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CONTENTS

Identifying The Causative Factors for Statistical Anxiety among Undergraduates
(With Special Reference to General Sir John Kotelawala Defence University)

Fernando W.W.D. P[1], Wathsanie M. V.[2], Kavinda R.P.M.[3],
Lankeshwara. P[4]

Anxiety is a huge barrier when studying and working with statistics. Considering the context in General Sir John Kotelawala Defence University (KDU), undergraduates' performance in statistics is considerably lower when compared to their performance in other subjects. Thus, this study aims to explore causative factors and reveal the highly influential factors for statistical anxiety among undergraduates. A sample of 162 participants was drawn from the faculties of Management, Social Sciences and Humanities of KDU using a stratified random sampling technique utilizing Morgan's approach of sample selection. The sample consisted of three strata, namely, undergraduates from Management and Technical Sciences (MTS), Logistics Management (LM) and Social Sciences

[1] *Department of Management and Finance, Faculty of Management, Social Sciences and Humanities, General Sir John Kotelawala Defense University, Sri Lanka. 0779623782 dinaliprabhasha.98@gmail.com*

[2] *Department of Management and Finance, Faculty of Management, Social Sciences and Humanities, General Sir John Kotelawala Defence University, Sri Lanka*

[3] *Department of Management and Finance, Faculty of Management, Social Sciences and Humanities, General Sir John Kotelawala Defence University, Sri Lanka*

[4] *Lecturer (Probationary), Department of Management and Finance, Faculty of Management, Social Sciences and Humanities, General Sir John Kotelawala Defence University, Sri Lanka*

(SS) degree programs. This study was primarily carried out with primary data that was gathered using a structured questionnaire and the necessary secondary data was obtained from the examination department of KDU. The study examines the relationship between Statistical Anxiety and six standard indicators from the Statistical Anxiety Rating Scale (STARS): worth of statistics, interpretation anxiety, computation self-concept, test and class anxiety, this study aims to examine the role played by the relationship with statistics teachers and some personal factors such as age, gender, advanced level stream and previous educational qualifications in the anxiety caused by statistics. The results wasm the factor and the canonical correlation analysis revealed that all six factors outlined in STARS are significantly influential in statistical anxiety. The recommendations of this study are to create a clear idea of the value of the subject when studying statistics and to direct the student to a qualified person or the subject instructor in situations where students of statistics experience difficulties.

Keywords: Statistical Anxiety, Statistical Anxiety Rating Scale (STARS), Undergraduates

Introduction

Quantitative aptitudes are significant for examining and understanding the social reality, since there are a few circumstances in which we should inevitably deal with information and numerical proof. The growing need for the utilization of statistical methods in various areas of employment and work environments has led colleges to incorporate at least one statistics course as a central part of their degree programs (Onwuegbuzie, A. J. and Wilson, 2003).

In the corporate world, business graduates with critical thinking and numerical skills are sought and appreciated (Quek, 2005), especially, if they have the skill for statistical analysis (Wellman, 2015). Statistical undertakings are major in the field of education and psychology, requiring probabilistic thinking forms, making assumptions or making inferences from information, and are often embedded into an applied context. (Primi & Chiesi, 2018). Anxiety towards

statistics has been seen as one of the most common attitudinal problems that students experience when following statistics courses (Birenbaum, M., & Eylath, 1994; Gal & Ginsburg, 1994; Perepiczka, Chandler, & Becerra, 2011).

Business statistics is a subject that is generally considered to be difficult by business graduates as it brings about an elevated level of anxiety. This creates a demonstrated higher disappointment rate when following statistics modules of the business colleges (Mocco, J., Ransom, E. R., Mack, W. J. and Al, 2006; Onwuegbuzie, A. J. and Wilson, 2003). When it comes to the examination records of KDU undergraduates, there exists a clear tendency to obtain lower results when compared to the results obtained for other subjects during the same semester. Observing the second semester (of year 2016_Intake 33) results (Grade percentages) for the business statistics subject of Management and Technical Sciences (MTS), Logistics Management (LM) and Social Sciences (SS) undergraduates in Intake 33, this situation is clearly revealed, confirming the existence of relatively low-grade attainment compared to the other subjects.

