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Statistics Anxiety and Achievement in a Statistics Course among Psychology Students

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Learning of statistics presents a challenge to psychology students whose background in mathematics is not strong. The percentage of students who failed Statistics course at the Department of Psychology in one university in Malaysia is of concern. A survey that included a measure of statistics anxiety was conducted at the beginning of a semester among students taking a statistics course. Performance measures included a basic mathematic review quiz, continuous assessment mark, final examination marks, and total marks. The course was divided into three sections, all taught by the same instructor. Scores from 139 students were used in the analysis. Statistics anxiety and attitude towards statistics are not significantly correlated and both are not related to the total marks. The mathematics quiz score is a significant predictor of total marks. The instrument for measuring pre-course mathematics ability could be used in class as part of the teaching strategy to improve students' learning experience.

Keywords: statistics anxiety, academic performance, psychology students

Statistics anxiety is a challenge for both the students and teachers of statistics. For the students, statistics anxiety is negatively related to performance in the course (Macher, Paechter, Papousek, & Ruggeri, 2011; Zare, Rastegar, & Hosseini, 2011) and research courses (Williams, 2010). It is also significantly related to fear of failure (Onwuegbuzie, 2004). For the teachers, statistics anxiety is considered a common problem faced by teachers of statistics courses (Rodarte-Luna & Sherry, 2008). This research paper reports a study of statistics anxiety among psychology students who took a statistics course in three different sections.

The context of research, a Department of Psychology in a university in Malaysia, offers a bachelor degree program in psychology. One required course for the degree program is introductory statistics. The statistics course is usually taken by students who are in their first or second year in the program. The course serves as a pre-requisite for other higher level courses, including research methodology and data analysis using statistical software package (SPSS).

An instructor of statistics courses (first author) at the Department of Psychology received verbal feedback that reflects the students' anxiety towards statistics. There are students who 'just don't like math' or 'not good at math". Then, there was a student who reported that he was good in secondary school level mathematics, but could not understand why he did poorly in a statistics course. From 2010 to 2013, across six semesters, the average failure rate for the statistics course at the Department is 16.20% (*min* = 4.17%, *max* =26.83%). In three of those semesters, the failure rates were the highest compared to other undergraduate courses offered in the same semesters. This study was undertaken to provide empirical evidence of students' anxiety towards statistics. It is hoped that the empirical data would be beneficial to redesign teaching and learning activities of the statistics course.

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Statistics anxiety

Onwuegbuzie, DaRos, and Ryan, (1997) defined statistical anxiety as "a state-anxiety reaction to any situation in which a student is confronted with statistics in any form and at any time. The reactions could include worry, tension and physiological symptoms of stress when students are faced with taking a statistical class (Zeidner, 1991). The definitions of statistical anxiety identified statistics – as an abstract concept or a tangible object such as a statistics teacher – as a stimulus that produce negatively perceived response. From the perspective of teaching, statistical anxiety, by definition, can be an obstacle to students' learning. However, Keeley, Zayac, and Correia (2008) viewed statistical anxiety as a necessary arousal to aid students to achieve optimal performance.

Aspects of statistics that can rouse anxiety had been explained by Cruise, Cash, and Bolton (1985). They identified six components of statistics anxiety, namely: (a) worth of statistics, (b) interpretation anxiety, (c) test and class anxiety, (d) computational self-concept, (e) fear of asking for help, and (f) fear of statistics teachers. These components comprise a measure of statistics anxiety that they developed: Statistics Anxiety Rating Scale (STARS). The STARS comprises 51 items measuring different aspects of statistics anxiety that are beyond mathematical anxiety (Williams, 2010). It was originally developed by Cruise and Wilkins (1980). It was also used to derive other measures like the Statistical Anxiety Scale (Vigil-Colet, Lorenzo-Seva, & Condon, 2008). Other measures include Statistics Anxiety Scale (Pretorius & Norman, 1992), Statistics Anxiety Inventory (Zeidner, 1991), and Statistics Anxiety Measure (Earp, 2007).

