttman coefficients between .830 and .904, and Spearman-Brown coefficients between .830 and .913. These values show that the SAS, adapted to Turkish, has a good level of internal consistency.

3.4. Item Analysis

In the adapted Turkish form of the OIC, the corrected item total correlations (r_{jx}) calculated to determine whether the items are discriminative or not are given in [Table 8](#). [Table 8](#) shows that item correlations take values varying between .446 and .691 (Büyüköztürk, 2010).

Table 8. Discrimination Values of the Items in the SAS.

Items	Corrected item-total correlation	Cronbach's Alpha (if item deleted)	Items	Corrected item-total correlation	Cronbach's Alpha (if item deleted)
Item-1	.650	.930	Item-14	.647	.930
Item-2	.557	.931	Item-15	.478	.933
Item-3	.600	.931	Item-16	.595	.931
Item-4	.481	.932	Item-17	.691	.929
Item-6	.568	.931	Item-18	.522	.932
Item-7	.604	.931	Item-19	.585	.931
Item-8	.660	.930	Item-20	.446	.933
Item-9	.616	.930	Item-21	.684	.929
Item-10	.585	.931	Item-22	.610	.930
Item-11	.644	.930	Item-23	.634	.930
Item-12	.679	.929	Item-24	.691	.929
Item-13	.461	.933			

3.5. Interpretation of Scores Obtained from SAS

The results EFA and item total correlation values showed that all but one of the items in the Turkish form of the SAS had sufficient factor loadings and discrimination values. Therefore, only item 5 with low factor load was removed from the adapted scale. Thus, the scores that can be taken from the scale vary between 23 and 115. Low scores from the scale indicate less anxiety, while high scores indicate a high level of anxiety. Similarly, high scores obtained from the sub-dimensions of the scale indicate a high level of asking for help anxiety, exam anxiety and interpretation anxiety.

4. DISCUSSION and CONCLUSION

In this study, SAS developed by Vigil-Colet et al. (2008) was adapted to Turkish. There is only one statistics anxiety scale developed for undergraduate students in the Turkish literature. However, it was determined that this scale was not found in any database or in the archive of the journal in which the study was published. Thus, this study contributes to the literature by filling an important gap in Turkish literature. In the study, scale adaptation has been made, generally considering the framework recommended by ITC (2017).

In the research, the construct validity of the Turkish form of SAS was examined by EFA and DFA. In addition, for the criterion validity of the adapted form, the scale developed by Faber et al. (2018) for graduate students and adapted to Turkish by Güler et al. (2019) was used. As a result of EFA using the Turkish scale form, a three-dimensional structure was obtained as in the original structure of the scale. The explained variance rate as a result of EFA was 62.229%. In the literature, there are different opinions about the explained variance rate. While Büyüköztürk (2010) stated that the explained variance rate should be at least 30%, Scherer et al. (1988) defined values of 40% and above as acceptable for the explained variance. Accordingly, it can be said that the variance ratio explained obtained as a result of this study is good. The factor loads of all items were above the lower limit of .32 (Tabachnick & Fidell, 2007) as a result of EFA. In addition, as a result of AFA, it was obtained that the number of dimensions obtained in the Turkish form is three, which is the same number as the original form of the scale. When the items that make up the dimensions as a result of EFA are examined, all items except one item gave the same result with the structure in the original form of the SAS. Only the fifth item “Asking a private teacher to explain a topic that I have not understood at all” associated with the asking for help dimension, was not included in the AFA-resulting structure. For this reason, the item five was not included in the SAS form adapted to Turkish. In this direction, it was determined that all the results obtained from EFA, which is the first of the two analyzes made for construct validity, constitute evidence for construct validity. According to the CFA results, which is the second analysis for construct validity, it was found that all fit index results of the model created for CFA were at an acceptable level. Thus, it was determined that CFA results support the three-factor structure obtained as a result of EFA.

As a result of the reliability analysis, the Cronbach's Alpha internal coefficients of the SAS and its subscales and, the Guttman and Spearman-Brown internal consistency coefficients of Split-Half Reliability methods were quite high and above the limit of .70 (Karagöz, 2016). For item discrimination, it can be said that items have good discrimination by obtaining values above .30 lower limit in the results. When the results of the study are evaluated as a whole, the SAS form adapted to Turkish can be used as a guiding scale to measure the statistics anxiety of undergraduate students, since the validity and reliability of the Turkish form of the statistics anxiety scale was ensured.