Figure 1

Comparison of results for statistics with other subjects (in MTS)
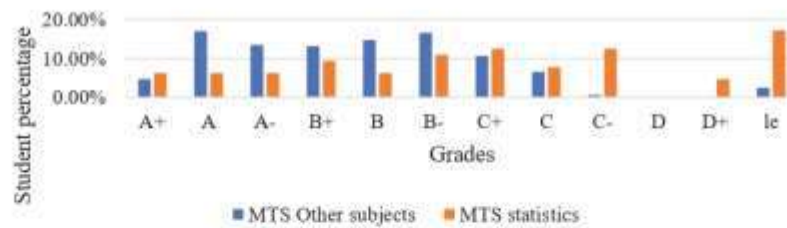
Source: Examination Department, KDU (2016)

Figure 2

Comparison of results for statistics with other subjects (in LM)
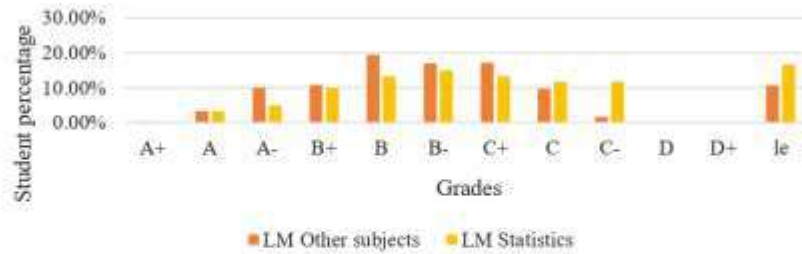
Source: Examination Department, KDU (2016)

Figure 3

Comparison of results for statistics with other subjects (in SS)
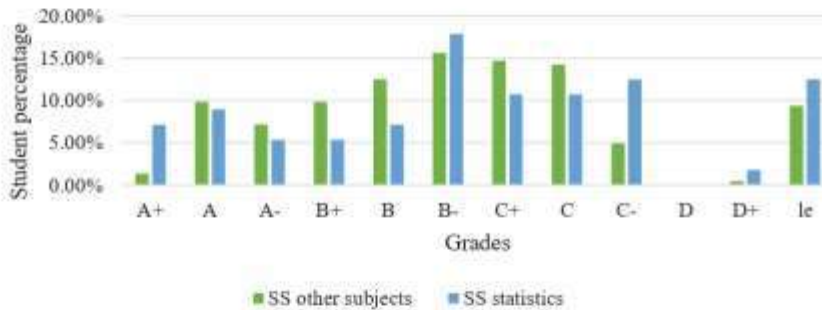
Source: Examination Department, KDU (2016)

Figure 1 indicates that 57.81% of students obtained grades above C+ for business statistics while 90.26% of students obtained grades above C+ for the other subjects. When considering LM students (figure 2), 59.99% of the students have achieved a grade above C+ for business statistics and it is 17.95% lower compared to other subjects. For SS, it is 62.5% and 71% of students attained grades above C+ for business statistic and for the other subjects respectively (Figure 3). It is observed that there is a tendency to attain lower grades for business statistics compared to other subjects. Thus, in view of the above, the

main objective of this study was to find whether the undergraduates have statistical anxiety and what factors significantly affect the level of statistical anxiety among the undergraduates (of KDU).

The negative impact of statistical anxiety has prompted analysts to revisit previous research to explaining his inclination and illuminating intercessions (Gina Dillon, Rafat Hussain, 2013). Situational, ecological and dispositional factors may be delegated to forecasters of statistical anxiety (Onwuegbuzie, A. J. and Wilson, 2003). Anxiety in training had consistently demonstrated an unmistakable and discrete outcome on learning and instruction. For example, anxiety was viewed as a noteworthy subjective factor that influences students' learning conduct, execution, consideration and data recovery (Cruise, R.J., Cash, R. W., and Bolton, 1985). Surveys with factual anxieties have shown that students have the least enthusiasm for statistics. Factual anxiety can be characterized as problems, strained quality, and apprehension of individual experience while taking care of, illuminating, examining, and translating any kind of measurable information (Macher, Paechter, Papousek, & Ruggeri, 2012).