The STARS is a commonly used measure of statistical anxiety with satisfactory psychometric properties. For example, the reliability coefficients for the subscales range from .64 to .95. The lowest and highest reported values found for each subscales are as in Table 1. Out of the six sub-scales, teacher of statistics was found to have lowest reliability. This could be due to the low number of items measuring this subscale compared to for other subscales. Worth of this statistics is the subscale which is the most reliable, having consistently being reported with high coefficient values.

Table 1

Range of internal consistency coefficients for sub-scales of STARS

Sub-Scale	Lowest	Highest	No. of Items
Test	0.68 (Cruise et al., 1985)	0.90 (Baloglu, 2003)	8
Asking for Help	0.79 (Baloglu, 2003)	0.95 (William, 2010)	4
Self-concept	0.84 (Baloglu, 2003)	0.90 (William, 2010)	7
Worth of statistics	0.92 (William, 2010)	0.94 (Onwuegbuzie, 2004)	16
Teacher of statistics	0.64 (Baloglu, 2003)	0.85 (Rodarte-Luna & Sherry, 2008)	5
Interpretation	0.87 (Cruise et al., 1985)	0.93 (Rodarte-Luna & Sherry, 2008)	11

The STARS had been translated into German (Papousek et al., 2012), Chinese (Liu, Onwuegbuzie, & Meng, 2011), and Arabic (Nasser, 1999). The translated versions had been reported with satisfactory internal reliability as well.

Objectives

Given the potentially debilitating effect of statistics anxiety, this study was carried out with the following objectives:

1. To measure the level of statistics anxiety among psychology students
2. To examine statistical anxiety and basic mathematic skills as the predictors of achievement in a statistics course

These objectives can help to explore the pattern of the relationship between performance in a statistics course and the six subscales of STAR. Additionally, the findings of the study are expected to help the instructors of statistics to understand the students' characteristics that influence their ability to perform in a statistics course. The understanding can help the instructor to focus on important issues that are directly relevant for students' performance in designing the curriculum of the statistics course. This augurs well with the student-centred learning approach adopted by the Department and the University in general. Based on the literature reviewed above and the objectives of the study, the following hypothesis was formulated: statistics anxiety and basic mathematical skills are significant predictors of course performance.

Method

Participants

The total number of students with major and minor in psychology, at the time of the data collection, was in excess of 500 people. All students who were registered for an introductory statistics course were recruited to be included in the study. The participation was voluntary and the students were told that their responses to the survey would not affect their grades.

As shown in Table 2, the participants were 26 males (18.7%) and 113 females (81.3%) recruited from students enrolled in a statistics course. The participation rate was 92 % out of 150 students. The mean age of the students is 21.67 years (SD = 1.2). The course is a core course for a psychology degree programme. It is also a required course for students with minor in psychology, of which there were 16 students (11.5%). The course lasted 14 weeks, excluding a one week break. There were three sections of the course taught by the same instructor. Each section received the same course contents (descriptive statistics, correlation, regression, *t-test, ANOVA*, and non-parametric statistics) and assessments (mid-semester examination, quizzes, and final examination).

Table 2

Frequency and percentage of demographic variables

Variable	*N*	%
Sex		
Male	26	18.7
Female	113	81.3
Major		
Psychology	123	88.5
Arabic	8	5.8
English	2	1.4
Others	6	4.3
First Language		
Bahasa Melayu	119	85.6
English	12	8.6
Others	8	5.8
Time taken		
First	122	87.8
Repeating	17	12.2
Section		
1	49	35.3
2	51	36.7
3	39	28.1

Instruments

The questionnaire comprised 3 parts. The first part has eight demographic items. The second part is the Statistics Anxiety Rating Scale and the third part is the mathematics quiz.

Statistics Anxiety Rating Scale (STAR).

The instrument to measure statistic anxiety is based on the modifications done by Hanna, Shevlin, and Dempster (2008) on the original Statistics Anxiety Rating Scale (Cruise et al., 1985). The revised version of STAR was used as it is more suitable for the intended sample. For example, the students are more familiar with the term ‘lecturer’ (revised version) rather than ‘professor’ (original version) when referring to their course instructors. The students are also more familiar with ‘secondary school’ than ‘seventh- and eighth-grade’. Further modifications were made to items that are potentially unclear as presented in Table 3.

