Statistics Anxiety, Basic Mathematics Skills and Academic Performance among Undergraduate Psychology Students

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Abstract

Statistics anxiety is a perennial problem among social science students who are faced with statistics as a programme requirement. At one Department of Psychology in Malaysia, the failure rates for a statistics course, across six semesters spanning 2010 to 2013, were the highest compared to other undergraduate courses. Thus, this study attempts to investigate the relationship between statistics anxiety, basic mathematics skills and academic performance among undergraduate psychology students. A survey that included an adapted Statistics Anxiety Scale (SAS) and basic mathematic skills were distributed to the students at the beginning of the semester. Academic performance was measured through mid-semester examination and three quizzes. Scores from 80 students was analysed by linear regression analysis. The adapted SAS had adequate reliability, Cronbach alpha = .946. It was found that both mathematics skills scores and statistics anxiety scores are significant predictors of the overall academic performance. The resulting regression equation was significant, $F(2,77)=14.255$, $p<.001$, $R^2=.270$. The results of the study confirmed that academic performance was negatively correlated with statistics anxiety and positively correlated with basic mathematics scores. The SAS can be used for assessing students' anxiety as part of class intervention, but its factor structure needs further investigation.

Keywords: statistics anxiety, basic mathematics skills, psychology students

Introductory statistics courses are required courses in many undergraduate psychology degree programs. However, not all students who registered for the course did it with high optimism and positive attitude. It is not uncommon for students to show evidence of anxiety when faced with statistics course. According to Cruise, Cash, and Bolton (1985), statistics anxiety can be defined as a specific anxiety when taking statistics courses which involve gathering, processing and interpreting the data. This paper presents a study that examines the relationship between basic mathematics skills, statistics anxiety and academic performance among undergraduate psychology students at a public university in Malaysia.

Statistics anxiety

Statistics anxiety may be manifested in the form of thoughts as well as physical arousals. Students found that statistics course is one of the most anxiety-inducing course, a barrier to completion of degree, and a course to be avoided early in the study (Macher, Paechter, Papousek, & Ruggeri, 2011). It can have deleterious effect on students' academic performance. Previous researches showed a significant relationship between statistics anxiety and academic performance. For example, Ali and Iqbal (2012) studied statistics anxiety among psychology post-graduate students by measuring their anxiety and their marks in statistics examination. They found that there is a moderate negative relationship between statistics anxiety and statistics examination's marks. It showed that students who have high statistics anxiety are predicted to have low score in their examination. The relationship could be explained by the effect of anxiety on procrastination and the amount of time and efforts spent on learning (Macher et al., 2011). Rodarte-Luna & Sherry (2008) found that both male and female students showed positive relationship between procrastination and statistics anxiety. However, female students were more able to use multiple learning strategies to deal with statistics anxiety.

Apart from that, Williams (2010) studied statistics anxiety and instructor immediacy among graduate students. The method used by Williams (2010) is slightly different from Ali and Iqbal (2012) in which, pre-test and post-test design was used to investigate the relationship between instructor immediacy and statistics anxiety among 76 graduate students. The measure of statistics anxiety used was Statistics

Anxiety Rating Scale (STARS) which has six factors. It was found that the instructor immediacy is significantly correlated to all factors of the STARS namely worth of statistics, computational self-concept, and fear of exam, teacher of statistics, asking help, and interpretation.

Furthermore, Onwuegbuzie (2004) also studied on academic procrastination and statistics anxiety and found that 80% of graduate students experienced high level of statistics anxiety. Onwuegbuzie (2004) used the same measurements like Rodarte-Luna & Sherry (2008). The result showed that academic procrastinations from fear of failure and fear of task were significantly related to the six dimensions of STARS.

Basic Mathematics Skills

Basic mathematics skills are very important in a statistics course. Previous researchers showed a positive relationship between basic mathematics skills and academic performance (Johnson & Kuennen, 2006; Lunsford & Poplin, 2011). Johnson and Kuennen (2006) identified the types of mathematics skills most associated with students' success in Introductory Business Statistics course by developing 15 questions of basic mathematics skills. They found that the scores of mathematics skills are positively correlated with academic performance in Introductory Business Statistics course. It means the higher the scores of basic mathematics skills the higher are the scores in Introductory Business Statistics course.

In addition, Lunsford and Poplin (2011) studied basic mathematics skills and success in Introductory Statistics. The students were given a basic mathematics skill test developed by Johnson and Kuennen (2006) and they also had an examination for Introductory Statistics. The result shows that the marks in Introductory Statistics were positively correlated to basic mathematics skills. It means that the students who got higher marks in basic mathematics skills test tend to get higher marks in their Introductory Statistics examination. Thus, Lunsford and Poplin (2011) stated that basic mathematics skills test was a significant predictor of performance in a statistics course. Self-reported mathematics achievements (prior to taking statistics course) were also found to be positively correlated with final grades of statistics course (Emmioğlu, 2011; Dupuis *et al.*, 2012; Feinberg, & Halperin, 1978).

