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Factor structure of Statistical Anxiety Scale (SAS) for a Malaysian Sample

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Abstract

A negative relationship between statistics anxiety and performance in statistics course had been demonstrated among Malaysian students, but the factor structure of the anxiety measure had not been examined. This paper seeks to examine the factor structure of Statistical Anxiety Scale (SAS) in Malaysian samples. The scale was administered to 342 undergraduate students who took Introduction to Psychology course at a Malaysia university. Principal axis factor with Promax rotation revealed five factor solution and confirmatory factor analysis was performed in AMOS. The analysis produced a four factor model and an independent variable that fit the data. This divergence from the original three factor structure is worth exploring.

Keywords: statistics anxiety; psychology students; factor structure; SEM

1. Introduction

Social sciences students may have the misperception that undergraduate degree programs do not require the study of statistics. It is not surprising then that statistics course is a significant source of anxiety for psychology undergraduate students. Moreover, the interest into the factors affecting undergraduate students' performance in statistics courses is not new.

Numerous researches had been conducted to investigate the correlates of academic performance. Statistics anxiety is one variable that had attracted considerable interest. It was proposed as a multidimensional construct (Baloglu & Zelhart, 2003) and not surprisingly, the existing scales to measures of statistics anxiety has more than one factors. Statistics Anxiety Rating Scale is the most frequently used scale in quantitative studies (Chew & Dillon, 2014a) and had been used for Malaysian sample (Abd Hamid & Sulaiman, 2014a). However, another scale, Statistics Anxiety Scale (SAS), was preferred for further development and investigation into its psychometric properties (Abd Hamid & Sulaiman, 2014b). This paper reports a continuation of the efforts to examine the usefulness of the SAS in Malaysian sample by focusing on its factor structure.

A detailed description of SAS and studies that used it are mentioned in Abd Hamid and Sulaiman (2014b). Briefly, SAS consisted 24 items representing three factors namely fear of interpretation, fear of asking for help and fear of examination. The three factor solution for SAS was replicated for the Italian version of SAS (Chiesi, Primi, & Carmona, 2011). The same factor structure is also replicated in Singaporean and Australian sample (Chew & Dillon, 2014b) by using exploratory factor analysis. The authors did not find any study that reported the factor structure of SAS using Malaysian sample.

Therefore, the objective of this paper is to examine the factor structure of SAS. Specifically, the study that was conducted aimed to identify the number of factors for a Malaysian sample. The findings from this study are expected to provide further evidence of the universality of SAS.

2. Method

2.1. Participants

Students enrolled in an introduction to psychology course in 2014, were recruited to participate in the study. Table 1 below shows the distribution of the students according to demographic characteristics. There were 88 male and 255 (age between 18 and 28) female undergraduate students who returned the questionnaire. The students who involved in this study were informed that their responses to the questionnaires would not affect their grade.

Table 1. Demographic background of the participants.

Demographic variables	**Mean (SD)**	**N**	**%**
Age	20.92 (1.493)		
Sex			
Male		88	25.6
Female		255	74.1
Language			
Bahasa Malaysia		292	85.9
English		32	9.4
Others (e.g. Arabic, Persian)		16	4.7
PSYC 1000			
Major		43	12.6
Minor		14	4.1
Elective		284	83.3
Section			
1		52	14.8
2		55	15.7
3		34	9.7
4		45	12.8
5		56	16.0
6		52	14.8
7		57	16.2

2.2. Materials

A set of questionnaire which consisted participants' background information and Statistics Anxiety Scale (SAS) developed by Vigil-Colet, Lorenzo-Seva, and Condon (2008) was used in the study. The version of SAS used in the study is the same one as reported in Abd Hamid and Sulaiman (2014b). Items were revised and adapted from the original source to suit the local participants. For example, the word 'teacher' was changed to 'lecturer'.

