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Research Article

Is Gender Imbalance in Brunei Tertiary Education Student Populations Caused by Inclusion of Mathematics in the Admission Criteria? Exploring the Personality Characteristics of High Mathematics Achievers

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Abstract: The study found some connections between personality and mathematics achievement. All the ten personality variables investigated in the present study correlated positively and significantly with mathematics achievement scores. However, only self-efficacy, resiliency, integrity and distortion were good predictors of achievement in mathematics. Female participants performed far much better on a mathematics test than their male counterparts. The personality characteristics of high mathematics achieving students differed significantly from those of low math scorers. Based on these findings, we recommend providing early individual and group counselling to vulnerable students at risk of failing mathematics. Educational interventions should also be provided in form of remedial teaching and motivational talks or workshops to sensitise students about the role of personality attributes in mathematics achievement. Further mixed-methods research is desired to gain additional insights into the problem and its solutions.

Keywords: Gender imbalance, mathematics achievement, personality attributes, sixth form, tertiary students

INTRODUCTION

Registration records in Brunei tertiary institutions have consistently, over the years, indicated that there were more females than males among students. However, critical examination of vital life incidence statistics (such as birth rates, infant mortality, diseases, accidents and death) revealed no significant differences in numbers between the two genders. Similarly, careful analyses of student enrolments have indicated no significant gender differences at three levels of the education system where students learn or study the same subjects, namely primary school stage (Years 1-6), lower secondary cycle (Years 7-8) and General Certificate of Education Ordinary Level, GCE O-Level (Years 9-11). At the pre-university level, also known as General Certificate of Education Advanced Subsidiary Level, GCE AS-Level (Year 12) and General Certificate of Education Advanced Level, GCE A-Level (Year 13) and students choose and study only few preferred subjects. Apparently, it was at this level of education (Year 12 and Year 13) where major differences in the number of female and male students emerged due to the males' poor performance in mathematics and English at GCE O-Level. It is assumed that the differences in math achievement persist throughout Year 12 and Year 13 between the two genders eventually impacting male admissions to tertiary institutions negatively. What is not known and understood in Brunei on this issue were answers to the following five related questions:

- What factors are likely to have led to the gender difference in mathematics achievement in Brunei?
- Why is this problem persisting?
- How can the problem be resolved?
- And why do females also perform better than males in and English?

This is where more focal attention, research priority and intervention efforts need to be directed and accorded. At the time of conducting the present study, Brunei had three universities, one university college, one polytechnic and few colleges. The admission criteria for two of the universities include mathematics and English. Mathematics is one of the subjects that challenges Brunei students at all levels of the education system. Brunei is a multilingual society. While English is spoken widely in the country, the main and official language is Bahasa Melayu. Studies have shown that Brunei students struggle with mathematics (Mundia, 2010a; Hamid *et al*., 2013; Matzin *et al*., 2013) and English. These same studies also indicate that female students outperform their male peers in both

mathematics and English subjects. Although no formal empirical study has been done to confirm low mathematics achievement in males as a possible cause of the observed gender disparity in Brunei tertiary institutions, ample documentary statistical evidence suggests the existence of such performance discrepancy (Department of Planning, Development and Research, 2010; Department of Statistics, 2011a). Poor achievement in mathematics and English can be attributed to a number of reasons such as unsatisfactory teaching, lack of appropriate learning resources and low interest or motivation in the subject, to name a few. In 2009, teacher education was reformed in order to improve the quality of teaching and education in Brunei (Mundia, 2012a). Efforts are also being made to prepare teachers who have high self-efficacy in special education (Bradshaw and Mundia, 2005, 2006; Haq and Mundia 2012; Tait and Mundia, 2012, 2013). Some of the causal factors may be psychological such as depression, anxiety and stress (Mundia, 2010b) and differences in career preferences (Mundia, 1998). Often, students do not know how to solve their academic problems (Law *et al*., 2015) and personal problems (Shahrill and Mundia, 2014). In such a situation, Brunei students need teachers who are both academic-oriented and also affective-oriented (Omar *et al*., 2014).