Objectives of Study and Hypotheses

The purpose of this present study is to examine the relationship between statistics anxiety, basic mathematics skills and academic performance among undergraduate psychology students. There are concerns about the students' performance in a statistics course (Abd Hamid & Sulaiman, 2014). Their study, using STAR as the measure of anxiety, did not find evidence for the relationship between statistics anxiety and performance. The reliability of the scales in STAR was not fully satisfactory. Thus, this study attempted to measure anxiety using a different scale namely Statistics Anxiety Scale (SAS).

The findings from the study are expected to help the course instructor to re-design teaching strategies by identifying the important factors that are related to performance in the course. Based on the reviewed literature, the following hypotheses were tested:
Basic mathematics skills are positively correlated with academic performance.
SAS scores are negatively correlated with academic performance

METHOD

Participants

The participants were 18 males (22.5%) and 62 females (77.5%) recruited from students enrolled in a statistics course. The participation was 84.2 % out of 95 students enrolled in the course. The course was one of the core courses for a psychology degree programme. Additionally, it is also a required course for students minoring in psychology, of which there were 15 students (18.8%). There were two sections of the course taught by the same instructor. Both sections 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). The medium of instruction used was English.

Instruments

The questionnaire comprised of three parts. The first part had eight demographic background items. The second part was the Statistics Anxiety Scale (SAS) and the third part is the basic mathematics skills.

Statistics Anxiety Scale (SAS). The instrument is a measure of statistic anxiety namely Statistical Anxiety scale (SAS) that is developed and validated by Vigil-Colet, Lorenzo-Seva, and Condon (2008). Some of the items were adapted from the Statistics Anxiety Rating Scale (STARS) by Cruise, Cash, and Bolton (1985). The SAS was revised by the researcher and used for this study as it is more suitable for the intended sample. For example, the IIUM students are more familiar with the term 'lecturer' (revised version) rather than 'teacher' (original version) when referring to the course instructors. The SAS had 24 items and it has three sub-scales which are Examination anxiety, Asking for help anxiety, and Interpretation anxiety. Each sub-scale have eight items. The items were measured on a 5-point Likert scale. All of the 24 items, the anchors are 1 to 5 where 1 indicates 'no anxiety' and 5 indicates 'strong anxiety'. Thus, the higher the score for these items, the higher the level of anxiety.

Mathematics Quiz. A quiz with 15 questions measuring basic mathematics 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; Abd Hamid & Sulaiman, 2014).The quiz encompassed of items measuring skills on systems of equation, ratios and geometrics. A higher score means a higher level of mathematics skills.

Procedure

A set of questionnaire consisted of three parts were distributed among the participants during 30 minutes before the class end at the second week of the semester. Participants were not allowed to use any calculator. In the classroom, participants participated voluntarily in this research and need to respond to all of the three parts of questionnaire. The questionnaire were collected to be analysed by the researcher and before the end of the session, the participants were debriefed that their responses will no affects their grades in the course.

On top of descriptive data analysis for the demographic variables, Pearson correlations were obtained for the main variables. Hierarchical multiple regression analysis was carried out with stats performance as the dependent variable. Basic mathematics skills and the subscales of SAS were entered as predictors using the forward option in SPSS 19.

RESULTS

Table 1

Count and percentage for demographic variables

Demographic variables	*N*	*%*
Gender		
Male	18	22.5
Female	62	77.5
Section		
1	44	55
2	36	45
First attempt		
Yes	75	93.8
No	4	5
First language		
Malay	66	82.5
English	9	11.3
Others	5	6.3
Program		
Major	64	80
Minor	15	18.8

As can be seen in Table 1, the participants are predominantly Malay speaking, females, and psychology major. The number of students in both sections were equal (n=48) early in the semester. However, there were students (n=3) who were listed in the class list even though they did not turn up at all due to health problem, immigration problem, and change of university. There were also students who started the semester after the administration of the survey. Additionally, three students withdrew from the course and two changed their section. Thus, the final number of students in each section was not equal.

The students had an average statistics score of 53.45 (out of 100). This is just 3.45 points above the passing mark (50). This is considered low performance for the statistics course. The scores range from 18.75 to 95. The big spread of the scores is also reflected in the standard deviation value. The SD value has a very significant implication for the letter grade. A score of 53.45 (the mean value) is graded C, and one standard deviation above the mean would deserve a B+ grade (after rounding of decimals) which is four letter grade above C.

