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That Old Devil Called 'Statistics': Statistics Anxiety in University Students and Related Factors

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The present study investigated relationships between statistics anxiety (SA), trait anxiety, attitudes towards mathematics and statistics, and academic achievement among university students who had at least one study course related to statistics in their study programme. Five hundred and twelve students from the University of Ljubljana completed the Statistics Anxiety Rating Scale (STARS), State-Trait Anxiety Inventory, and answered questions about their perceptions of mathematics and statistics. The results showed below-average mean scores on the STARS dimensions, except for the Test and Class Anxiety with the average score around the midpoint of the scale. Female students reported higher levels of SA than male students did. The highest levels of SA were reported by students who perceived mathematics and statistics as a threat. The subscales of the STARS correlated positively with students' trait anxiety. Students who reported less enjoyment in mathematics in high school perceived statistics to be a less worthy subject and had a lower computation self-concept. Students who had better mathematics performance in high school and higher average study grades also reported a higher computation self-concept. In the present study, we translated the STARS questionnaire into Slovenian and confirmed the six-factor structure of the questionnaire. The results provide a basis for further research on statistics anxiety and further validation of the STARS questionnaire. The results can also aid statistics teachers in better understanding students' worries, fears, and attitudes towards statistics and in learning about the factors that affect students' statistics anxiety and their work in the course.

Keywords: statistics anxiety, trait anxiety, attitudes towards mathematics and statistics, university students

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Statistična anksioznost pri študentih in povezani dejavniki

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V raziskavi smo preučevali odnos med statistično anksioznostjo (SA), anksioznostjo kot potezo, stališči do matematike in statistike ter študijsko uspešnostjo pri študentih, ki so imeli v svojem študijskem programu vsaj en statistični predmet. 512 študentov Univerze v Ljubljani je izpolnjevalo vprašalnik za merjenje statistične anksioznosti (STARS) in lestvico anksioznosti (STAI-X2) ter odgovarjalo na vprašanja o doživljanju matematike in statistike. Rezultati so pokazali, da je bilo pet dimenzij statistične anksioznosti izraženih pod povprečjem, dimenzija testna anksioznost in anksioznost v razredu pa je bila povprečno izražena. Študentke so poročale o več statistične anksioznosti kot študenti. O najvišji statistični anksioznosti so poročali študenti, ki so doživljali matematiko in statistiko kot grožnjo. Dimenzije STARS so bile pozitivno povezane z anksioznostjo kot potezo pri študentih. Študenti, ki so bili manj navdušeni nad matematiko v srednji šoli, so poročali o nižji vrednosti statistike in imeli nižjo samopodobo na področju računskih sposobnosti. Študenti z višjo zaključno oceno pri matematiki v srednji šoli in višjo povprečno študijsko oceno so imeli višjo samopodobo na področju računskih sposobnosti. V raziskavi smo prevedli vprašalnik STARS in potrdili 6-faktorsko strukturo vprašalnika. Rezultati predstavljajo izhodišče za nadaljnje raziskovanje statistične anksioznosti in nadaljnje validacije vprašalnika. Učiteljem statistike lahko pomagajo pri boljšem razumevanju strahov in skrbi študentov, njihovih stališč do statistike ter dejavnikov, ki vplivajo na doživljanje statistične anksioznosti in delo pri predmetu.

Ključne besede: statistična anksioznost, anksioznost kot poteza, stališča do matematike in statistike, študenti

Introduction

Statistics is a mathematical discipline that investigates how statistical data can be collected, summarised and presented. Statistical knowledge is useful in many scientific fields (e.g., medicine, computer science, mathematics, economics, finance, etc.). For example, modern medicine is based on statistics: randomised controlled trials have been described as 'one of the simplest, most powerful and revolutionary tools in research' (Hand, 2008, p. 2). Governments use statistical analysis of data to explain economic and social issues. Farmers, food technologists, and supermarkets implicitly use statistics to decide what to grow, process, package, and finally distribute (Hand, 2008). Statistics is undoubtedly the basis of all science and scientific research. It is also a tool that can help us make important discoveries. In the modern data-driven world, it would be impossible to make decisions without using statistical methods.

Statistical knowledge helps to promote critical and logical thinking (Lehman & Nisbett, 1990; VanderStoep & Shaunghessy, 1997) and is essential in many academic and professional fields (Maat & Rosli, 2016). Learning statistics in the social sciences equips students with specific research skills, such as the appropriate use of scientific methods and procedures, the ability to define research problems and hypotheses, plan research, conduct research, analyse, and interpret results, report on results, and similar. Since mathematics and statistics are crucial to many academic disciplines, it is important to study students' attitudes and feelings towards these subjects. Research suggests that students' positive attitudes towards mathematics and science are important for achieving greater interest in science-related professions. Attitudes can change over time; if they change towards more positive attitudes, students are likely to be better prepared and interested in science careers (Ing & Nylund-Gibson, 2017). Unfortunately, students have identified statistics as their most anxiety-inducing course (Chew & Dillon, 2014), and 80% of university students experience some form of statistics anxiety (Onwuegbuzie & Wilson, 2003). Statistics anxiety is negatively related to various academic outcomes, such as failing a statistics course, dropping out of a course, lower academic grades, difficulties with the research part of a thesis, and the perception of statistics as unimportant (Siew et al., 2019).

In this article, we focused on statistics anxiety as experienced by students of the University of Ljubljana. We also examined factors associated with statistics anxiety, such as gender, academic performance, attitudes and experiences with mathematics and statistics, and students' trait anxiety. The study data could aid statistics teachers in better understanding students' worries, fears, and attitudes related to statistics and in learning more about the factors related to students' statistics anxiety.