Objectives of the study: Taking into consideration the fact that both genders are basically brought up in the same culture, attended similar schools and are taught by teachers with comparable qualifications and experience, the causes of the difference in academic performance at "AS and "A" Levels is obscure or baffling and remains a puzzle to many educational stakeholders such as teachers, parents and employers. Many plausible explanations and speculations may be made here. The present study is one of the three investigations conducted by the same author(s) which sought to identify some of the potential factors that enable or disable male students from performing well in AS-Level and A-Level mathematics. The present and first study compared the personality characteristics of low and high achieving female and male students in mathematics. The variables that were investigated in the present study included: ability in mathematics and differences in personality factors (e.g., perseverance; self-regulation; critical thinking; and achievement motivation) based on ability level in mathematics. The importance personality variables in facilitating teaching and learning was also emphasised in the study by Mahalle *et al*. (2013) Briefly, the two main objectives of the present study were to:

- Determine the differences in mathematics achievement between female and male students.
- Find the differences in personality variables between low, average and high achievers in mathematics.
- Identify the good predictors of achievement in mathematics from the personality variables investigated.

The rationale and justification for including these research objectives and variables in the study was three-fold. First, due to lack of research, the degree to which these variables impact performance in mathematics is not known in the Brunei context. Second, if these variables could help improve achievement in mathematics examinations for males, then equating gender performance at "AS" and "A" Level examinations in mathematics might be the key to partly addressing and reducing the gender gap in tertiary student populations. Third, pre-university students in Brunei undergo two stressful years of preparing for "AS" and "A" Level examinations. It might be helpful to know if effective management of personality factors was related to good academic performance in mathematics.

METHODOLOGY

The strategies used in carrying out the present study are briefly described below under S Design-Data analysis.

Design: The field survey approach was used to investigate the problem. Under this procedure, the researcher personally went to relevant educational institutions to directly collect the data from the participants. Clarifications made to the participants on completing the instruments accurately helped to increase the number of usable returns. The research strategy was thus different from other forms of surveys (postal, telephone, online and longitudinal).

Sample: Two random samples were used in the study. The pilot sample had 32 participants (16 females, Mean age = 20.125, SD = 1.586 and 16 males, Mean age = 21.375, SD = 2.802). The pre-test sample came from one Sixth Form Centre (also known as Pre-University College in Brunei). Data collected from this trial sample was not included in the main study. The main study sample consisted of 330 participants (179 females, Mean age = 17.543, SD = 0.061 and 151 males, Mean age = 17.799, SD = 0.805). Participants in the main study came from six different Sixth Form Centres. There were two inclusion criteria. First, both genders were recruited. Second, all participants were drawn from GCE A-Level (Year 13) cohorts.

Instruments: Finding suitable research instruments is one of the main problems facing educational

Table 1: Descriptive statistics, standard error of measurement and alpha reliability

Scale name	Subscale	Number of items	Maximum score[1]	Mean	SD[2]	SEmeas[3]	Average I-S correlation[4]	Alpha reliability
TPP-R	Assertive	8	16	17.950	2.641	1.666	0.301	0.602
	Analytical	8	16	19.200	2.547	1.603	0.306	0.604
	Extrovert	7	14	16.104	2.461	1.491	0.346	0.633
	Self-Critical	7	14	17.416	2.434	1.394	0.381	0.672
	Leadership	6	12	13.329	2.080	1.348	0.323	0.580
	Resiliency	10	20	24.046	3.343	1.614	0.435	0.767
	Caring	8	16	20.495	2.617	1.380	0.418	0.722
	Intellectual	8	16	18.720	2.435	1.584	0.287	0.577
	Achievement	7	14	17.964	2.258	1.275	0.395	0.681
	Integrity	6	12	14.635	2.135	1.384	0.319	0.580
	Distortion	8	16	12.944	2.879	1.561	0.400	0.706
SAT	Math Test	40	40	27.218	7.824	2.437	0.417	0.903

[1]: The highest possible score from each scale; [2]: Standard deviation of total scores; [3]: Standard Error of Measurement; [4]: Item-to-Scale Correlation (corrected)

researchers in Brunei. Most of the good instruments are written in advanced English and many tend to be too long (Mundia and Abu Bakar, 2010; Mundia, 2011). The data for the present study were collected by two quantitative instruments (one psychometric and one educational), namely: the Revised Tajima Personality Profile, TPP-R (Ninggal, 2010) and an adopted SAT mathematics test.