2.3. Procedure and data analysis

At the beginning of a semester, SAS was distributed to students in seven sections of Introduction to Psychology. The surveys were conducted during the class session. It took about 10 minutes for students to complete the survey with the basic of the demographic background. The data were analyzed by using SPSS (internal reliability, exploratory factor

analysis) and AMOS (confirmatory factor analysis). Participants with missing value for any of the 24 items were removed from the analysis.

3. Results

3.1. Internal reliability of SAS

The results showed that the revised SAS have sufficient internal consistency, with Cronbach alpha (α) value of 0.884. The three factors' internal consistencyare also acceptable: Examination (α=0.82), Interpretation (α=0.78), and Asking for help (α=0.883). With the adequate internal consistency, the SAS will able to be used in order to examine the factor structure of SAS.

3.2. Exploratory factor analysis

The EFA was done on 322 participants after removal of participants with incomplete responses. The extraction method used was Principle Axis Factor using Promax rotation. A preliminary extraction with a forced one factor solution resulted in 27.17% of variance explained, indicating the lack of Common Method Bias. In the first iteration, the data is shown to be suitable for EFA (adequate sample size – KMO = .887, test of Sphericity – p <. 0001).

However, the iteration yielded a six factor solutions that explain 51.77% of the variance. Examination of the pattern matrix in Table 2 showed a good clustering of items except for I8, I2 and I19 that were grouped with items from a different sub-scale. The Examination and Asking factors seem to be divided further into two factors each. Further discussion about the factors are mentioned in the 'Discussions and Conclusion' section.

For the second iteration, nine items with communalities value less than 0.5 were removed (refer to Table 2for the communalities values) with the aim to increase the percentage of variance value. The resulting analysis yielded a three factor solution with 49.99% of the variance explained. Further iterations were not performed due to the decrease in the percentage of variance explained, and the presence of communalities values of less than 0.5 in the second iteration. Considering a relatively good fit of items to the existing factors and Beavers et al's (2013) guide that 50% variance explained is acceptable, the confirmatory factor analysis was performed using all 24 items.

Table 2. Factor loading in Statistical Anxiety Scale (SAS).

	Factor						
Items	**1**	**2**	**3**	**4**	**5**	**6**	**Communality**
A7	.813						**.658**
A12	.787						**.605**
A3	.764						**.607**
A21	.750						**.673**
A17	.716						**.610**
A23	.643						**.569**
I19	.409						.428
EX1		.830					**.542**
EX11		.606					.482
EX9		.589					**.565**
I2		.512					.331
I8		.475					.457

EX14				.319
I16				.346
EX13	.780			**.605**
EX15	.750			**.596**
EX20	.747			**.586**
EX4	.465			.384
I6		.864	.695	**.614**
I18		.687		.400
I22		.553		**.509**
I10		.497		.283
A24			.728	**.715**
A5			.648	**.542**

3.3. Confirmatory factor analysis

A model with three original factors was tested in AMOS. Model 1 forced all 24 items to one factor. This initial model does not have acceptable indices as can be seen in Table 3. Improvement to the RMSEA and Normed Chi-Square to an acceptable level was observed in the Model 2 in which by the 24 items were grouped into three factors. Examination of the modification indices from the second model led to Model 3. Co-variances were introduced between pairs of error terms (EX5-EX8, EX7-EX8, and EX5-EX7). This model showed further improvement to the RMSEA but not to the CFI. The removal of data from 51 participants based on Mahalanobis distance values (P1<0.5) were done to produce Model 4, but the CFI, but it did not get bigger than 0.9.

The next analysis was performed using the five factors indicated by the EFA. Two items (EX14 and I16) were not included due to the low loading coefficients to any factor. Item I6 which loaded onto two factors was treated as an item for factor 4 (Interpretation). Model 5 forced all 22 items to one factor. Modifications suggested from Model 5 include the removal of item I8 was together with participants whose Mahalanobis distance value is smaller than 0.5. These modifications led to Model 6 with an acceptable CFI value (.905).