The description of the subscales were provided by Cruise et al. (1995) and cited by Liu et al. (2011) as the following.

1. *Worth of statistics* refers to a student’s perception of the relevance of statistics.
2. *Interpretation anxiety* refers to the anxiety experienced when a student is faced with making a decision based on statistical data.

3. *Test and class anxiety* refers to the anxiety involved when taking a statistics class or test.
4. *Computational self-concept* refers to the anxiety experienced when attempting to solve mathematical problems, as well as the student's perception of her/his ability to do mathematics.
5. *Fear of asking for help* is defined as the anxiety experienced when asking a fellow student or professor for help in understanding the material covered in class, or with any type of statistical data, such as that contained in an article or a printout.
6. *Fear of statistics teachers* is concerned with the student's perception of the statistics instructor.

The STAR is measured on a 5-point Likert scale. For the first 23 items, the anchors are 1 to 5 where 1 indicates 'no anxiety' and 5 indicate 'strong anxiety'. Thus, the higher the score for these items, the higher the level of anxiety. For the remaining 28 items, the anchors used are 1 (strongly agree) to 5 (strongly disagree). For calculating the scores, the responses are reverse-scored so that higher scores indicate more negative attitude or higher anxiety.

Table 3

Revisions of STAR items

No.	Version	Item
4	Hannah et al. (2008)	Doing the coursework for a statistics course
	Revised	Doing the assignments for a statistics course
9	Hannah et al. (2008)	Reading an advertisement for a car which includes figures on miles per gallon, depreciation, *etc*
	Revised	Reading an advertisement for a car which includes figures on fuel mileage, insurance, *etc*
16	Hannah et al. (2008)	Asking one of your lecturers for help in understanding a printout
	Revised	Asking one of your lecturers for help in understanding the results of statistical calculation
18	Hannah et al. (2008)	Watching a student search through a load of computer printouts from his/her research
	Revised	Watching a student search through a load of computer generated results of statistical calculation from his/her research
19	Hannah et al. (2008)	Asking someone in the computer lab for help in understanding the results of statistical calculation
	Revised	Asking someone in the computer lab for help in understanding a printout
23	Hannah et al. (2008)	Asking a fellow student for help in understanding a printout
	Revised	Asking a fellow student for help in understanding the results of statistical calculation

Mathematics Quiz.

A quiz with 15 questions measuring basic mathematic skills was taken from Johnson and Kuennen (2006). The score on the quiz was found to be a significant predictor of grades obtained in basic statistics course (Johnson & Kuennen, 2006; Lunsford, 2011).The quiz

consists of items measuring skills on systems of equation, ratios, and geometrics. Each item in the quiz has five answer options. A higher score means a higher level of skills in mathematics.

Data Collection

Students were informed of the purpose of the research at the beginning of the semester which started in February 2012. Their participation is not credited towards final grade. They were ensured that participation is not compulsory and that their responses would not affect their grades. The students were told that the researcher will not be able to see their responses until their final grade for the course had been formally released. The questionnaires were distributed in the first week of the semester by a research assistant during class time.

Results

Based on the values reported in Table 4, the students' score on the math quiz (60.2%) is similar to the total score (62.17). The students did better in the pre-final assessments (71.0%) than their final examination (48.9%). It seemed that the continuous assessment made up for the lower performance in the final examination.

Table 4

Mean score and standard deviation of the performance variables and internal consistency of the STAR's sub-scales

Variable	Mean	*SD*	Cronbach's alpha
Math quiz (max = 15)	9.03	2.57	
Course performance			
Pre-final (max = 60)	42.62	7.36	
Final (max = 40)	19.56	5.96	
Total (max = 100)	62.17	12.10	
Stats Anxiety			
Test (max = 40)	30.01	5.39	.81
Asking for help (max = 20)	13.32	3.94	.84
Self-concept (max = 35)	21.85	5.97	.82
Worth of statistics (max = 80)	34.89	11.29	.91
Teacher of statistics (max = 25)	20.48	3.36	.73
Interpretation (max = 55)	35.96	5.57	.75

For the level of anxiety, the dimension with the highest level of anxiety was teacher of statistics (81.92%), followed by test (75.03%), asking for help (66.67%), interpretation (65.38%), self-concept (62.43%), and worth of statistics (43.62%). All subscales have acceptable internal consistency coefficients, ranging from .73 (teacher of statistics) to .91 (worth of statistics).