In 1985, J.R. Cruise, R.W. Cash and L.D. Bolton published the Statistical Anxiety Rating Scale (STARS) to measure statistical anxiety. Initially 89 items were completed by 1150 participants in USA as pilot instruments and the data was subjected to factor analysis, using the Principle Components Method (PCM) with varimax rotation (Cruise, R.J., Cash, R. W., and Bolton, 1985). According to the study (Chew, Dillon, & Swinbourne, 2018), interpretation anxiety, test and class anxiety, fear of asking help, worth of statistics, computation self-concept and fear of statistics teachers were the six factors causing statistical anxiety. Several studies have tested the psychometric properties of STARS and have found empirical evidence for the six-factor structure: some examples for such studies are studies based on student populations in South Africa (Eduljee & Lebourdais, 2015), the United Kingdom (Hanna, Shevlin, & Dempster, 2008) China, and Australia (Paechter, Macher, Martskvishvili, Wimmer, & Papousek, 2017). As such, this paper tries to fill this

research gap in order to help to comprehend the statistical anxiety in KDU undergraduates by revealing the underlying factors that affect it.

Methodology

The study used a quantitative research design to examine the major factors of statistical anxiety and to explore whether the undergraduates of KDU encounter statistical anxiety. A correlational research design is used to identify the relationship between the independent variables and the dependent variable. The diagnostic research design was helpful when investigating the root causes of statistical anxiety.

The target population of this study was the undergraduates of the faculties of Management, Social Sciences and Humanities at KDU. A sample of 162 was chosen out of a population of 280 following the Krejcie and Morgan's table of sample size determination (Krejcie & Morgan, 1970). The sample of 162 comprised of 38, 43 and 81 undergraduates from Management and Technical sciences, Logistic Management and Social Sciences degree programs respectively. The number of undergraduates for each sub-sample representing the degree programs is calculated proportionally according to the population of the degree programs and the sample was selected using the stratified random sampling technique.

The study utilized both primary and secondary data. Primary data has been collected using a structured questionnaire. The questionnaire consists of 9 demographic questions and an additional 51 questions derived from STARS. The level of statistical anxiety is considered as the dependent variable and worth of statistics, interpretation anxiety, test and class anxiety, computation self-concept, fear of asking help and fear of statistics teachers, gender, age, advanced level stream and previous educational qualifications were considered the independent variables. The dependent variable was evaluated using 4 measurements: the grade obtained for statistics, satisfaction with that result, expected-grade for statistics and the satisfaction on the statistics results when compared with other results. The secondary data was obtained from the

examination department of KDU in order to compare results for statistics with the results of other subjects.

Factor analysis and canonical correlation analysis were used as data analysis techniques. Since the research considers ten independent variables, first a factor analysis was carried out to identify common factors. Canonical correlation analysis was utilized due to the fact that the interdependence between two multivariate groups were to be analyzed and this study used four variables to measure the dependent variable.

Results

Firstly, factor analysis is used to find out the underlying factors for statistical anxiety. Prior to the analysis, diagnostic tests for descriptive statistics, normality, reliability and the KMO and Bartlett test were carried out. All those tests have recommended the suitability of the data set for the analysis.

Table 1

Descriptive statistics according to variables

	N	Minimum	Maximum	Mean	Variance
Average WOS	162	1.50	4.44	2.7343	.296
Average IA	162	1.64	4.27	2.8796	.293
Average TCA	162	1.00	5.00	2.9688	.447
Average CSC	162	1.00	4.71	2.8464	.518
Average FAH	162	1.25	5.00	2.7778	.480
Average FST	162	1.25	5.00	2.7778	.480

Source: Sample Survey (2019)

Table 2

Reliability Statistics

	Cronbach's Alpha	N of Items
Worth of Statistics	.835	16
Interpretation Anxiety	.795	11
Test and Class Anxiety	.790	8
Computation Self Concept	.784	7
Fear of Asking Help	.651	4
Fear for Statistic Teachers	.736	5

Source: Sample Survey (2019)

Cronbach's Alpha Statistic (CAS) was used to check whether the data are reliable or not for the analysis. The general rule of thumb is to recommend the data for factor analysis if CAS $\geq$ 0.7. Those values from reliability test recommended the data set for the analysis.