Statistics anxiety has been defined as 'feelings of anxiety encountered when taking a statistics course or doing statistical analyses' (Cruise et al., 1985, p. 92). It occurs when people are confronted with statistics in any form and at any level (Onwuegbuzie et al., 1997). For example, students may experience anxiety when confronted with statistical ideas, problems or questions, instructional situations, or evaluative assessments (Onwuegbuzie & Daley, 1999; Onwuegbuzie & Seaman, 1995; Zeidner, 1991). Statistics anxiety is a pervasive phenomenon that occurs mainly in the social sciences, such as psychology, education, and sociology (Onwuegbuzie, 2004; Onwuegbuzie & Wilson, 2003; Ruggeri et al., 2008). It can affect both exam performance and the quality of learning statistics, as it refers to the interference of task-relevant thoughts with task-irrelevant thoughts, such as worries and ruminations. As a result, the cognitive resources required for successful task completion are reduced (Eysenck et al., 2007). Statistics anxiety is, in some ways, similar to mathematics anxiety, but various studies have also confirmed its different nature (Chew & Dillon, 2014; Paechter et al., 2017). Understanding mathematical concepts and using mathematical symbols is an important part of statistics anxiety, but learning basic mathematical concepts is different from learning statistics (Aksentijević, 2015). Statistical tasks in the fields of education, psychology, or sociology are more related to verbal comprehension (Buck, 1987) and require cognitive operations that include thinking about probabilities, possible effects, and understanding social phenomena.

Many authors conceptualised statistics anxiety as a multidimensional construct (Cruise et al., 1985; Onwuegbuzie, 1997; Onwuegbuzie et al., 1997). Using factor analysis, Cruise et al. (1985) identified six components of statistics anxiety: Interpretation Anxiety, Test and Class Anxiety, Fear of Asking for Help, Computation Self-Concept, Fear of Statistics Teachers, and Worth of Statistics. *Interpretation anxiety* is related to the fear that students feel when interpreting statistics results. *Test and class anxiety* refers to anxiety when a person attends lectures on statistics or takes an exam. *Fear of asking for help* is a component related to the feeling of anxiety when asking for help in understanding statistical material. *Computation self-concept* refers to the perception of one's own ability to solve mathematical or computational tasks. *Fear of teachers of statistics* is related to the negative perception of statistics teachers by individuals. Finally, *Worth of statistics* refers to the students' perception of the importance and usefulness of statistics.

A higher level of statistics anxiety relates to negative attitudes towards statistics (Chiesi & Primi, 2010; Kesici et al., 2011). However, more recent findings support the idea that positive attitudes towards statistics can mitigate the negative effects of statistics anxiety on students' academic performance (Najmi et al., 2018). González et al. (2016) claim that students with a higher level of statistical self-image and the intrinsic value of statistics; specifically, those students who show confidence in their competence to learn statistics and who believe that statistical courses and content are valuable experience less anxiety during class, use more self-regulating and deep-learning strategies, and show more persistence in accomplishing difficult tasks, leading to better statistical performance. Baloğlu et al. (2011) found that students who believe that statistical skills are important for future career development show lower computational anxiety, lower fear of statistics teachers, lower fear of asking for help, and lower interpretation anxiety. Accordingly, they show a more positive attitude towards statistics.

Students' experiences and attitudes towards mathematics contribute to their attitude towards statistics, which in turn contributes to feelings of statistics anxiety (Marchis, 2011). Some students experience statistics anxiety due to a lack of mathematics knowledge, lower previous achievement, and negative previous experience in mathematics courses and fear of mathematics (Lalayants, 2012; McGrath, 2014). Students with less experience in mathematics reported higher levels of statistics anxiety and difficulties in following lectures in statistics and often found statistics to be a difficult and useless course (Baloğlu, 2001). Similarly, Trimarco (1997) found that people with a higher level of knowledge in scientific research and statistics reported a lower level of statistics anxiety.

Previous research reported associations of statistics anxiety with stable personality traits, such as trait anxiety. It refers to individuals' tendency to experience stressful situations as threatening, which in turn increases the level of anxiety (Ronchini Ferreira & Ribeiro Silva, 2016). Anxious people tend to have low self-esteem and have a higher fear of failure (Lamovec, 1988). Macher et al. (2012) reported a positive correlation between anxiety as a personality trait and statistics anxiety. Anxiety is also an important component of neuroticism, which determines how we experience and overcome stressful situations (Musek, 2010). It has been shown that neuroticism is related to the dimensions of statistics anxiety, such as the lower worth of statistics, the fear of asking for help and the fear of statistics teachers (Chew & Dillon, 2014).

The Present Study

In brief, the present study aimed to examine the level of statistics anxiety and its dimensions in a sample of Slovenian university students who took at least one statistics course during their studies. Furthermore, we were interested in personal factors that might be related to statistics anxiety. For this study, we translated the Statistics Anxiety Rating Scale (STARS, Cruise et al., 1985) from English into Slovenian and tested the factor structure of the questionnaire.

Based on the results of previous studies, we hypothesised that statistics anxiety would be expressed in above-average responses to the items. Students of different disciplines experience statistics as a course that causes most of their anxiety (Onwuegbuzie & Wilson, 2003; Zeidner, 1991).

Secondly, we hypothesised that female students would have a higher level of statistics anxiety than male students did. Research has shown that women have higher anxiety as a personality trait than men do (Benson, 1989; Demaria-Mitton, 1987; Macher et al., 2012; Zeidner, 1991). However, research on the relationship between statistics anxiety and gender has not yet produced consistent results. In some studies, female students reported higher levels of statistics anxiety than male students did (Onwuegbuzie, 1995; Stroup & Jordan, 1982; Zeidner, 1991), but some authors also reported a nonsignificant gender difference in statistics anxiety (Baloğlu, 2003; Cruise & Wilkins, 1980).

Thirdly, students who perceive mathematics and statistics as a threat will report the highest levels of statistics anxiety.

Finally, we hypothesised that students' enjoyment of mathematics, final grade in mathematics in the fourth year of secondary school, and average study grade would correlate negatively with their statistics anxiety, while students' trait anxiety would correlate positively with their statistics anxiety.

