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Contributing Factors to Statistics Achievement: A Study of Psychology Students

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Contributing Factors to Statistics Achievement: A Study of Psychology Students

Abstract. Psychology students perceive Statistics as a difficult subject even though the statistical analysis is taught using statistical software. The present study investigated multiple factors that contributed to students' achievement in a statistics course. Eighty-one psychology students participated in the study (male = 13, female = 68; age mean = 19.01, SD= .51). We used three validated survey instruments that measured mathematical thinking skills, a statistical anxiety scale (anxiety, fearful behavior, attitude, expectation, the history and self-concept, and performance), as well as a computer anxiety rating scale (fear and anticipation). Students' achievement was measured by students' test scores on a statistics course. Using multiple regression analysis, the results show that mathematical thinking skills have a significantly positive contribution to students' achievement in a statistics course. Our findings are the first step toward interventions that enhance the instructional methods of statistics courses.

Keywords: Statistics achievement, mathematical thinking skills, psychology students

1. Introduction

Statistics is one of the essential subjects for Psychology students since they have to conduct quantitative research as final requirements to graduate. However, Statistics is still considered a difficult subject even though it is taught by software for statistical data analysis. The negative attitude of students toward Statistics makes it difficult for students to understand and apply well.

The difficulties in the statistics learning process are not only due to cognitive factors such as students' intellectual capabilities. Cognitive factors are student learning abilities relating to how to receive and process information in the learning process (Lee, et al., 2002). Non-cognitive factors also influence them to do well in statistics courses (Chiesi & Primi, 2009). Non-cognitive factors are matters outside the student's learning ability related to psychological and environmental factors (Lee, et al., 2002). The non-cognitive factors include students' attitudes, beliefs, and emotions that increase the level of cognitive involvement and understanding (Ashaari, Judi, Mohamed, Tengku, & Wook, 2011). According to (Vanhoof,

2010), students' attitudes, beliefs, and emotions decrease the level of students' affective involvement, the intensity of response, and response stability. (Tempelaar, Loeff, & W.H. Gijselaers, 2007) stated that the main focus of statistics educators is on non-cognitive factors such as students' attitudes and beliefs not emotion because the concept of students' emotions is difficult and unpredictable to be assessed.

The effects of anxiety tests on academic performance are more related to the worry component than to the emotional component (Ferrando, 1999). Vigil-Colet & Morales-Vives (2005) state that in recent years, research on the relationship between personality and academic performance have begun to involve anxiety variables. Several authors have investigated the predictive factors on achievement in statistics courses. It was found that statistics courses cause a high level of anxiety in the student as well as in other non-math oriented students. Meanwhile, statistics examination also triggers more anxiety compared to other examinations (Mustafa, 2003).

Based on the above-mentioned background, the present study investigated multiple factors contributing to students' achievement in a statistics course. The factors investigated included cognitive and non-cognitive factors. We examine mathematical thinking skills as a cognitive factor as well as statistical anxiety and computer anxiety as non-cognitive factors.

2. Method

Participants

The data for the present analysis were derived from eighty-one psychology students (male = 13, female = 68; age mean = 19.01, SD= .51) enrolled in an undergraduate behavioral statistics course at the Faculty of Psychology Universitas Padjadjaran Indonesia. The course was scheduled to take place over 12 weeks.

Measures

We used three English-validated survey instruments, translated to Bahasa (Indonesian Language).

Statistical Anxiety Scale measurement consisted of six subscales: anxiety (20 items), fearful behavior (20 items), attitude (20 items), expectation (20 items), the history and self-concept (20 items), and performance (20 items). A four-point Likert Scale was used in this measurement, ranging from 1 (strongly disagree) to 4 (strongly agree). Reliability of Statistical Anxiety measurement using internal consistency achieved satisfactory values, with α= 0.882 (anxiety), α= 0.825 (fearful behavior), α=0.784 (attitude), α= 0.723 (expectation), α= 0.862 (history and self-concept), and α= 0.870 (performance).

To measure computer anxiety, we used the Computer Anxiety Rating Scale (CARS) (Heinssen, Glass, & Knight, 1987). Two dimensions were measured by CARS: fear (10 items) and anticipation (9 items). A four-point Likert Scale was used in this measurement, ranging from 1 (strongly disagree) to 4 (strongly agree). The reliability of the translated version using internal consistency achieved satisfactory values, with α= 0.784 (fear) and α=0.856 (anticipation).

Mathematical Thinking Skills were measured by Rechenaufgaben (RA), a subscale of the Intelligence Structure Test (IST) (Kumolohadi & Suseno, 2012). RA consisted of 20 items of word problems. The participant responded to each item

by choosing numbers provided in accordance with the answer to the problem. The correct answer was scored 1, and the wrong answer was scored 0. RA was validated in Indonesian undergraduate students, and achieved acceptable internal consistency (α= 0.650) (Agung & Fitri, 2020).

Students' achievement was measured by students' final scores on a statistics course, ranging from 0 to 100.

Data Analysis

Statistical Package for Social Sciences (IBM SPSS Statistics version 22) was used. We calculated the mean and standard deviation of the investigated variables to describe the data. Pearson correlation coefficient was used to examine the association between variables. Correlation coefficient of .70 - .90 is considered strong; .40 - .60 is considered moderate, and .10 - .30 is considered weak (Dancey & Reidy, 2011). Then, three multiple regression analyses (MRA) were conducted to predict students' achievement based on statistical anxiety, computer anxiety, and mathematical thinking skills.