Table 3

Normality Statistics

Worth of Statistics	Interpretation Anxiety	Test & Class Anxiety
Computation Self Concept	Fear of Asking Help	Fear of Statistics Teachers
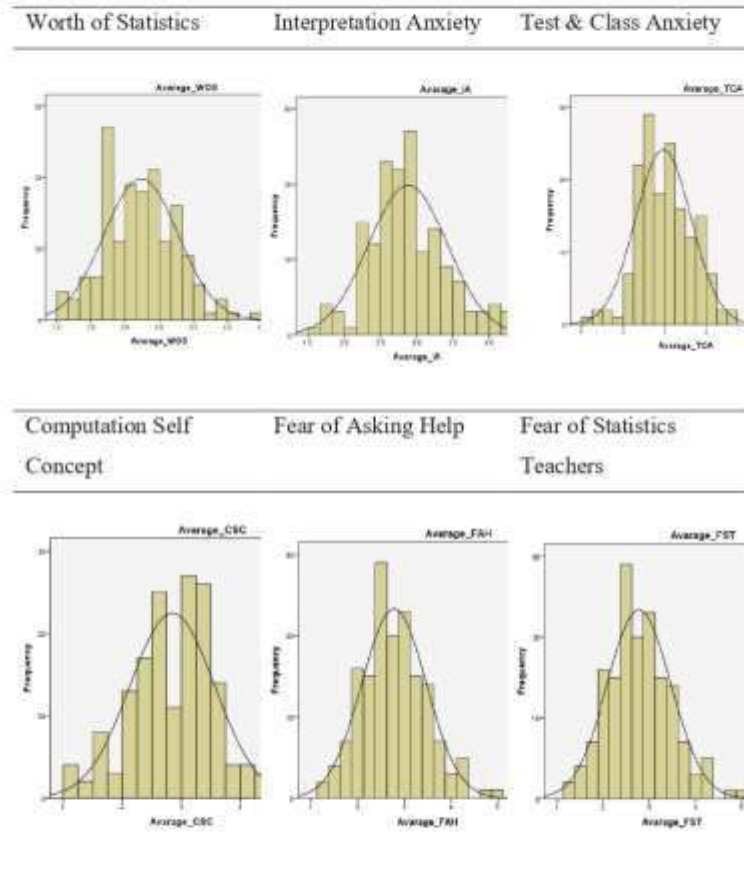
Source: Sample Survey (2019)

Average values for the worth of statistics, interpretation anxiety, test and class anxiety, computation of self-concept, fear of asking help and fear of statistics teachers were taken and then the normality was checked. The data set also satisfied the normality assumption providing bell shapes in histogram for the independent variables.

Table 4

KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.787
Bartlett's Test of Sphericity	Approx. Chi-Square	3727.638
	df	1275
	Sig.	.000

Source: Sample Survey (2019)

Results in Table 4 indicate that the KMO statistic (0.787) is greater than 0.6 confirming that the data satisfied sampling adequacy for factor analysis.

Factor analysis was done with the total set of data collected to identify common factors for all three streams. Based on the eigenvalues (>1) it can be concluded that only the first three components can be used as the common factors and those three common factors accounted for a 65% variance across 10 observed variables.

Table 5

Total variance explained

Compo nent	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulati ve %	Total	% of Variance	Cumulati ve %	Total	% of Variance	Cumulativ e %
1	3.872	38.717	38.717	3.872	38.717	38.717	3.430	34.299	34.299
2	1.429	14.295	53.011	1.429	14.295	53.011	1.856	18.559	52.857
3	1.172	11.715	64.727	1.172	11.715	64.727	1.187	11.870	64.727
4	.896	8.961	73.688						
5	.799	7.988	81.675						
6	.675	6.748	88.423						
7	.494	4.941	93.364						
8	.362	3.615	96.979						

9	.302	3.021	100.000
10	1.003 E-013	1.030E-013	100.000

Extraction Method: Principal Component Analysis.