Method

Participants

The sample consisted of 512 students at the University of Ljubljana who had at least one study course related to statistics in their study program. There were 400 female students (78.1%) and 112 male students (21.9%); most of the sample were undergraduate students (386 students, 75.39%). The participants were students in the Faculty of Arts (161 students, 31.4%), the Faculty of Social Sciences (106 students, 20.7%), the School of Economics and Business (150 students, 29.3%) and the Faculty of Education (95 students, 18.6%). The average age of the students was 21.6 years (SD = 2.03).

Participants of the Faculty of Arts were students of psychology (n = 150), geography (n = 10), and one student of sociology. There were 122 undergraduate students of psychology (six statistics courses, 32 ECTS; e.g., Descriptive Statistics, Methodology of Psychological Research, Statistical Inference) and 28 graduate students (one statistics course (Applied Psychometrics), 7 ECTS). Students of geography were undergraduate students who take a compulsory statistics course (Methods for Geographers, 4 ECTS), while students of sociology (bachelor's level) take two statistics courses (Basics of Sociological Research I and II, 9 ECTS). Participants of the Faculty of Social Sciences were undergraduate students of the International Relations (n = 19, one statistics course (Statistics), 5 ECTS), Communication (n = 17, one statistics course (Statistics), 5 ECTS), Political Science (n = 6, one statistics course (Statistics), 5 ECTS), Cultural Studies (n = 10, one statistics course Statistics, 5 ECTS), Journalism (n = 23, one statistics course (Statistics), 5 ECTS), and Social Informatics (n = 34, 10 statistics courses, 50 ECTS). Seventy-five undergraduate students of the School of Economics and Business had one statistics course in their program (Basics of Statistics, 6 ECTS) and 75 graduate students who had one statistics course in their study programme (Research Methods and Techniques, 7 or 10 ECTS). The participants of the Faculty of Education were students of the Special and Rehabilitation Pedagogy (56 undergraduate students, one statistics course (Statistical Analysis of Data), 4 ECTS, and 8 graduate students, one statistics course (Statistical Multivariate Analysis of Data), 6 ECTS) and students of Speech Therapy and Surdopedagogy (21 undergraduate students, one statistics course (Statistical Analysis of Data), 4 ECTS and 10 graduate students, one statistics course (Statistical Multivariate Analysis of Data), 6 ECTS).

Instruments

The students first answered questions on gender, age, faculty, course of study, final grade in mathematics in the fourth year of high school and the average study grade in the current academic year. The following questions related to the students' experiences and their attitudes towards mathematics and statistics: *I enjoyed mathematics in my high school* (1 = I strongly disagree, 5 = I strongly agree); *How did you perceive mathematics in high school* ((a) as a threat, (b) as a challenge, (c) as something in between, and (d) none of these); *Did you expect statistics to be one of the courses in your study program?* (yes, no); *In my study program, the amount of statistics is …* (fair enough, too high, insufficient); *How do you perceive the statistics in your study program?* ((a) as a threat, (b) as a challenge, (c) something in between and (d) none of these). After these questions, the participants answered the questionnaires on statistics anxiety and trait anxiety.

Statistics Anxiety Rating Scale (STARS; Cruise et al., 1985)

The Statistics Anxiety Rating Scale (STARS; Cruise et al., 1985) is the most widely used measure for testing statistics anxiety, especially in the academic but also in the non-academic fields. The STARS contains 51 questions that describe six domains of statistics anxiety: (a) Worth of Statistics (example of an item: *statistics takes more time than it's worth*), (b) Interpretation Anxiety (example of an item: *interpreting the meaning of a probability value once I have found it*), (c) Test and Class Anxiety (example of an item: *studying for an examination in a statistics course*), (d) Computation Self-Concept (example of an item: *I have not done maths for a long time. I know I'll have problems getting through statistics*), (e) Fear of Asking for Help (example: *asking someone in the computer lab for help in understanding a printout*) and (f) Fear of Statistics Teachers (example: *statistics teachers speak a different language*).

The STARS consists of two parts. The first contains 23 items that describe different situations related to statistics. Participants rate the items on a 5-point scale according to their level of anxiety in each situation (1 – no anxiety; 5 – strong anxiety). The second part consists of 28 items that relate to the participants' attitude towards statistics. The participants circle the level of their agreement with the item (1 – strongly disagree; 5 – strongly agree)[3].

Cruise et al. (1985) reported that the items on the STARS load onto six factors, and they confirmed good internal reliabilities of the subscales: Interpretation Anxiety (α = .87), Test and Class Anxiety (α = .68), Fear of Asking for Help (α = .89), Worth of Statistics (α = .94), Computation Self-Concept (α = .88), and Fear of Statistics Teachers (α = .80). The construct

3 Higher scores on the subscales indicate higher levels of anxiety (i.e., interpretation anxiety, test and class anxiety, fear of asking for help) or higher levels of negative attitudes (i.e., fear of statistics teachers, less worth of statistics and lower computation self-concept).

validity of the STARS was examined by verifying the factor structure of the questionnaire and its relationship to other measures of statistics anxiety (Cruise et al., 1985; Hanna et al., 2008; Mji & Onwuegbuzie, 2004). Hanna et al. (2008) confirmed the six-factor structure of the questionnaire, first proposed and validated by Cruise et al. (1985).

The translation of items mostly followed the meaning of the original items, except for the three items that were slightly adapted to the Slovenian cultural and academic context.

We present the data on the construct validity and reliability of the STARS results obtained in a Slovenian sample of university students in the Results section.

State Trait Anxiety Inventory – STAI-X2 (Spielberger et al., 1983)

State Trait Anxiety Inventory – STAI-X2 (Spielberger et al., 1983; translated into Slovenian by Lamovec, 1988) measures anxiety as a personal characteristic. Participants assess how they feel in typical situations that everyone experiences daily and how they react to situations with different levels of anxiety. STAI-X2 consists of 20 items, which the participants answer on a 4-point scale (1 – almost never, 4 – almost always). Examples of the items include 'I worry too much over something that really doesn't matter', 'I am inclined to take things hard'. Kranjec, et al. (2016) found a high internal consistency of the scale (α = .90), which was also confirmed in our study (α = .91).