4.1. Limitations and Recommendations

In this study, as O'Bryant (2017) and Grazjel (2019) did in their study, some words in the original of the scale were slightly changed due to cultural differences and with the approval of

experts. In addition, such small changes may occur due to cultural differences as Baloglu et al. (2011) and Liu et al. (2011) revealed in their study. Using the test-retest method in future scale adaptation studies will provide even stronger support for the reliability results. In addition, for item discrimination, it is recommended to perform item discrimination not only with one method as in this study, but also by using other methods such as Ferguson Delta. Finally, it is recommended that the academicians who teach statistics should use scales that specifically measure statistics anxiety to understand whether students have high statistics anxiety and to take the necessary measures in this direction.

Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research publishing ethics. The scientific and legal responsibility for manuscripts published in IJATE belongs to the authors. **Ethics Committee Number:** Duzce University, 2020-272.

Authorship Contribution Statement

Ismail Durak: Investigation, Methodology, Resources, Visualization, Software, Formal Analysis, and Writing -original draft. **Yalcin Karagoz:** Methodology, Supervision, and Validation. Authors may edit this part based on their case.

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6. APPENDIX

Appendix-A. Turkish Version of Statistics Anxiety Scale*

Açıklama: Lütfen istatistikle ilgili aşağıdaki durumların her birinde hissettiğiniz kaygı miktarını 1 ile 5 arasında derecelendirin. 1= “Kaygılanmam”, 5= “Çok fazla kaygılanırım” anlamına gelmektedir.

Faktör 1: Sınav Kaygısı						
1	Bir istatistik dersinin sınavı için çalışırken	1	2	3	4	5
4	Sınavdan bir gün önce, kolay sandığım bazı soruları yapamadığımı fark ettiğim zaman	1	2	3	4	5
8	Bir istatistik dersinin final sınavındayken	1	2	3	4	5
10	İstatistik sınavı olmak için sınıfa doğru giderken	1	2	3	4	5
12	Derste işlediğimiz tüm konuları gözden geçirmeden sınavdan önceki gün geldiğinde	1	2	3	4	5
13	İstatistik sınavının olacağı günün sabahında uyandığımda	1	2	3	4	5
14	Sınava girmeden hemen önce belli bir konuya hazırlanmadığımı fark ettiğimde	1	2	3	4	5
19	Çalışmak için yeterince zaman bulamadan bir istatistik sınavına girdiğimde	1	2	3	4	5
Faktör 2: Yorumlama Kaygısı						
3	İstatistik hocasından anlamakta zorlandığım bir ders kitabı/ders notu hakkında bireysel yardım isterken	1	2	3	4	5
6	Bir olasılık tablosunun (z, t, ki kare vb.) nasıl kullanılacağını dersin hocasına sorduğum zaman	1	2	3	4	5
11	İstatistikle ilgili bir alıştırmamın nasıl yapılacağını dersin hocasına sorarken	1	2	3	4	5
16	İstatistiksel bir analizin sonuç çıktısını anlamak için istatistik hocamdan yardım istediğimde	1	2	3	4	5
20	Bir istatistiksel sonuç tablosunu yorumlamak için istatistik hocamdan yardım istediğimde	1	2	3	4	5
22	Soru sormak için istatistik hocamın odasına giderken	1	2	3	4	5
23	Bir istatistiksel alıştırmamın nasıl yapılacağını anlatması için bir istatistik uzmanından ücret karşılığı yardım istediğimde	1	2	3	4	5
Faktör 3: Yardım İsteme Kaygısı						
2	Bir ders kitabındaki/ders notundaki tablonun anlamını yorumlarken	1	2	3	4	5
5	İstatistiksel analizler içeren bir ders kitabı/ders notu okurken	1	2	3	4	5
7	Bir matematiksel formülü anlamaya çalışırken	1	2	3	4	5
9	Bir otomobil reklamında yakıt tüketimi, yasal düzenlemelere uygunluk vb. özelliklerle ilgili şekilleri/oranları incelerken	1	2	3	4	5
15	İstatistik hocamın tahtaya yazılan matematiksel bir alıştırmayı açıkladığı esnada onu deftere geçirirken	1	2	3	4	5
17	Bir şans oyununda (piyango, zar vb.) kazanma olasılıklarını anlamaya çalışırken	1	2	3	4	5
18	Çözdüğü bir problemin sonuç tablosunu dikkatle inceleyen bir sınıf arkadaşımı gördüğümde	1	2	3	4	5
21	Bir gazete, kitap, makale vb. kaynakta yer alan istatistiksel analizleri anlamaya çalışırken	1	2	3	4	5

* Permission from the authors is not required for the use of the scale. Citing the source is sufficient