Source: Sample Survey (2019)

Table 6

Factor loadings of 3 – factor model (PCF and Varimax)

	Component		
	1	2	3
Average CSC	.798	.121	-.039
Average IA	.785	.077	.027
Average WOS	.763	-.031	.028
Average TCA	.743	.301	.092
AL Stream	.671	-.002	-.099
Average FAH	.504	.770	-.149
Average FST	.504	.770	-.149
Gender	-.267	.600	.224
Age	-.059	.273	.799
Edu Qualifications	-.091	.351	-.658

Source: Sample Survey (2019)

According to the results of Table 6, the worth of statistics, interpretation anxiety, test and class anxiety, computation self-concept and advanced level stream load on factor 1 and fear of asking help and fear of statistical teachers and gender load on factor 2. Age loads on factor 3. Thus the 10 variables were reduced to a 3-dimension system and two common factors were sufficient to explain the correlation structure among the 10 variables observed. Before conducting the canonical correlation analysis, the significance of the data set was tested as this study consisted of four components of the dependent variable and ten covariate variables.

All the variables were recorded as significant. They were then tested for the relationship between the ten independent variables and four measures of

dependent variables which are grades obtained for the business statistics module, satisfaction with the business statistics results, expected-results for the business statistics and satisfaction with business statistics results when compared to that of other subjects.

Table 7

The relationship between independent variables and grade obtained for business statistics module:

Covariate	B	Beta	Std. Err.	t-value	Sig. of t	Lower-95%	CL-Upper
Gender	.362	.091	.030	1.20	.230	-.231	.957
Age	.397	.017	.172	2.31	.022	.057	.735
AL-Stream	-.135	-.065	.186	-.722	.471	-.504	.234
Edu-Qual	.645	.290	.168	3.842	.000	.313	.977
Average	.213	.058	.367	.580	.563	-.513	.939
Averag_1	-.467	-.127	.371	-1.25	.210	-1.20	.266
Averag_2	.801	.268	.313	2.55	.012	.180	1.42
Averag_3	-.223	-.080	.293	-.76	.447	-.803	.355
Averag_4	.068	.023	.262	.261	.794	-.450	.587
Averag_5	.000	.000	.000	.	.	.	.

Source: Sample Survey (2019)

It is clear that there is a highly significant relationship between the fear of asking for help and the grade obtained for statistics (Significant= 0.794). Also, there is a significant relationship between the worth of statistics and the grade obtained for statistics (Significant=0.563).

Table 8

The relationship between independent variables and satisfaction with business statistics results:

Covariate	B	Beta	Std. Err	t-Value	Sig of t	Lower 95%	CL-Upper
Gender	.021	.020	.080	.260	.795	-.138	.180
Age	.063	.105	.046	1.31	.189	-.030	.151
AL Stream	.036	.070	.050	.729	.467	-.062	.135
Edu-Qual	.078	.140	.045	1.745	.083	-.013	.167
Average	.093	.100	.098	.949	.344	-.101	.288
Averag_1	.106	.113	.099	1.064	.289	-.093	.302
Averag_2	.101	.134	.084	1.205	.230	-.064	.267
Averag_3	-.2051	-.292	.078	-2.607	.010	-.360	-.049
Averag_4	-.072	-.099	.070	-1.02	.307	-.211	.067
Averag_5	.000	.000	.000	.	.	.	.

Source: Sample Survey (2019)

Results in Table 8 show that a highly significant relationship exists only between satisfaction with the statistics results and the gender (Significance=0.795).

Table 9

The relationship between independent variables and expected-results for business statistics:

Covariate	B	Beta	Std. Err	t-Value	Sig of t	Lwr-95%	CL-Upper
Gender	-.120	-.030	.316	-.380	.704	-.746	.505
Age	.117	.051	.181	.649	.517	-.240	.475
AL Stream	-.089	-.043	.196	-.455	.649	-.478	.299
Edu-Qual	.419	.189	.176	2.368	.019	.069	.768
Average	-.114	-.031	.386	-.294	.768	-.878	.650

Averag_1	.300	.081	.390	.767	.444	-.472	1.07
Averag_2	.565	.190	.330	1.712	.089	-.087	1.218
Averag_3	.224	.081	.308	.727	.468	-.385	1.218
Averag_4	.039	.013	.276	.143	.886	-.506	.586
Averag_5	.000	.000	.000	.	.	.	.