3. Result and Discussion

Table 1. Descriptive Statistics

Scales/Sub-scales	Mean	SD
Mathematical Thinking Skill	99.27	8.97
Statistical Anxiety		
Anxiety	39.75	8.68
Fearful Behavior	52.17	6.30
Attitude	42.90	5.88
Expectation	52.99	5.87
The History and Self-Concept	45.60	6.95
Performance	57.62	6.06
Computer Anxiety		
Fear	20.71	4.08
Anticipation	29.37	3.40
Student's Achievement	84.4035	8.04012

Table 2. Correlation Matrix

	1	2	3	4	5	6	7	8	9	10
Mathematical Thinking Skill	1	-.282*	-.210	-.177	-.344**	-.364**	.298**	-.224*	-.002	.352**
Anxiety		1	.487**	.315**	.316**	.575**	-.438**	.232*	-.117	-.173
Fearful Behavior			1	.640**	.569**	.648**	-.455**	.209	-.021	-.277*
Attitude				1	.294**	.685**	-.340**	.200	-.211	-.121
Expectation					1	.572**	-.299**	.248*	.169	-.255*
The History and Self-Concept						1	-.417**	.217	-.088	-.266*
Performance							1	-.200	.244*	.219*
Fear								1	-.338**	.075
Anticipation									1	-.090
Student's Achievement										1

*p < 0.05
**p < 0.01

Table 1 shows the mean and standard deviation of each variable and its dimensions. The correlation between variables and dimensions in Table 2 shows that not all variables/dimensions were significantly correlated. The significant correlation ranged from -.455 to .685.

Table 3. Multiple Regression

Outcome	Predictor	Adj R2	Unst. B	Unst. SE	Stand β	F	T	p
Student's Achievement	Mathematical Thinking Skill	0.123	.278	.106	.310	6.640	2.614	.011
	Anxiety		.048	.130	.052		.371	.712
	Fearful Behavior		-.320	.221	-.251		-1.449	.152
	Attitude		.211	.234	.154		.904	.369
	Expectation		-.023	.210	-.017		-.109	.914
	The History and Self-Concept		-.152	.226	-.131		-.670	.505
	Performance		.094	.171	.071		.550	.584
	Fear		.385	.236	.195		1.628	.108
	Anticipation		-.037	.293	-.016		-.126	.900

As can be seen in Table 3, using multiple regression analysis, the results show that only mathematical thinking skills had a significant positive contribution to students' achievement in a statistics course. The statistical anxiety and computer anxiety did not have a contribution to statistics achievement.

4. Discussion

The present study investigated multiple factors that contributed to students' achievement in a statistics course. We examined mathematical thinking skills as a cognitive factor, while statistical anxiety and computer anxiety were as non-cognitive factors. The result indicated only mathematical thinking predicted students' achievement in the statistical course. The non-cognitive factors examined in this study, i.e., statistical anxiety and computer anxiety, did not play a role in predicting achievement in statistics.

Mathematical thinking skills are the ability to think practically by counting, thinking logically and mathematically, reasoning, and thinking coherently in concluding. The ability to think mathematically through various studies has been proven to influence the mastery of material on statistics because the principles of mathematical thinking are the same as the principles in studying and solving statistical problems.

According to (Mason, Burton, & Stacey, 2010), Mathematical thinking is a significant element of education to make students become good mathematical thinkers. Students who are good at mathematical thinking will use these abilities to

make mathematics make sense. This will facilitate students when learning Statistics because the content of Statistics is mostly Mathematics.

(Chua & Chen, 1997) defined computer anxiety as "high anxious responses to interaction or anticipated interaction with electronic data processing systems. Simonson (1984) summarized behaviors of a person with computer anxiety as follows: (1) avoiding computer activities, (2) excessive caution when using computers, (3) negative remarks toward computers, and (4) attempts to short periods in using computers. Thus, to be succeeded in a statistics course, computer activities, and positive prior experience with computers would be helpful. In contrast, high levels of anxiety related to computers would be unhelpful. In this study, computer anxiety does not affect statistics achievement. The possible explanation for this result is the students are now accustomed to using computers as tools used in their daily lives; therefore, they no longer feel anxious when using computers.

Statistics anxiety describes the apprehension of individual experience in instructional, evaluation, and doing tasks related to statistics. This anxious feeling is enduring. Consequently, students report manifold problems throughout their statistics education (Macher, Paechter, Papousek, & Ruggeri, 2012). The antecedents of statistics anxiety can be classified as situational, dispositional, and environmental (Onwuegbuzie & wilson, 2003). In this study, statistics anxiety does not affect students' achievement in Statistics. This finding is in line with research from (Hamid & Sulaiman, 2014), stating that in several studies, no or only low insignificant correlations were found between statistics anxiety and academic performance.

In their synopsis of 11 reviews, (Paechter, Macher, Matskvishvili, Wimmer, & Papousek, 2017) found that the direct effect of statistics anxiety in the examination is harmful. However, its indirect effects can be positive. The negative effect of statistics anxiety in the examination is influenced by time management and procrastination during the preparation (Onwuegzie, 2004). Procrastination is also negatively related to the use of deep-level cognitive strategies and metacognitive strategies (Howell & Watson, 2007). However, when anxiety level is moderate, statistics anxiety has advantages, such as increasing student effort (Macher, Papousek, Ruggeri, & Paechter, 2015). Thus, the negative and positive effects of statistics anxiety may outweigh each other.

5. Conclusion

Mathematical thinking is an important cognitive factor contributed to the statistics achievement. It is suggesting that mathematical thinking should be the focus of the instructional approach to help the student increase achievement in statistics. The student should be given a basic mathematical knowledge and basic mathematical thinking before taking a statistics course. Given that non-cognitive factors investigated in this study do not contribute to statistics achievement, future research should explore and examine other possible non-cognitive factors as well as social factors.

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