Table 2

Mean, SD and alpha Cronbach for the main variables

	N	*M*	*SD*	*α*
Statistics Performance	75	53.45	16.05	
Basic math skill	80	9.23	2.349	
SAS Total	80	3.2875	.97037	.946
Asking	80	2.8063	.90749	.939
Interpretation	80	2.7953	.82082	.873
Exam	80	3.7641	.78856	.866

The adapted SAS had adequate reliability for the full scale and the subscales as presented in Table 2. The level of anxiety, as indicated by the total SAS score is above 50%. This means the students are experiencing noticeable level of statistics anxiety. However, only the fear of examination appears as an anxiety-inducing component of SAS.

Table 3

Correlation matrix for statistics performance, basic mathematics skills, and statistics

	1	2	3	4	5
Basic mathematics skills					
Total SAS	-.280*				
SAS Interpretation	-.270*	.887**			
SAS Exam	-.267*	.854**	.641**		
SAS Asking	-.206	.897**	.704**	.637**	
Statistics Performance	.350**	-.332**	-.336**	-.252*	-.285*

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

The correlation among the main variables in this study is presented in table 3. Mathematics skills scores are positively related to performance in the statistics course.

The total SAS score and the SAS subscales score are negatively correlated with statistics performance. The total SAS scores are highly correlated with its subscale. The subscales are also strongly correlated with each other. The subscales, and the total scales, were negatively correlated with math skill, except for fear of asking for help.

The regression analysis yielded a two step solution as presented in Table 4. The final model derived from step 2 of the hierarchical multiple regression analysis is significant, R^2 = .270, $F(2,77)=14.244$, $p<.001$, and with a constant value = 49.84.

Table 4

Hierarchical multiple regression analysis relating statistical performance with math skill and statistics anxiety

Step and predictor variable	β	ΔR^2
1	.455**	.207**
math skill		
2		.063*
math skill	.384**	
SAS Interpretation	-.261*	

Note: *p<0.05, **p<0.001

DISCUSSIONS

Both hypotheses tested in this study were accepted: statistics anxiety and mathematics skills are related to academic performance in the expected direction. For describing the relationship among the variables, the correlation values show a clear and consistent picture. Students performed better when they have higher basic mathematics skills and lower statistics anxiety. Additionally, it was also found that basic mathematics skills are related to statistics anxiety, except for the sub scale asking for help. In short, it seems that math skills are important to be developed before taking the course.

The practical implications of the findings are discussed primarily in relation to study by Abd Hamid and Sulaiman (2014). They reported a study with similar samples and the same statistics course. In their study, none of the components of anxiety (as measured by STARS) emerged as a predictor of performance. However, in the present

study, fear of interpretation is identified as a predictor of academic performance. The interpretation aspect of statistics emerged as a predictor despite having a lower correlation value than fear of examination. This could perhaps be due to fear of interpretation being a more domain-specific anxiety than fear of examination. In other words, fear of interpretation is more likely to exert a specific influence on academic performance than the fear of examination.

Moreover, the majority of the students' first language is not English. Hence, the students are learning statistics in a second language. The language of instruction is important because language is "used to express, characterize, and apply .. [mathematical] .. concepts" (Cuevas, 1984, p 138). Thus, it would not be surprising that students who have difficulty with the English language would experience anxiety in interpreting statistical results which invariably involves explaining the numbers using clear sentences. Additionally, language competency is linked to higher mathematics achievement (Howie, 2003; Beal, Adams, & Cohen, 2009). For example, strategies to improve comprehension of mathematics problems had been linked to facilitative effect on the development of mathematics skills (Orosco, 2013). It is reasonable to postulate the same relationship exists between language competency and performance in a statistics course. Future studies should examine the effect of using second language instruction on academic performance. This is an advantage for using SAS for future studies with similar samples.

The present study also strengthens the earlier conclusion made by Abd Hamid and Sulaiman (2014) regarding the importance of basic mathematical skills in relation to performance in a statistics course. The mathematics skills explain more variability in the academic performance than components of statistics anxiety. This should be the emphasis in the future design of the teaching and learning activities for the course. For example, the mathematics quiz could be used as a diagnostic tool to identify students who are at risk for poor performance in a statistics course.

With regards to the measure of statistics anxiety, SAS showed a better reliability compared to STAR reported in Abd Hamid and Sulaiman (2014). The alpha Cronbach for the sub-scales of SAS are higher than the comparable subscales in STAR (interpretation = .75, asking for help = .84, examination = .81). This lends further credit for SAS to be used for future studies. It warrants further investigation into the psychometric properties of SAS such as confirming its factor structure.

In conclusion, this study achieved the objectives of describing the relationship among mathematic skill, statistics anxiety and performance in a statistics course. It also helped to identify basic mathematics skill and fear of interpretation as the predictors of statistics performance. These findings could be used by future instructors of the course to help students achieve better understanding and competence of statistics. Considering the level of performance achieved by the students in this study, there are much rooms for improvement to be made.

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