The TPP-R (Ninggal, 2010) inventory is a factor-analysed screening personality test that was developed and normed in Malaysia. It was designed to assess the psychological wellbeing of an individual. The TPP-R was thought to be suitable for use in Brunei because it was developed and normed in Malaysia, a country which basically shares the same national language (Bahasa Melayu) and similar majority religion (Islam) as its neighbour Brunei. In view of this, the TPP-R was adopted for use in Brunei without factor analysing it again. The scale has 83 items each with a 3-multiple choice response format (always, scored 3; Seldom, scored 2; and Rarely, scored 1). The items are divided into 11 subscales: Assertive (8 items); Analytical (8 items); Extrovert (7 items); Self-Critical (7 items); Leadership (6 items); Resiliency (10 items); Caring (8 items); Intellectual (8 items); Achievement (7 items); Integrity (6 items); and Distortion (8 items). The SAT math test had 40 items each with a 4-point multiple choice response format. The right answer and distractors were scored dichotomously (Right response = 1; Wrong responses = 0).

The 40-item objective SAT mathematics test (Diehl and Joyce, 2006) covered eight topics (algebra, plane geometry, solid geometry, coordinate geometry, trigonometry, functions, probability and statistics and numbers and operations) which are taught to all students in Brunei secondary schools up to GCE O-Level. Each item had four-response options (A, B, C, D, E) with one correct answer and three distractors scored dichotomously as zero (0) if wrong and as one (1) when right. Altogether the 40 items measured a wide range of high-order skills such as understanding, interpretation, analysis, synthesis, application, evaluation and critical thinking. The difficulty for this test was set at the GCE O-Level standard. SAT tests are international college selection/entrance assessments. They are taken by students with Year 11 and above level of education all over the world. In terms of contents, the test was suitable for Brunei students in Years 12-13.

Using data from the pilot sample, the quality, suitability and feasibility of the instruments were determined. The instruments' descriptive statistics and reliability are presented in Table 1 while validity indices for the measures are provided in Table 2. All the personal factors were related to mathematics achievement as shown in Table 2. The measures were both reliable and valid for use with Brunei Year 13 students as students' curriculum covered all the topics and skills embedded in the test.

Procedures: This study was originally done as part of the PhD doctoral dissertation research using sponsorship funds from the University of Brunei Darussalam. Permission to collect the data from the Sixth Form Centres (schools) was obtained from the Ethical Committee of the University. In addition, permission to conduct the study in schools was also granted by the Ministry of Education in the Government of Brunei Darussalam. Ethical requirements for involvement in the study were explained to all the participants. No deception was used. Only students who voluntarily agreed to participate in the study were recruited as respondents. Names of the six participating schools were concealed.

Data analysis: The five psychometric scales and the SAT test of mathematics were scored according to instructions in their respective technical manuals. Raw quantitative data were analysed by a variety of procedures that included descriptive statistics, correlation, t-test for independent groups and One-Way ANOVA. These techniques were deemed suitable to address the objectives of the study.

Table 2: Convergence validity and discriminant validity by inter-scale correlations

Scale name	Subscale	Mean	SD[1]	1	2	3	4	5	6	7	8	9	10
TPP-R	Assertive	16.876	4.679	1									
	Analytical	18.073	4.945	0.807**	1								
	Extrovert	15.170	4.319	0.800**	0.845**	1							
	Self-Critical	16.367	4.607	0.728**	0.787**	0.701**	1						
	Leadership	12.552	3.639	0.804**	0.853**	0.834**	0.639**	1					
	Resiliency	22.600	6.302	0.792**	0.884**	0.807**	0.747**	0.828**	1				
	Caring	19.303	5.208	0.781**	0.846**	0.821**	0.798**	0.786**	0.864**	1			
	Intellectual	17.661	4.744	0.838**	0.898**	0.836**	0.763**	0.845**	0.866**	0.864**	1		
	Achievement	16.927	4.577	0.791**	0.867**	0.818**	0.747**	0.864**	0.858**	0.839**	0.862**	1	
	Integrity	13.770	3.927	0.748**	0.832**	0.768**	0.782**	0.771**	0.861**	0.886**	0.827**	0.818**	1
	Distortion	12.218	4.010	0.607**	0.638**	0.673**	0.562**	0.621**	0.658**	0.609**	0.635**	0.613**	0.648**
SAT	Math test	23.712	9.879	0.201**	0.233**	0.230**	0.184**	0.191**	0.329**	0.292**	0.252**	0.298**	0.052