Procedure

We collected the data in May and June 2018. The participants were recruited through personal contact with professors of statistics at the four faculties of the University of Ljubljana. The professors who agreed to participate allowed us to apply the questionnaires to students during their lectures. The students were first informed about the purpose of the study, their voluntary participation, and their anonymity. Afterwards the participants answered the questionnaires in paper-pencil form. The whole procedure took about 15 minutes.

The data were analysed with Excel, SPSS 20.0 and R (laavan package).

Results

In a first step, we checked the results on students' general experiences and attitudes towards mathematics and statistics. The average level of students' enjoyment of mathematics in their high school was slightly above the scale's midpoint ($M = 3.22$, $SD = 1.23$). In addition, 11.3% of the students perceived mathematics at their high school as a threat, 35.7% as a challenge, 36.7% as something in between, and 15.8% of the students perceived mathematics neither as a threat nor as a challenge. The most frequent answer thus indicates that the perception of mathematics among students can be quite ambivalent (they perceive it both as a challenge and as a threat).

In contrast, we can also observe a positive attitude towards mathematics among more than one third of the respondents (who perceive it as a challenge). Compared to the attitude towards mathematics, there was a higher percentage of students who perceived statistics as a threat (22.3%), a similar percentage of students who perceived statistics as something between a challenge and a threat (36.3%), and a lower percentage of students who perceived it as a challenge (24.2%). In addition, 70.7% of students reported that they expected statistics to be one of the courses in their study program. Most students (61.5%) reported that the amount of statistics in their study program was fair enough, while almost a third of students (31.5%) thought that the amount of statistics was too high.

Since the STARS (Cruise et al., 1985) was translated into Slovenian and used for the first time in the Slovenian academic environment, we used confirmatory factor analysis (CFA) to validate the factor structure of the original questionnaire. We used the *weighted least squares with mean and variance adjusted* (WLSMV; Muthén, 1993) estimation. In assessing the fit of the model to the data, we followed the criteria for cut-off values recommended by Hu and Bentler (1999): *CFI*, *TLI* close to or > .90, *RMSEA* < .08, and *SRMR* < .08. The fit of the 6-factor model to the data in our study was marginally satisfactory: $\chi2 = 2077.304$; $df = 1209$; $p < .000$; $RMSEA = .039$, 90 % *IZ* [.037–.042]; $CFI = .867$; $TLI = .860$; $SRMR = .058$. Table 1 shows the standardised loadings, reliabilities (α), means (*M*) and standard deviations (*SD*) for the scales of the STARS.

Table 1

The range of standardised factor loadings, Cronbach α coefficients, means and standard deviations for the STARS scales

STARS subscales	Factor loadings	*M*	*SD*	α
Interpretation	.47–.71	2.31	.71	.86
Test and class	.55–.76	3.13	.87	.87
Help	.65–.85	2.33	.93	.70
Computation SC	.37–.76	2.14	.81	.85
Teachers	.55–.73	2.21	.85	.79
Worth	.44–.82	2.41	.81	.94

Note. Interpretation = Interpretation Anxiety; Test and class = Test and Class Anxiety; Help = Fear of Asking for Help; Computation SC = Computation Self-Concept; Teachers = Fear of Statistics Teachers; Worth = Worth of Statistics. The subscale scores of the STARS were calculated as average score per item. The range of the response scale was 1 to 5. Higher scores on Computation Self-Concept and Worth of Statistics mean lower self-rates on the two constructs.

The standardised factor loadings presented in Table 1 indicate a good construct validity of the Slovenian version of the STARS. The average loadings for the six STARS subscales were: $M_{\text{Interpretation}} = .64$, $M_{\text{Test and class}} = .61$, $M_{\text{Help}} = .75$, $M_{\text{Computation SC}} = .67$, $M_{\text{Teachers}} = .65$ and $M_{\text{Worth}} = .70$. The six STARS subscales also showed good internal consistency with Cronbach α coefficients ranging from .70 to .94. Table 1 also shows the mean scale-scores with respect to the possible range of these scores, which correspond to the range of the response scale used (1 to 5). The scale scores close to value 3 indicate intermediate levels of a particular dimension of statistics anxiety, while the scores closer to the minimum and maximum values of the possible range indicate low and high levels of a particular construct. Participants scored below the scale's mid-point levels on the five STARS scales, while the average score of participants on the Test and Class Anxiety scale was around the midpoint of the scale.

Next, we performed a one-way ANOVA to find out whether students with different attitudes towards mathematics and statistics (which they each perceive as a threat, a challenge, something in between or none of these) differed in their statistics anxiety. The results showed that the four groups of students with different attitudes towards mathematics differed significantly in all dimensions of the STARS questionnaire: $F(3, 490) = 7.93$, $p < .001$, $d = .94$ (Interpretation Anxiety), $F(3, 492) = 9.66$, $p < .001$, $d = 1.20$ (Test and Class Anxiety), $F(3, 501) = 6.52$, $p < .001$, $d = .51$ (Fear of Asking for Help), $F(3, 494) = 11.19$, $p < .001$, $d = 1.04$ (Worth of Statistics), $F(3, 500) = 60.21$,

p < .001, d = 2.07 (Computation Self-Concept), $F(3, 499)$ = 4.19, p = .006, d = .65 (Fear of Statistics Teachers). Similarly, significant differences in statistics anxiety scores were found among groups of students with different attitudes towards statistics: $F(3, 489)$ = 25.67, p < .001, d = .32 (Interpretation Anxiety), $F(3, 491)$ = 59.38, p < .001, d = 1.91 (Test and Class Anxiety), $F(3, 500)$ = 12.46, p < .001, d = 1.09 (Fear of Asking for Help), $F(3, 493)$ = 43.11, p < .001, d = 1.72 (Worth of Statistics), $F(3, 499)$ = 16,98, p < .001, d = 1.08 (Computation Self-Concept), $F(3, 498)$ = 25.58, p < .001, d = 1.39 (Fear of Statistics Teachers).