Source: Sample Survey (2019)

From the above, it can be seen that fear of statistics teachers has the strongest relationship with the expected grade for statistics placed at the significant value of 0.886 among the ten independent variables.

Table 10

The relationship between independent variables and satisfaction on business statistics results when compared to the other subjects' results:

Covariate	B	Beta	Std. Err	t-Value	Sig of t	Lwr-95%	CL-Upper
Gender	-.048	-.048	.0774	-.629	.503	-.201	.104
Age	.1017	.178	.0442	2.301	.023	.014	.189
AL Stream	.0006	.001	.0480	.0141	.989	-.094	.095
Edu-Qual	.107	.194	.0432	2.49	.014	.022	.193
Average	-.004	-.0005	0.945	-.0052	.996	-.187	.186
Averag_1	.081	.088	.0954	.857	.393	-.106	.270
Averag_2	.240	.322	.0807	2.97	.003	0.80	.0399
Averag_3	-.105	-.151	.0753	-1.394	.165	-.254	.043
Averg_4	-.04449	-.062	.0657	-.664	.507	-.178	.885
Averg_5	.000	.000	.000	.	.	.	.

Source: Sample Survey, 2019

When considering the satisfaction with statistics results compared to the other subjects' results, the data shows a high relation with the worth of statistics and the advanced level stream, placed at significant values of 0.996 and 0.989 respectively.

Discussion

With the results of factor analysis, the research found the factors that affect statistical anxiety. Out of those factors, three common factors have been extracted. The first extracted factor includes the following variables: worth of statistics, interpretation anxiety, test and class anxiety, computation self-concept and advanced level stream. The second extracted factor includes fear of asking for help and fear of statistical teachers and gender. The variable of age is the third extracted factor. According to this study, there is no relationship between anxiety and the educational qualification. The same variables were identified for two factors with the varimax rotation from both the method PCF and MLF.

According to the literature, the students' history in mathematics seems to be a good predictor of statistical anxiety (Hanna et al., 2008). In addition, the literature indicated that self-efficiency affects statistical anxiety. The more self-efficacy someone has, the less anxiety they experience towards statistics (Perepiczka et al., 2011). This study considers the advanced level stream followed by the student to study his/her previous mathematical history. This research also found that there is an impact on statistical anxiety by advanced level stream. According to the results, gender and age also affect statistical anxiety.

With the results found in factor analysis, the researchers conducted a canonical correlation analysis to find the relationship between statistical anxiety and those underlying factors. When it comes to the relationship between the grade obtained for statistics and the independent variables, it is clear that there is a highly significant positive relationship with fear of asking help (Significant= 0.794) and there is a significant relationship with worth of statistics (Significant=0.563). In addition, results show that there is a highly significant relationship between the satisfaction with statistics results and gender (Significance=0.795). When considering the expected grade for statistics, it is observed that the fear of statistics teachers has the strongest relationship with the expected grade for statistics (significance=0.886). There is a highly significant relationship between the worth of statistics (significance value=0.768) and the expectations for results. According to the results, there is a high relationship between gender and

the expected results at the significant value of 0.704. Further results revealed that satisfaction with the statistics results when compared with other results is highly related with the worth of statistics and the advanced level stream having the significant values of 0.996 and 0.989 respectively.

According to the finding of this study, there is no significant relationship between statistical anxiety and interpretation anxiety, computation self-concept and test and class anxiety although they are extracted in factor analysis.

Conclusion

As per the findings of this study, it can be concluded that the worth of statistics, fear of asking for help, fear of statistics teachers, advanced level stream, age, and gender influence statistical anxiety. Further, it is clear that having a fear of asking help for any statistical issue from others is the most correlated factor with the grade obtained for business statistics. In addition, results revealed that satisfaction with the results depend on gender. The factor having the highest relationship with the expected result is the fear of statistics teachers, lecturers or whoever is teaching statistics. If someone has fear of their instructor, their expectation is less. Thinking statistics as a useless thing leads to having a low expectation of results for statistics. Further, gender, age, worth of statistics and advanced level stream affected the satisfaction regarding results for statistics when compared to other results.

With the obtained results from the study, it can be recommended that it is better to have a clear idea about the value of the subject when studying it and if there is any problem it is better to ask from someone who has a better idea or from the subject instructor.

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