[1]: Standard deviation of total scores

Table 3: Means, standard deviations, F-values and ETA for psychological/personality factors by mathematics ability (N = 315)

	Bottom (n = 85)		Middle (n = 142)		Top (n = 88)				
Subscale	Mean	SD[1]	Mean	SD[1]	Mean	SD[1]	F (df = 2, 314)	P (2-tailed)	Eta
Assertive	16.271	4.972	17.556	3.482	17.921	3.367	4.3560	0.014*	0.165
Analytical	17.506	5.554	18.655	3.489	19.341	3.234	4.4620	0.012*	0.167
Extrovert	14.482	4.844	15.880	3.232	16.102	2.909	5.1930	0.006**	0.179
Self-Critical	15.624	5.217	17.289	3.313	17.159	2.940	5.5430	0.004**	0.185
Leadership	11.929	4.108	13.232	2.741	13.182	2.424	5.3460	0.005**	0.182
Resiliency	20.988	6.818	23.754	4.349	24.455	4.304	11.396	0.000**	0.261
Caring	18.247	5.932	20.141	3.502	20.830	3.119	8.8730	0.000**	0.232
Intellectual	17.106	5.127	18.268	3.429	18.864	3.078	4.6290	0.010*	0.170
Achievement	16.106	5.226	17.796	3.141	17.943	2.854	6.7620	0.001**	0.204
Integrity	12.741	4.681	14.521	2.767	14.830	2.167	10.721	0.000**	0.254
Distortion	12.377	4.783	12.683	3.122	12.375	3.045	0.2800	0.756	0.042

[1]: Standard deviation of total scores, *p<0.05 (2-tailed), **p<0.01 (2-tailed)

Table 4: Means, Standard Deviations, ANCOVA F-values, T-values and effect size for psychological/personality factors by gender (N = 315)

	Females (n = 174)		Males (n = 141)					
Subscale/Scale	Mean	SD[1]	Mean	SD[1]	ANCOVA F	T (df = 313)	P (2-tailed)	Effect size
Assertive (AS)	17.517	3.035	17.057	4.852	7.970	-1.028	0.305	0.080
Analytical (AN)	18.851	3.024	18.149	5.173	7.363	-1.501	0.134	0.100
Extrovert (EX)	15.718	2.965	15.376	4.463	5.384	-0.815	0.416	0.071
Self-Critical (SC)	17.540	3.002	15.894	4.612	5.427	-3.817	0.000**	0.207
Leadership (LD)	13.150	2.585	12.518	3.687	3.026	-1.783	0.076	0.114
Resiliency (RS)	24.098	3.972	22.099	6.403	5.513	-3.390	0.001**	0.183
Caring (CR)	20.718	2.946	18.716	5.367	13.011	-4.202	0.000**	0.221
Intellectual (IT)	18.460	2.987	17.702	4.812	5.397	-1.710	0.088	0.113
Achievement (AC)	17.862	2.778	16.787	4.751	8.546	-2.503	0.013*	0.149
Integrity (IG)	14.672	2.654	13.454	3.985	5.999	-3.243	0.001**	0.182
Distortion (DS)	12.310	2.924	12.766	4.322	8.302	1.112	0.267	0.027
SAT Maths Test	26.178	7.197	23.192	9.863	26.902	-3.103	0.002**	0.173

[1]: Standard deviation of total scores, *p<0.05 (2-tailed), **p<0.01 (2-tailed)

RESULTS

The results of the study are presented below according to the data collection instruments used.

Findings from the Revised Tajima Personality Profile (Ninggal, 2010): According to Table 3, top math achievers were more assertive, analytical and intellectual than middle and bottom math scorers (p<0.05). In addition, students with higher math ability were extroverted, resilient and caring about their learning and studies than their less-able and average-ability counterparts (p<0.01). Furthermore, the top math scorers tended to have higher achievement motivation and integrity than the middle and bottom math scorers (p<0.01). Although average math achievers were more self-critical (conscientiousness) than low and top math scorers, they also possessed leadership qualities such as being dominant and persuasive (p<0.01).