This study was done with the sample from three difference sections taught by the same instructor. One of the statistical tests used is *ANOVA* to find the difference between three sections with the variable as shown in Table 5. Based on the result, all three sections reported the same level of anxiety. This means the sections are comparable in terms of their anxiety

level. Their performance in the math quiz and pre-final (continuous assessment) assessments were also the same.

However, the sections performed differently in the final examination, $F(2,136) = 3.587$, $p = 0.03$ and the total mark $F(2,136) = 3.797$, $p = .025$. Post hoc analysis was done using Tukey's HSD. For final examination, section 1 performed better than section 3 with a 3.16 marks difference, $p = 0.05$. For total mark, section 1 also outperformed section 3 with a 6.57 marks difference, $p = 0.05$.

Table 5

ANOVA for performance measures and anxiety sub-scales among students in three sections

Variable	Source	*SS*	*df*	*MS*	*F*	*p*
Final	Between Groups	245.79	2	122.89	3.587	.030
	Within Groups	4,658.96	136	34.26		
Total	Between Groups	1,068.78	2	534.39	3.797	.025
	Within Groups	19,142.35	136	140.75		
Pre Final	Between Groups	289.57	2	144.79	2.738	.068
	Within Groups	7,191.80	136	52.88		
Math Quiz	Between Groups	31.83	2	15.91	2.470	.088
	Within Groups	876.06	136	6.44		
Test	Between Groups	6.32	2	3.16	.107	.898
	Within Groups	3,978.68	135	29.47		
Interpretation	Between Groups	62.55	2	31.28	1.010	.367
	Within Groups	4,088.26	132	30.97		
Teacher of statistics	Between Groups	64.06	2	32.03	2.915	.058
	Within Groups	1,494.64	136	10.99		
Self-Concept	Between Groups	22.17	2	11.09	.309	.735
	Within Groups	4,887.24	136	35.94		
Asking for help	Between Groups	75.59	2	37.80	2.492	.086
	Within Groups	2,062.48	136	15.17		
Worth of statistics	Between Groups	320.53	2	160.26	1.263	.286
	Within Groups	16,744.81	132	126.86		

To further investigate the properties of the sub-scales, correlation analysis was done on the performance measures and the sub-scales of STAR (see Table 6). The math quiz was positively correlated with all measures of statistics course performance. Among the sub-scales, only self-concept was found to be correlated with a measure of performance namely pre-final and total marks.

Among the subscales, there were positive correlations found among some of the subscales. Most notable is that the higher the anxiety about statistical tests, the higher is the anxiety about interpretations of statistical results. Asking for help was correlated with test and interpretation. Three negative correlations were found. Worth of statistics were negatively correlated with teacher of statistics and self-concept. This means the more the students viewed statistics as worthy, the less will be their worry about the teachers and their self-concept.

Table 6

Inter-correlations of performance measures and sub-scales of STAR

	1	2	3	4	5	6	7	8	9
1. Pre-final									
2. Final	.646**								
3. Total	.927**	.886**							
4. Math Quiz	.389**	.327**	.398**						
5. Test	-.044	.080	.014	-.235**					
6. Interpretation	.053	.101	.082	-.096	.508**				
7. Teacher of statistics	.028	-.041	-.003	.040	-.079	-.013			
8. Self-concept	.259**	.131	.222**	.343**	-.222**	-.022	.403**		
9. Asking for help	-.048	-.005	-.032	-.129	.371**	.331**	-.138	-.022	
10. Worth of statistics	-.090	-.013	-.061	-.214*	.130	-.002	-.690**	-.675**	.126

*p< .05. ** p<.01.

Scatter plots depicting the relationship between the sub-scales of anxiety and final grade did not indicate non-linear relationships as argued by Keeley et al. (2008). Thus, a linear regression analysis was done to investigate the sub-scales as predictors of performance in the statistics course. The pre-final marks and final examination marks are highly correlated with the total mark. Therefore, the regression analysis focuses on total mark as the dependent variable. The predictors entered into the regression equation are the math quiz score and the scores of STAR's subscales.