Tables 2 and 3 show descriptive statistics for the six subscales of the STARS in groups of students who perceived mathematics and statistics as a threat, a challenge, something in between, or none of these.

Table 2

Statistics anxiety (interpretation anxiety, test and class anxiety, fear of asking for help) according to students' perceptions of mathematics and statistics

		Interpretation	Test and class	Help
		M(SD)	*M(SD)*	*M(SD)*
Mathematics	threat	2.62 *(.70)*	3.55 *(.88)*	2.71 *(1.09)*
	something in between	2.35 *(.74)*	3.21 *(.83)*	2.39 *(.94)*
	challenge	2.29 *(.66)*	3.06 *(.83)*	2.28 *(.86)*
	none of these	2.03 *(.69)*	2.80 *(.92)*	2.04 *(.83)*
Statistics	threat	2.67 *(.75)*	3.87 *(.74)*	2.74 *(1.03)*
	something in between	2.40 *(.64)*	3.16 *(.71)*	2.32 *(.84)*
	challenge	1.95 *(.57)*	2.67 *(.76)*	2.06 *(.88)*
	none of these	2.16 *(.70)*	2.73 *(.81)*	2.19 *(.85)*

Note. Interpretation = Interpretation Anxiety; Test and class = Test and Class Anxiety; Help = Fear of Asking for Help. The results are shown as the average score per item.

The results in Table 2 show that students who perceived mathematics and statistics as a threat had the highest scores on Interpretation Anxiety, Test and Class Anxiety and Fear of Asking for Help subscales. Students who perceived mathematics neither as a threat nor as a challenge had the lowest scores in the three statistics anxiety dimensions, while students who perceived statistics as a challenge had the lowest anxiety in these dimensions.

Table 3

Statistics anxiety (worth of statistics, computation self-concept, fear of teachers) according to students' perceptions of mathematics and statistics

		Worth	Computation SC	Teachers
		M(SD)	*M(SD)*	*M(SD)*
Mathematics	threat	2.84 *(.86)*	3.00 (.86)	2.45 (.96)
	something in between	2.50 *(.82)*	2.34 *(.76)*	2.30 *(.85)*
	challenge	2.19 *(.73)*	1.70 *(.50)*	2.11 *(.79)*
	none of these	2.37 *(.78)*	2.05 *(.76)*	2.05 (.84)
Statistics	threat	3.00 *(.88)*	2.57 (.88)	2.74 (.99)
	something in between	2.39 *(.71)*	2.09 (.75)	2.19 (.73)
	challenge	1.92 (.58)	1.89 (.75)	1.87 (.68)
	none of these	2.38 *(.71)*	2.02 *(.66)*	2.06 *(.71)*

Note. Worth = Worth of Statistics; Computation SC = Computation Self-Concept, Teachers = Fear of Statistics Teachers. The results are shown as the average score per item. Higher scores on Computation Self-Concept and Worth of Statistics mean lower selfrates on the two constructs.

Table 3 shows that students who perceived mathematics and statistics as a threat had the lowest Worth of Statistics and Computation Self-Concept and the highest Fear of the Statistics Teachers. Students who experienced mathematics and statistics as a challenge reported the highest Worth of Statistics and Computation Self-Concept, while the group of students who perceived mathematics as neither a threat nor a challenge reported the lowest score on the Fear of Statistics Teachers.

Table 4

Gender differences in the STARS dimensions

	Gender	*M*	*SD*	*t*	*d*
Interpretation	male	2.06	.68	-4.29**	0.47
	female	2.38	.71		
Test and class	male	2.73	.88	-5.46**	0.59
	female	3.23	.84		
Help	male	2.32	.92	-0.17	0.02
	female	2.33	.93		
Worth	male	2.27	.81	-1.99*	0.21
	female	2.45	.81		

	Gender	*M*	*SD*	*t*	*d*
Computation SC	male	2.06	.78	-1.19	0.13
	female	2.16	.81		
Teachers	male	2.15	.87	-0.89	0.09
	female	2.23	.84		

Note. Interpretation = Interpretation Anxiety; Test and class = Test and Class Anxiety; Help = Fear of Asking for Help; Worth = Worth of Statistics; Computation SC = Computation Self-Concept, Teachers = Fear of Statistics Teachers. The subscale scores of the STARS were calculated as average score per item.
**p* < .05, ***p* < .01.

As shown in Table 4, female students reported higher Interpretation Anxiety, Test and Class Anxiety, and lower Worth of Statistics than male students. The effect sizes (*d*) were of small to medium magnitude.

Table 5

Correlations between the subscales of the STARS and trait anxiety, enjoyment in mathematics in high school, final grade in mathematics in the last year of high school, and average study grade

STARS	Trait anxiety	Enjoyment in mathematics	Final grade in mathematics	Average study grade
Interpretation	.323**	-.047	.036	.061
Test and class	.366**	-.058	.122**	.029
Help	.364**	-.080	.053	-.059
Worth	.126**	-.209**	-.083	-.071
Computation SC	.312**	-.488**	-.307**	-.117**
Teachers	.194**	-.058	.053	.003

Note. Interpretation = Interpretation Anxiety; Test and class = Test and Class Anxiety; Help = Fear of Asking for Help; Worth = Worth of Statistics; Computation SC = Computation Self-Concept; Teachers = Fear of Statistics Teachers. Higher scores on Computation Self-Concept and Worth of Statistics mean lower self-rates on the two constructs.
***p* < .01.

The results in Table 5 show statistically significant and positive correlations between trait anxiety and all subscales of STARS. In addition, students who showed higher enjoyment of mathematics in high school reported higher Worth of Statistics and higher Computation Self-Concept. Students with a higher final grade in mathematics in high school reported a higher Test and Class Anxiety and higher Computation Self-Concept. in the end, students with a higher average study grade reported higher Computation Self-Concept.

Discussion

In this study, we investigated the occurrence of statistics anxiety in the sample of students of social sciences at the University of Ljubljana. We were also interested in personal factors related to the experience of statistics anxiety.