Thus, a structural model (Model 7) was tested, but the CFI value dropped to .862. The regression weight for the link between Anxiety and Preparation was found to be -.07, which is counterintuitive. Thus, Preparation was redirected to Examination to produce Model 8. Because of unsatisfactory CFI value, modifications indices for regression weights pointed to the need to remove item I2. Thus, item I2 was deleted. Model 9 that resulted from the removal of item 12 modifications has acceptable fit indices and was accepted as the preferred model.

Table 3. Goodness-of-fit statistics and their Comparisons for nine alternative measurement models SAS.

Model	X^2	df	p	Normed X^2	CFI	RMSEA
1	1442.676	252	<.001	5.725	.609	.121
2	922.498	249	<.001	3.705	.779	.092
3	717.920	246	<.001	2.918	.845	.077
4	654.128	246	<.001	2.569	.864	.078
5	563.480	199	<.001	2.832	.871	.076
6	430.062	179	<.001	2.403	.905	.071
7	548.691	184	<.001	2.982	.862	.085
8	455.280	184	<.001	2.474	.898	.073
9	376.723	165	<.001	2.283	.916	.068

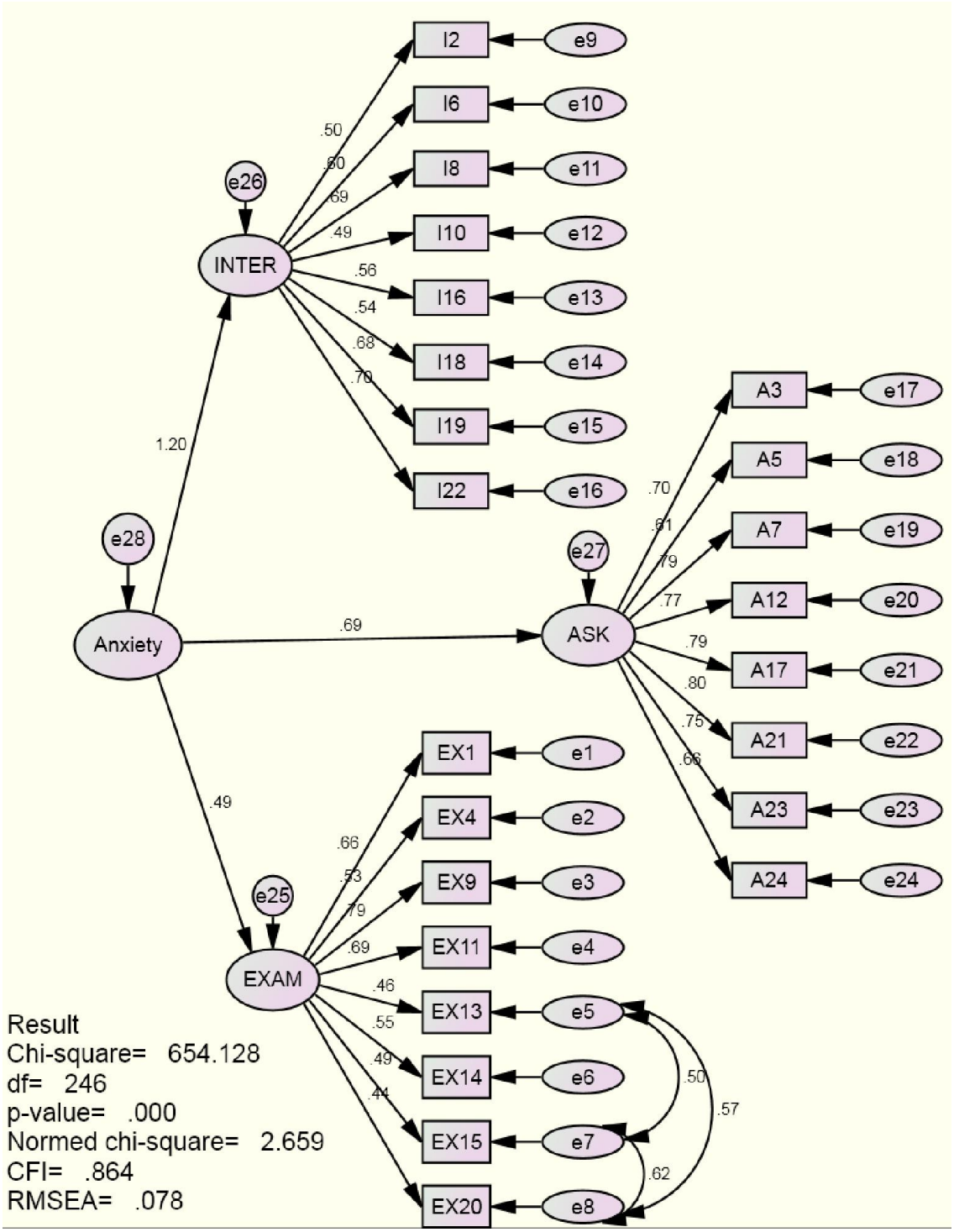

Figure 1. SAS' structural model (Model 4)