The regression model is found to be significant in predicting the total marks, R^2=.197, F (7, 124) = 4.334, p<.001. The model explains 19.7% of the variance in the total marks which can be considered a high effect size. The math quiz score emerged as the only significant predictor as presented in Table 7. None of the subscales of STAR had significant beta values.

Table 7

Standardised coefficients for the predictors in the regression model

Predictors	*B*	*SE B*	*β*	*t*	*p*
Constant	25.515	17.336		1.472	.144
Test	.162	.225	.071	.717	.475
Interpretation	.180	.208	.081	.866	.388
Teacher of statistics	-.066	.398	-.019	-.165	.869
Self-concept	.418	.231	.210	1.810	.073
Asking for help	-.186	.272	-.062	-.685	.494
Worth of statistics	.138	.148	.130	.933	.353
Math quiz	1.728	.402	.381	4.304	.000

Discussion and Implications

The study found that the students in the three sections had comparable level of statistics anxiety. Therefore, the sample can be regarded as homogenous in terms of their level of statistics anxiety. In addition, it was observed that there are more repeaters in Section 1 (n = 10, 20.4% of the class) compared to Section 2 (n = 6, 11.8%) and Section 3 (n = 1, 2.6%). However, *ANOVA* results reveal that there were no significant differences between first time takers and repeaters on all measures of performance and math quiz. Thus, the students can be considered as similar in terms of their performance regardless of the number of time that they are taking the course. Regression analysis did not yield significant predictors from the subscales of STAR. Thus, the hypothesis was partially accepted. Only the math quiz was found to be a significant predictor. The rest of this section will discuss the results and their implications for research or teaching.

The students taking the statistics course seemed to have a high level of statistics anxiety. The scores on five subscales were more than 50%. The students were least anxious about the worth of statistics. This could be due to the perceived importance of statistics which is a required course for them. Anxiety aroused by the teacher was found to be the highest from among the subscales. The course instructor needs to ensure that students will feel comfortable with him or her. For example, the instructors may focus on verbal and nonverbal immediacy behaviours to reduce the students' anxiety (Williams, 2010) and enhance learning performance (Witt, Wheeless, & Allen, 2004).

Internal reliability values were found to be comparable with the values for the original scale. However, two subscales have values near .70, which are considered the cut-off point for good internal consistency. Moreover, the Interpretation scale has alpha Cronbach value of .73, which is below the lowest published value for the scale (refer to Table 1). Further review of the items indicates that some of the items may be unclear. Therefore, the items need to go through further adaptation so that the scale is more suitable to the local sample. The measurement reliability could explain the lack of relationship found between statistical anxiety and performance.

Additionally, it is also desirable to translate the scale into the local language so that it can be used among students whose English proficiency is lower. The importance of the medium of instruction (mother tongue vs. foreign language) was shown to affect cognitive development of schemas in learning mathematics (Jäppinen, 2005). This expansion of the use

of the scale will allow comparison to be made on the effect of medium of instruction to the performance and anxiety level.

Scores on the math quiz is a significant predictor for total marks for the course. Therefore, the math quiz can be used to identify students who would require extra assistance. Interventions should be done early in the semester because it was found that the quiz score correlated positively with continuous assessment marks. The feedback on mathematical skills would be beneficial to improve students' perception of their mathematics ability which, in turn, affect their motivation, interest, and efforts for statistics course (Galagedera, Woodward, & Degamboda, 2000).

Statistics anxiety should be measured at multiple points throughout the course. This would allow the instructor to gauge the effect of the interventions, such as the mathematics review, on the level of anxiety of the students. Current findings did not reveal significant correlation between STARS and course performance. To provide an empirical evidence of the effectiveness of any intervention, the immediate and delayed effects need to be considered. Thus, anxiety should be measured in the beginning, during, and at the end of the course.

In general, this study yielded encouraging results for the psychometric properties of STAR. It could be developed further to be used in class-room research. Secondly, the study also provided evidence for designing better teaching and learning experience. With empirical evidence such as the ones presented here, the course instructors can take necessary and justifiable actions for continual improvements for the course.

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