The findings indicate that our participants experienced average to below-average levels of statistics anxiety. We could speculate that students who have statistics courses in their study program have on average no significant difficulty interpreting statistics results and asking teachers or colleagues for help if they have problems understanding the course material. The students in our sample also showed relatively positive perceptions of their competencies to solve mathematical or computational tasks, and a positive perception of statistics as an important and useful course. The results of our research are, therefore, not consistent with other studies that showed substantial levels of statistics anxiety among university students (Chew & Dillon, 2014; Onwuegbuzie, 2004; Onwuegbuzie & Wilson, 2003; Ruggeri et al., 2008). It can be assumed that modern educational technology enables students to access various learning materials and use extensive information on statistics on the Internet. In this way, students can feel more comfortable studying statistics.

Nevertheless, teaching statistics in the social sciences means that more females than males are taught. Previous findings showed that women have a higher level of anxiety as a personality trait than men (Benson, 1989; Macher et al., 2012; Zeidner, 1991). Also, Stroup and Jordan (1982), Onwuegbuzie (1995), and Zeidner (1991) reported significant gender differences in the experience of statistics anxiety, with female students showing a higher level of statistics anxiety than male students did. In our study, gender differences occurred in certain dimensions of statistics anxiety. Female students reported a higher Interpretation Anxiety and Test and Class Anxiety, and a lower Worth of Statistics. Interpretation anxiety is a form of anxiety that students experience when interpreting statistical results. It may be that females question their statistics knowledge more than male students do, which in turn may affect their higher test and class anxiety. A lower Worth of Statistics may also indicate that statistics is less important for female students. For example, Štraus et al. (2013) found that Slovenian female adolescents do not like mathematics as much their male counterparts do, which may later be reflected in their more negative perception of statistics. At this point, it should be noted that effect sizes (*d*) in gender differences were small to medium, suggesting that gender is not so important in experiencing statistics anxiety.

Furthermore, we cannot generalise gender differences, since our sample included about 80% female students. Although the sample was unbalanced by gender, it is representative of the gender ratio of students in the faculties included in the study. However, further studies should investigate the gender differences in statistics anxiety using a more balanced sample.

In this study, we also examined the relationship between attitudes towards mathematics and statistics and the statistic anxiety. The results showed that students who perceived mathematics as a threat had the highest scores in all dimensions of statistics anxiety. In contrast, students with a neutral perception of mathematics (who perceived mathematics as neither a threat nor a challenge) scored lowest in most dimensions of statistics anxiety. The only exceptions were Worth of Statistics and Computation Self-Concept. Students who perceived mathematics as a challenge in high school reported the most positive beliefs about the value of statistics and the highest computational competencies, which may be because students who had a positive experience of mathematics in high school developed a similarly positive attitude towards statistics during their studies. The results are consistent with the study by Macher et al. (2012), which found that students with a more positive mathematical self-image reported lower levels of statistics anxiety. However, we found the lowest results in four dimensions of statistics anxiety among students with a neutral attitude towards mathematics. Such individuals probably did not develop a negative attitude towards mathematics in their earlier school years and were, therefore, less likely to develop statistics anxiety.

Similar results were obtained when we analysed the relationship between students' perception of statistics and their level of statistics anxiety. About one-fifth of the students in our sample perceived statistics as a threat, and they had the highest scores in all dimensions of statistics anxiety. Students who perceive statistics as a threat are likely to be more anxious about statistics because of their negative attitudes towards the subject, which may reinforce their anxiety. Also, individuals with higher statistics anxiety may be more likely to interpret their work in a statistics course as a threatening experience. Since anxious students need more structure in the classroom, it is important to provide clear and informative instructions and to ensure that the student workload and the complexity of statistical tasks increase gradually.

Regarding the experience of statistics as a challenge, our results show that students who experienced statistics as a challenge had the lowest level of anxiety in all statistics anxiety dimensions. Students who view statistics positively and see it as a challenge are likely to be less concerned about learning statistical material and performing statistical tasks and are not afraid of possible obstacles to understanding statistics. In this way, they can more easily meet the challenges of statistics. Again, the results are consistent with the study by Macher et al. (2012), in which the authors found that students who are more interested in statistical content are less anxious about statistics. The results also agree with Najmi et al. (2018), who showed that a positive attitude towards statistics can mitigate the negative effects of statistics anxiety on students' academic performance.

Our study confirmed that all dimensions of statistics anxiety are related to anxiety as a personality trait. The correlations were mostly low but statistically significant. A significant correlation between anxiety as a personality trait and statistics anxiety was also reported by Macher et al. (2012) and Walsh and Ugumba-Agwunobi (2002). Test and Class Anxiety and Interpretation Anxiety appear in situations such as passing exams in statistics, accepting or rejecting null hypotheses and interpreting statistics results (Cruise et al., 1985). In these situations, a highly anxious individual may perceive the possibility of making a mistake as a threat. Eysenck (1997) found that highly anxious individuals focus on potential threats while processing information from the environment, especially in situations that they perceive as ambiguous. Exams or lectures in statistics are examples of such situations, since there is always the possibility that the individual does not understand learning content or does not solve the tasks correctly.

The relationship between anxiety as a personality trait and the dimensions Fear of Asking for Help and Fear of Statistics Teachers can be explained by an individual's concern about possible social ignorance, which can be a stressful situation for anxious individuals. A similar explanation was provided by Onwuegbuzie and Daley (1999), when they explained the relationship between socially prescribed perfectionism and the fear of asking for help. Socially prescribed perfectionism refers to an individual's concern that society might perceive his or her efforts or work as inadequate or inferior. Such individuals are often very anxious while performing various tasks. Their performance is not motivated by the desire to succeed or be the best, but by the fear of failure or the desire to avoid shame, fear and guilt (Klibert, et al., 2005).

Furthermore, anxiety as a personality trait is related to students' self-concept about computing skills. From this, it could be concluded that people who are particularly concerned about their self-image are also more likely to be anxious when solving statistical tasks with mathematical operations.