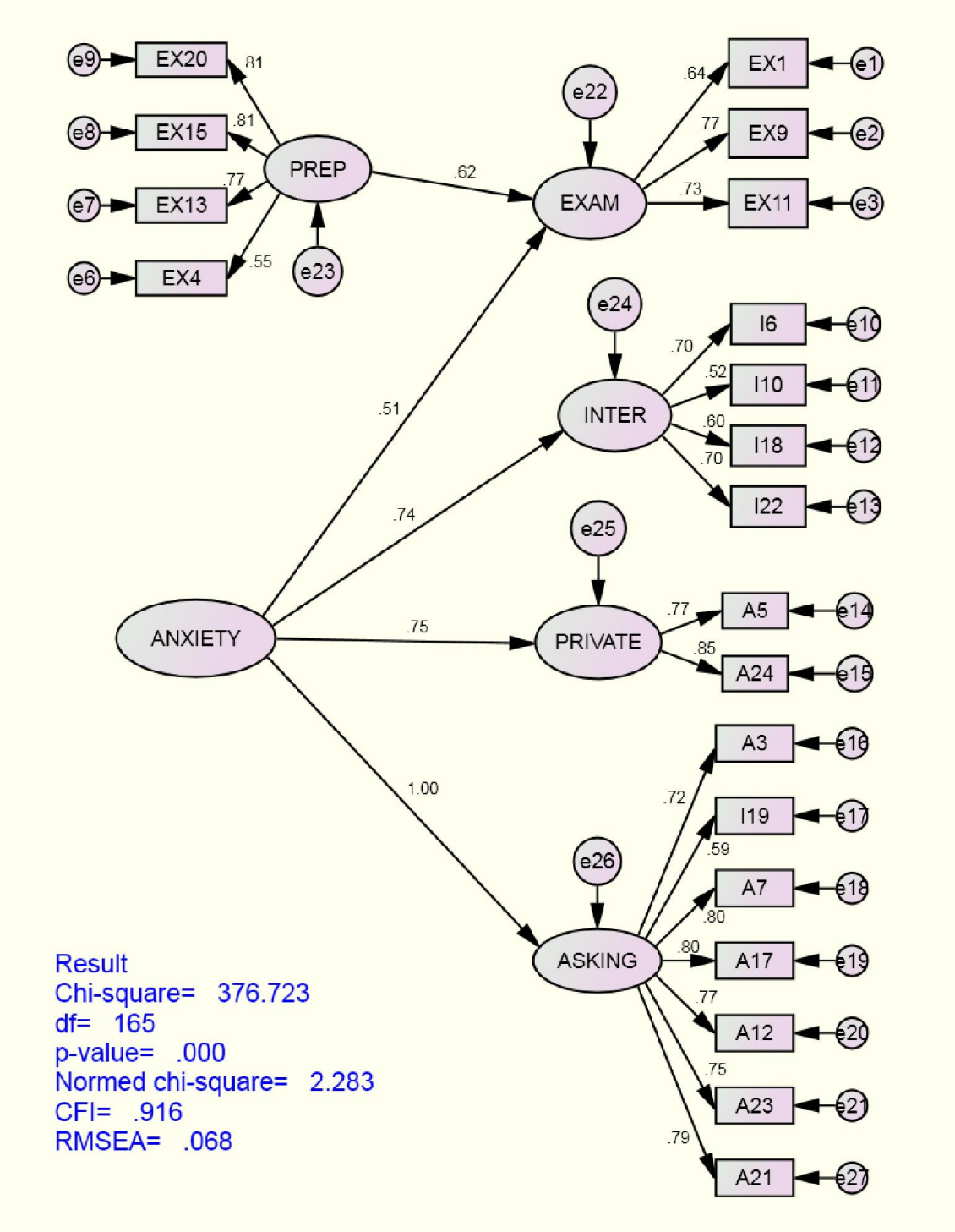

Figure 2 SAS' structural model (Model 9)

Cronbach alpha values, as stated in Table 4, of the five factors show adequate internal reliability of the five factors. The inter-factor correlations are in the expected directions. Additionally, the analysis highlights the lack of relationship between Preparation and other factors except for Examination. This follows the structure in Model 9 where Preparation is a separate factor that correlate only to Examination.

Table 4. Factor correlation and reliability from Model 9 of SAS

	1	2	3	4	α	*Mean*	*SD*
1. Asking					.896	3.39	.77
2. Examination	.399**				.746	3.66	.77
3. Preparation	-.081	.490**			.824	3.69	.87
4. Interpretation	.584**	.378**	.075		.718	3.18	.71
5. Private help	.634**	.183**	-.100	.444**	.786	3.21	1.00

*p*** < .001

5. Discussion

This study focused on the factor structure of SAS among Malaysian samples. The data was suitable for CFA based on the EFA. The CFA produced a less than satisfactory model when the original three factor solution was used. Based on the EFA, a five factor solution was tested in AMOS. The analysis resulted in a four-factor model. In general, the model replicates the factor structure found through the EFA. However, based on the CFA, some items for Examination (factor 3 labeled as Preparation) should be treated as an independent variable. It was found to be an independent variable predicting fear of examination. Further discussion about these factors follows.

There are 6 factors that merged from the EFA in which in the development of the students, found three factors of SAS. Asking for help was divided into two. It seems that the participants perceived Asking for help differently when it involve teachers and private teachers. Factor 5 in Table 1 comprises item A5 and A24 that refers to asking for help from a private teacher. This differentiation may be due to 'private teacher' having the connotation of financial implications, which could compound the anxiety. Thus, Factor 5 could be fear of 'Asking Help from Private Teachers'.