Differences in personality traits and mathematics ability by gender: As shown in Table 4, there were significant differences between female and male participants on five personality variables and the mathematics test. Females were more self-critical/conscientious, resilient/persistent and caring for their studies than their male peers (p<0.01). In addition, the female top math scorers also had higher achievement motivation (p<0.05) and integrity such as being honest and responsible (p<0.01). Furthermore, the females outperformed their male counterparts on the mathematics test (p<0.01).

Table 5: Hierarchical multiple regression of personality factors on mathematics test[a, b, c, d]

Model	factors	Unstandardized coefficients		Standardized coefficients			95% C I for B	
		B	Std. error	β	t	Sig.	Lower	Upper
1	Self-efficacy	0.240	0.088	0.264	2.727	0.007	0.067	0.413
	AS	0.157	0.203	0.106	0.771	0.441	-0.243	0.556
	AN	-0.159	0.274	-0.115	-0.580	0.563	-0.698	0.381
	EX	0.350	0.246	0.213	1.421	0.156	-0.135	0.834
	SC	0.114	0.184	0.075	0.621	0.535	-0.248	0.476
	LD	-0.500	0.306	-0.252	-1.637	0.103	-1.102	0.101
	RS	0.628	0.200	0.569	3.142	0.002	0.235	1.022
	CR	0.237	0.246	0.183	0.962	0.337	-0.247	0.721
	IT	-0.295	0.275	-0.208	-1.075	0.283	-0.836	0.245
	AC	0.149	0.262	0.101	0.569	0.570	-0.366	0.664
	IG	0.388	0.294	0.215	1.320	0.188	-0.190	0.967
	DS	-0.401	0.167	-0.199	-2.400	0.017	-0.730	-0.072
7	Self-efficacy	0.266	0.083	0.292	3.203	0.002**	0.102	0.429
	EX	0.403	0.218	0.245	1.848	0.066	-0.026	0.831
	LD	-0.512	0.269	-0.258	-1.900	0.058	-1.042	0.018
	RS	0.628	0.180	0.568	3.483	0.001**	0.273	0.982
	IG	0.556	0.244	0.307	2.276	0.024**	0.075	1.037
	DS	-0.415	0.164	-0.206	-2.524	0.012**	-0.738	-0.091

a: Dependent Variable: Maths; b: Linear Regression through the Origin; c: Full names of abbreviated scales are in Table 4; d: **p<0.01

Table 6: Model summary of changes to R, R^2 and F-change statistics†

Model	R	R Square[b]	Adjusted R^2	Std. Error of the Estimate	Change statistics				
					R^2 Change	F Change	df1	df2	Sig. F Change
1	0.950[a]	0.902	0.899	8.37136	0.902	233.571	12	303	0.000**
2	0.950[c]	0.902	0.899	8.36204	0.000	0.32400	1	303	0.570
3	0.950[d]	0.902	0.899	8.35210	0.000	0.27500	1	304	0.600
4	0.950[e]	0.902	0.899	8.34282	0.000	0.32000	1	305	0.572
5	0.950[f]	0.902	0.899	8.34110	0.000	0.87400	1	306	0.351
6	0.949[g]	0.902	0.899	8.34113	0.000	1.00200	1	307	0.318
7	0.949[h]	0.901	0.899	8.34212	0.000	1.07400	1	308	0.301

a: Predictors: DS, Self-efficacy, SC, LD, AS, IG, EX, RS, AC, IT, CR, AN; b: For regression through the origin (the no-intercept model), R Square measures the proportion of the variability in the dependent variable about the origin explained by regression. This CANNOT be compared to R Square for models which include an intercept; c: Predictors: DS, Self-efficacy, SC, LD, AS, IG, EX, RS, IT, CR, AN; d: Predictors: DS, Self-efficacy, SC, LD, AS, IG, EX, RS, IT, CR; e: Predictors: DS, Self-efficacy, LD, AS, IG, EX, RS, IT, CR; f: Predictors: DS, Self-efficacy, LD, IG, EX, RS, IT, CR; g: Predictors: DS, Self-efficacy, LD, IG, EX, RS, CR; h: Predictors: DS, Self-efficacy, LD, IG, EX, RS; ***p<0.001 (two-tailed); †See Table 4 for full names of abbreviated scales