Finally, the correlation between anxiety as a personality trait and the dimension Worth of Statistics was lowest but still statistically significant. Students who consistently show higher rates of anxiety tend to perceive statistics as an unimportant and useless course and perceive it as a waste of time. Enjoyment in mathematics was related only to the Worth of Statistics and the Computation Self-Concept. Based on these results, we can conclude that students who are intrinsically motivated to learn mathematics are more likely to value statistics and feel more competent in dealing with statistical challenges.

The students' final grade in mathematics correlated positively with the Test and Class Anxiety. The correlation was low but statistically significant. The result may reflect our sample unbalanced by gender. Females are generally more anxious about school, education, and passing exams, although they have a similar or even higher academic achievement than males. For example, Puklek Levpušček (2014) showed that 15-year-old girls were just as successful as boys in mathematics in the PISA 2012 study, but they were more concerned about poor grades in the subject.

Nonetheless, better high school mathematics performers reported a better self-image in computational skills. The students' average study grade related to the students' computation self-concept, while there was no relationship between students' academic success and other dimensions of statistics anxiety. It appears that academically more successful students do not necessarily experience lower statistics anxiety. Further studies should also include student grades in statistics courses, which could better illustrate the correlation between statistics anxiety and performance.

Conclusions

Our study showed an average to below-average levels of statistics anxiety among students of social sciences at the University of Ljubljana. It confirmed that statistics anxiety is related to anxiety as a personality trait and to the students' perceptions of mathematics and statistics. It also showed that previous achievements and motivation in mathematics play a role in experiencing statistics anxiety at university. Attitudes towards mathematics in primary and secondary school are extremely important, since a positive attitude towards mathematics can contribute to successful and effective problem solving (Marchis, 2011). At the entry point to upper secondary school, students generally have a positive attitude towards mathematics, but over the years, this attitude can change in a negative direction due to the difficulty of learning material in mathematics (Ma & Kishor, 1997). Therefore, it is important to motivate and help students throughout the educational process to develop a more positive learning self-concept and attitude towards mathematics and statistics. Also, it might be a good idea that teachers showed students all the benefits of studying and understanding statistics and used authentic research projects that link statistics knowledge to its application in the real world.

Interventions for students who experience higher levels of statistics anxiety should focus on their negative beliefs about their mathematical and computational skills that might undermine their motivation and willingness to learn statistics. Teachers of statistics should identify areas where students have concerns about the subject (e.g., low self-worth in computation, understanding the logic of statistical concepts, worries about the interpretation of statistical results, fear of exams) and identify possible misconceptions about the study of statistics. They should also think about how to reduce the distance to students and how to balance effective work with a warm classroom atmosphere. Experimental studies are also needed to determine which teaching methods could reduce statistics anxiety and lead to a better statistical knowledge of students. Also, future studies should examine other factors that might contribute to statistics anxiety, such as perfectionism, attitudes towards science, mathematics anxiety, and previous experience and achievement in statistics courses.

References

Aksentijević, A. (2015). Statistician, heal thyself: Fighting statophobia at the source. *Frontiers of Psychology*, *6*, 1558. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4600901/

Baloğlu, M. (2001). *An application of structural equation modeling techniques in the prediction of statistics anxiety among college students* [Unpublished doctoral dissertation]. Texas A&M University-Commerce.

Baloğlu, M. (2003). Individual differences in statistics anxiety among college students. *Personality and Individual Differences*, *34*(5), 855–865.

Baloğlu, M., Deniz, M. E., & Kesici, Ş. (2011). A descriptive study of individual and cross-cultural differences in statistics anxiety. *Learning and Individual Differences, 21*(4), 387–391.

Benson, J. (1989). Structural components of statistical test anxiety in adults: An exploratory model. *Journal of Experimental Education*, *57*(3), 247–261.

Buck, J. L. (1987). More on superiority of women in statistics achievement: A reply to Brooks.

Teaching of Psychology, *14*(1), 45–47.

Chew, K. H., & Dillon, D. B. (2014). Statistics anxiety and the big five personality factors. *Procedia - Social and Behavioral Sciences, 112*, 1177–1186.

Chiesi, F., & Primi, C. (2010). Cognitive and non-cognitive factors related to students' statistics achievement. *Statistics Education Research Journal, 9*(1), 6–26. http://iase-web.org/documents/SERJ/SERJ9(1)_Chiesi_Primi.pdf

Cruise, R. J., Cash, R. W., & Bolton, D. L. (1985). Development and validation of an instrument to measure statistical anxiety. Paper presented at the annual meeting of the Statistical Education Section. Proceedings of the American Statistical Association, Chicago, IL, 92–97.

Cruise, R. J., & Wilkins, F. M. (1980). *STARS: Statistical Anxiety Rating Scale.* Unpublished manuscript. Andrews University.

Demaria-Mitton, P. A. (1987). *Locus-of-control, gender and type of major as correlates to statistics anxiety in college students*. [Unpublished doctoral dissertation]. American University.

Eysenck, M. W. (1997). *Anxiety and cognition*. Psychology Press.

Eysenck, M. W., Derakshan, N., Santos, R., & Calvos, M. G. (2007). Anxiety and cognitive performance: Attentional control theory. *Emotion, 7*(2), 336–353.

González, A., Rodríguez, Y., Faílde, J. M., & Carrera, M. V. (2016). Anxiety in the statistics class: Structural relations with self-concept, intrinsic value, and engagement in two samples of undergraduates. *Learning and Individual Differences, 45*, 214–221. https://doi.org/10.1016/j.lindif.2015.12.019

Hanna, D., Shevlin, M., & Dempster, M. (2008). The structure of the statistics anxiety rating scale: A confirmatory factor analysis using UK psychology students. *Personality and Individual Differences*, *45*(1), 68–74.

Hand, D. J. (2008). *Statistics: A very short introduction*. Oxford University Press.

Ing, M., & Nylund-Gibson, K. (2017). *The importance of early attitudes toward mathematics and science*. Teachers College Record.