Factor 2 and 3 comprise mainly of Examination items. However, they differ in that Factor 2 reflects anxiety about the examination itself. Whereas, Factor 3 tapped into the lack of preparation before taking an examination. Again, there might be a compounding effect observed here that resulted in the separation of the Examination items into two separate factors. Factor 3 can then be called as fear of 'Exam Preparation'. Additionally, two Interpretation items are also loading onto Factor 2. It is not clear how these items ('interpreting the meaning of a table in a journal article' and 'trying to understand a mathematical demonstration') could be grouped into the Examination factor.

Four out of eight Interpretation items make up Factor 4. These items refer to the interpretation of statistics in outside of the context of the course such as lottery (item 18) and advertisement (item 10). It could be said that these four items are about the applications of statistics rather than interpretation of statistical calculation per se. The tendency for separating class room statistics and real world statistics is also reflected in the cross loading of item 6 into two factors. While it fits into the application of statistic (for reading a journal article), it is also observe to stand on its own as a factor. Therefore, the Interpretation factor could be revised into fear of Statistics Applications.

Participants may have difficulty to understand the relevance of item 14 ('waking up in the morning on the day of a statistics test) and 16 (copying a mathematical demonstration from a whiteboard while the lecturer is explaining it'). These items do not load to any factor. Upon further analysis, item 14 could have fit into Factor 2 (Examination) as its coefficient is

highest for that factor. What is less clear is the loading for item 16 as its coefficient is also highest for Factor 2.