Personality attributes as predictors of achievement in mathematics: SPSS produced 7 steps each of which was a regression model. Only the first step (Model1) and last step (Model 7) are shown in Table 5 since there was not much change between steps 2-6. Besides distortion, DS (which is a validity scale) only self-efficacy, Resiliency (RS) and Integrity (IG) were predictors of high or good performance in mathematics (Table 5). The other personality variables were not predictors of achievement in mathematics. Table 6 shows the changes that occurred to R, R^2 and F-Change statistics in the seven-step analysis.

DISCUSSION

The personality characteristics of the low, average and high mathematics achievers are summarised in Table 7. As indicated in this table, low math achievers were deficient in most of the salient attributes possessed by top and medium math achievers. Top math scorers had most of the desirable personal qualities required in studying mathematics effectively. Females were the majority among the top and average math performers while males were overrepresented in the low ability group.

We briefly describe below the meaning of some of the concepts presented in Table 7 in the context of the present study:

Assertive: A person who is assertive is expressive and speaks her/his mind without offending others (Ninggal, 2010).

Analytical: This refers to a person who capable of logical thinking and reasoning (or critical thinking) and the individual is often able to synthesise or combine ideas (Paul, 1995).

Extrovert: An individual with good interpersonal skills that enable her/him to enjoy networking, consulting more-able peers and function effectively in group settings (e.g., doing group work, collaborative projects, teamwork and cooperative learning). The person performs well because of being open to learn from others.

Self-critical: This is linked to several other self concepts (such as self-regulation, self-control, self-direction and self-management) all of which refer

Table 7: Significant personality characteristics of three different ability groups in math*

Top scorers, n = 88 (F = 50, M = 38)	Average scorers, n = 142 (F = 93, M = 49)	Low scorers, n = 85 (F = 31, M = 54)
• Assertive, analytical and intellectual ($p < 0.05$) • Extroverted, resilient and caring in learning and studying ($p<0.01$) • Achievement-oriented, integrity and distortion ($p<0.01$)	• Self-critical ($p<0.01$) • Possessed leadership qualities such as being dominant and persuasive ($p<0.01$)	• Nil/none

*F: Females, M: Males

to the notion or idea of being your own master, independent of excessive influence from others (Kitsantas *et al*., 2009). Self-regulated students set their mastery oriented goals rather than performance goals, as they use and distinguish the effective and ineffective self-regulated learning strategies to attain these goals (Kitsantas *et al*., 2009).

Resiliency: The word means the same thing as perseverance and persistence. It is the tendency of an individual to act on her/his own accord without being reinforced and despite encountering serious setbacks or hardships (Carlson and Heth, 2010).

Achievement oriented: An ambitious individual who is self-motivated to attain high self-imposed goals (Busari, 2011; Stapleton, 2001).

Integrity: Being honest in one's own work; dependability.

Distortion: Scoring high on the validity scale thereby suggesting that the responses provided were reliable and valid.

CONCLUSION AND RECOMMENDATIONS

According to the findings of the present study, a relationship existed between the ten personality variables investigated and mathematics achievement scores. One of the personality factors, resiliency, was also a predictor of performance in mathematics. Consistent with the results of previous studies in Brunei and elsewhere, females scored significantly higher on a mathematics test than their male peers. Participants of different ability in mathematics (low, average and high) performed differently on the personality subscales. By comparing the mean scores, we identified the dominant personality attributes of high mathematics achievers which low math performers lacked. We recommend providing educational interventions (e.g., remedial teaching) and counselling/psychotherapy (e.g., on the roles of personality traits in mathematics achievement) to weak students in mathematics (both in individual and group settings). Further mixed-methods research is required to acquire deeper understanding of the problem and the needed solutions.

Limitations of the study: There are two main limitations to this research. The first one is that it is a survey and as such does not show cause-and-effect relationships among the variables investigated. Secondly, the study lacks a qualitative component to supplement the survey data and findings. Despite these and other constraints, the study has practical significance in that it tackled a major problem in the Brunei education system and made contributions to findings and suggested solutions to the problem.

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