Kesici, Ş., Baloğlu, M., & Deniz, M. E. (2011). Self-regulated learning strategies in relation with statistics anxiety. *Learning and Individual Differences, 21*(4), 472–477.

Klibert, J. J., Langhinrichsen-Rohling, J., & Saito, M. (2005). Adaptive and maladaptive aspects of self-oriented versus socially prescribed perfectionism. *Journal of College Student Development*, *46*(2), 141–156.

Kranjec, E., Košir, K., & Komidar, L. (2016). Factors of academic procrastination: The role of perfectionism, anxiety and depression. *Horizons of Psychology, 25*, 51–62.

Lalayants, M. (2012). Overcoming graduate students' negative perceptions of statistics. *Journal of Teaching in Social Work, 32*(4), 356–375.

Lamovec, T. (1988). *Priročnik za psihologijo motivacije in emocij* [A handbook for psychology of motivation and emotions]. Filozofska fakulteta, Oddelek za psihologijo.

Lehman, D. R., & Nisbett, R. E. (1990). A longitudinal study of the effects of undergraduate training on reasoning. *Developmental Psychology, 26*(6), 952–960.

Macher, D., Paechter, M., Papousek, I., Ruggeri, K., Freudenthaler, H. H., & Arendasy, M. (2012). Statistics anxiety, state anxiety during an examination, and academic achievement. *British Journal of Educational Psychology*, *83*(4), 535–549.

Marchis, I. (2011). Factors that influence secondary school students' attitude to mathematics. *Procedia Social and Behavioral Science*, *29*, 786–793.

Maat, S. M., & Rosli, M. K. (2016). The Rasch model analysis for Statistical Anxiety Rating Scale (STARS). *Creative Education, 7*(18), 2820–2828.

McGrath, A. L. (2014). Content, affective, and behavioral challenges to learning: Students' experiences learning statistics. *International Journal for the Scholarship of Teaching and Learning, 8*(2), 1–21.

Musek, J. (2010). *Psihologija življenja* [Psychology of life]. Inštitut za psihologijo osebnosti.

Muthén, B. (1993). Latent variable modeling of growth with missing data and multilevel data. In C. R. Rao & C. M. Cuadras (Eds.), *Multivariate analysis: Future directions 2* (pp. 199–210). North-Holland.

Najmi, A., Raza, S. A., & Qazi, W. (2018). Does statistics anxiety affect students' performance in higher education? The role of students' commitment, self-concept and adaptability. *International Journal Management in Education*, *12*(2), 95–113.

Onwuegbuzie, A. J. (1995). Statistics test anxiety and female students. *Psychology of Women Quarterly*, *19*(3), 413–418.

Onwuegbuzie, A. J. (1997). Writing a research proposal: The role of library anxiety, statistics anxiety, and composition anxiety. *Library and Information Science Research*, *19*(1), 5–33.

Onwuegbuzie, A. J., & Daley, C. E. (1999). Perfectionism and statistics anxiety. *Personality and Individual Differences, 26*(6), 1089–1102.

Onwuegbuzie, A. J. (2004). Academic procrastination and statistics anxiety. *Assessment & Evaluation in Higher Education, 29*(1), 3–19.

Onwuegbuzie, A. J., DaRos, D., & Ryan, J. (1997). The components of statistics anxiety: A phenomenological study. *Focus on Learning Problems in Mathematics*, *19*(4), 11–35.

Onwuegbuzie, A. J., & Seaman, M. A. (1995). The effect of time constraints and statistics test anxiety on test performance in a statistics course. *The Journal of Experimental Education*. *63*(2), 115–124.

Onwuegbuzie, A. J., & Wilson, V. A. (2003). Statistics anxiety: Nature, etiology, antecedents, effects, and treatments: A comprehensive review of the literature. *Teaching in Higher Education*, *8*(2), 195–209.

Paechter, M., Macher, D., Martskvishvili, K., Wimmer, S., & Papousek, I. (2017). Mathematics anxiety and statistics anxiety. Shared but also unshared components and antagonistic contributions to performance in statistics. *Frontiers in Psychology*, *8*, 1196.

Puklek Levpušček, M. (2014). Mathematics anxiety and mathematics performance. *Didactica Slovenica – Pedagoška obzorja*, *29*(2), 46–60.

Ronchini Ferreira, C., & Ribeiro Silva, R. (2016). The Spielberger Inventory like a tool for assess the trait and state anxiety. In A. Bradley (Ed.), *Trait and state anxiety* (pp. 1–4). Nova Science Publishers.

Ruggeri, K., Dempster, M., Hanna, D., & Cleary, C. (2008). Experiences and expectations: The real reason nobody likes stats. *Psychology Teaching Review*, *14*(2), 75–83.

Siew, C. S. Q., McCartney, M. J., & Vitevitch, M. S. (2019). Using network science to understand statistics anxiety among college students. *Scholarship of Teaching and Learning in Psychology, 5*(1), 75–89. http://dx.doi.org/10.1037/stl0000133

Stroup, D. F. & Jordan, E. W. (1982). *Statistics: Monster in the university*. Proceedings of Statistical Education, pp. 135–138. The American Statistical Association.

Štraus, M., Šterman Ivančič, K., & Štigl, S. (2013). *OECD. PISA 2012*. Pedagoški inštitut.

Trimarco, K. A. (1997). The effects of graduate learning experience on anxiety, achievement and expectations in research and statistics. *28th Annual Conference of the Northeastern Educational Research Association*, pp. 28–30, New York.

VanderStoep, S. W., & Shaughnessy, J. J. (1997). Taking a course in research methods improves reasoning about real-life events. *Teaching of Psychology, 24*(2), 122–124.

Walsh, J., & Ugumba-Agwunobi, G. (2002). Individual differences in statistics anxiety: The roles of perfectionism, procrastination and trait anxiety. *Personality and Individual Differences, 33*(2), 239–251.

Zeidner, M. (1991). Statistics and mathematics anxiety in social students: Some interesting parallels. *British Journal of Educational Psychology*, *61*(3), 319–328.

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