In summary, the factor structure of SAS as tested with a Malaysian sample show a different form compared to the original structure. Interestingly, the study found that two of the existing factors can be further expanded into separate factors. Moreover, one of the factor could be treated as an exogenous variable contributing towards statistics anxiety. This study point to the possible cultural differences that should be considered when examining statistics anxiety. Further refinement of the measure should explore more fully the dimensions of statistics anxiety among Malaysians.

Appendix A. SAS items used in the study

NO	ITEMS
1	Studying for an examination in a statistics course.
2	Interpreting the meaning of a table in a journal article.
3	Going to ask my statistics lecturer for individual help with material I am having difficulty understanding.
4	Realizing the day before an exam that I cannot do some problems that I thought were going to be easy.
5	Asking a private tutor to explain a topic that I have not understood at all.
6	Reading a journal article that includes some statistical analyses.
7	Asking my statistics lecturer how to use a probability table.
8	Trying to understand a mathematical demonstration.
9	Doing the final examination in a statistics course.
10	Reading an advertisement for a car which includes figures on fuel mileage, insurance, etc
11	Walking into the classroom to take a statistics test.
12	Asking my statistics lecturer about how to do an exercise.
13	Getting to the day before an exam without having had time to revise the syllabus.
14	Waking up in the morning on the day of a statistics test.
15	Realizing, just before you go into the exam that I have not prepared a particular exercise.
16	Copying a mathematical demonstration from the whiteboard while the lecturer is explaining it.
17	Asking one of your lecturers for help in understanding the results of statistical calculation.
18	Trying to understand the odds in a lottery.
19	Seeing a classmate carefully studying the results table of a problem he has solved.
20	Going to a statistics exam without having had enough time to revise.
21	Asking my statistics lecturer for help when trying to interpret a results table.
22	Trying to understand the statistical analyses described in the abstract of a journal article.
23	Going to my statistics lecturer's office to ask questions.
24	Asking a private tutor to tell me how to do an exercise.

References

Abd Hamid, H.S., & Sulaiman, K. (2014b). Statistics anxiety, basic mathematics skills and academic performance among undergraduate psychology students. *Proceedings of The Asian Conference on Psychology & the Behavioral Sciences,* 28-30 March 2014, Osaka, Japan, 452-463.

Abd Hamid, H.S., & Sulaiman, M. K. (2014a). Statistics anxiety and achievement in a statistics course among psychology students. *International Journal of Behavioral Science*, *9*(1), 55-66.

Baloglu, M., & Zelhart, P.F. (2003). Statistical anxiety: A detailed review of the literature. *Psychology and Education*, *40*(2), 1-15.

Beavers, A. S., Lounsbury, J. W., Richards, J. K., Huck, S. W., Skolits, G. J., & Esquivel, S. L. (2013). Practical considerations for using exploratory factor analysis in educational research. *Practical Assessment, Research & Evaluation*, 18(6). Available online: http://pareonline.net/getvn.asp?v=18&n=6.

Chew, P. K. H., & Dillon, D. B. (2014a). Statistics Anxiety Update: Refining the Construct and Recommendations for a New Research Agenda. *Perspectives on Psychological Science*, *9*(2), 196-208.

Chew, P. K. H., & Dillon, D. B. (2014b). Psychometric properties of the statistical anxiety scale among students in Singapore and Australia. In T.J. Jordan & D. Chhabra (Eds.) *3rd Annual International Conference on Cognitive and Behavioral Psychology* (CBP 2014), 24 February 2014.

Chiesi, F., Primi, C., & Carmona, J. (2011). Measuring Statistics Anxiety: Cross-Country Validity of the Statistical Anxiety Scale (SAS). *Journal of Psychoeducational Assessment,* 29(6), 559-569.

Vigil-Colet, A., Lorenzo-Seva, U., & Condon, L. (2008). Development and validation of the Statistical Anxiety Scale. *Psicothema*, *20*(1), 174-180.