



The Relationship between Personality and Quantitative Reasoning: Views based on Brunei Preservice Student Teachers

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ABSTRACT

Not much research has been done on personality attributes and dispositions that facilitate the learning and mastery of quantitative subjects such as mathematics and statistics, feared by many students. The present study investigated the role of personality preferences (PPs) and personality types (PTs) in quantitative reasoning (QR) subjects and tests. A field survey design (N = 138 randomly selected Brunei preservice student teachers, 30 males, aged 21 to 50) was used to probe the issue. Data were collected by the Myers-Briggs Type Indicator (MBTI). Adjusted odds ratios revealed that extroversion and introversion personality preferences were involved in quantitative reasoning but the relationships were statistically insignificant. Relative risk ratios showed that males were more vulnerable and at-risk of failing a QR test compared to females. Low scorers on thinking and extroversion had the lowest risk ratios for underachievement. Logistic regression further indicated that the ISTPs, ESFJs, and ENTJs had the highest likelihood for achievement on a QR test compared to the INFPs (reference PT group). On the contrary, the ENTPs and ISFPs were far less likely to succeed on the QR test. Although all the findings were statistically non-significant, a trend was established which showed that some PPs and PTs had potential to contribute to QR. Appropriate interventions were needed for students with high support needs. Large-scale mixed-methods research was desired to confirm and expand the pattern of findings in the current study.

Key Words: Personality preferences; Personality types; Quantitative reasoning; Student teachers; Brunei

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Introduction

Brunei teachers need quantitative skills to be able to evaluate students effectively under the ongoing school-based assessment policy. However, quantitative disciplines such as mathematics, statistics, econometrics and psychometrics are challenging subjects often feared by Brunei secondary school students (Mundia, 2010a) and perhaps tertiary students in faculties of arts, social sciences, and education. Mathematics and statistics are important subjects

as they have wide applications that require the use of quantitative reasoning (QR) not only in education but also in the civil service, industry, and commerce.

Under the present educational reforms in Brunei, which renovated the curriculum contents and assessment practices, teachers are required to play a central role in assessing students both qualitatively and quantitatively (Ministry of Education, 2007; Mundia, 2010b).

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In view of this, Brunei teacher education has been reformed to ensure that preservice trainee teachers received adequate educational testing and psychometric skills required in assessing students quantitatively (Mundia, 2012; Tait & Mundia, 2012). This may not be enough. Teachers who still feel inadequate in psychometrics might consult colleagues who are proficient in this mathematics-based discipline. However, no research has yet been conducted in Brunei to determine the relationship between trainee teachers' personality and QR skills in psychometrics and educational testing.

Why personality was chosen for investigation

Larsen and Buss (2002) defined personality as a set of psychological traits and mechanisms within the individual that are organized and relatively enduring and that influence his or her interactions with, and adaptations to, the environment. As Mundia (2015) pointed out, personality is measured by many different established psychological instruments such as the Myers-Briggs Type Indicator (Myers, 1962; Briggs-Myers & Briggs, 1985), NEO-Personality Inventory - Revised, NEO-PI-R (Costa & McCrae, 1987), Eysenck Personality Questionnaire - Revised, EPQ-R (Eysenck & Eysenck, 1991), the 16 Personality Factor scale, 16PF (Cattell, Cattell, & Cattell, 1994) and the Minnesota Multiphasic Personality Inventory-2, MMPI-2 (Butcher et al., 2001). The construct of personality was, in particular, investigated in the present study because empirical evidence shows that certain behavioral traits such as conscientiousness and openness were significantly related to academic achievement (see Reeve, 2011; Caprara et al., 2010). Extroverts and introverts often achieve high academic results in quantitative subjects possibly for different reasons that need to be clarified by empirical research. For example, it might be easier for extroverts than introverts to collaborate and consult with peers when they do not understand something while introverts may succeed due to their perseverance, persistence, and repeated attempts. Beyond these and other personality domains, some personality traits interact and work jointly to produce unique behaviors that may impact academic achievement positively. The relationship between different personality traits (referred to as the MBTI personality preferences and personality types in the current study) and academic achievement on quantitative courses has not received much attention in Brunei. The present

study was an attempt to understand difficulties in quantitative reasoning from a personality perspective of the Brunei trainee teachers. The findings of the current study might inform educational and counseling interventions for Brunei student teachers with high support needs in learning mathematics-related subjects such as psychometrics, educational and psychological testing, statistics, and quantitative research. By knowing the personality preferences and personality type of a student, an instructor might have clues / hints about how to help a vulnerable student at risk of failing a QR-related course thereby helping reduce the dropout rate and wastage. Such students often exhibit some observable forms of tension, anxiety and stress from learning QR-based subjects (see Hamid et al., 2013). Literature reviewed by Hamid et al (2013) and Metussin (2015) showed that students in Brunei and other countries tended to fear mathematics / statistics and that this phobia continued up to the tertiary level of education where students with mathematics / statistics anxiety avoided quantitative subjects or courses. However, these previous studies did not discuss the anxieties according to the students' personality traits, a knowledge gap that the present study seeks to narrow.

Why quantitative reasoning was targeted for investigation

Dwyer et al (2003) defined QR as the ability to think or reason in numerical terms. According to Dutton & Van der Linden (2017), the ability to pause and reason critically is what allows for better problem solving. QR is taught and measured in a variety of ways including using mathematics (Steen, 2001; 2004) and statistics (Beins, 1993; Tufte, 2001). From mathematics and statistics, students can learn a lot of QR skills such as descriptive and inferential statistics, chance and probability, graphical presentations of data, modeling, research design and methods, and interpretation of tables and figures (Lutsky, 2006). The Educational Testing Service (ETS) often incorporates items measuring QR skills in educational admission tests that predict success at tertiary level of education (e.g. the Scholastic Aptitude Test, SAT; Graduate Record Examination, GRE; and Graduate Management Admission Test, GMAT). In all these measures, the contents and type of items used vary considerably. Methods of teaching QR skills also involve a variety of strategies. Lutsky (2006) suggested emphasizing: (a) the value of



quantitative approaches to understanding a dataset; (b) using QR in constructing arguments; (c) knowing how to find or generate relevant quantitative information; (d) representing and communicating quantitative information clearly; and (e) evaluating quantitative information critically. Overall, the test scores form part of the selection criteria for students to enter college or receive scholarships. Trainee teachers are taught QR skills mainly to enable them to design, administer, analyze, interpret, and use test / examination scores or results properly. Because instructors are trained to teach a wide range of school subjects, those that choose and are being prepared for non-quantitative subjects often find it difficult to pass quantitative courses such as psychometrics and educational testing. The failing or low achievement causes a lot of tension, anxiety, and stress in these students. Research that investigates the personality characteristics of student teachers who are deficient in QR and how they may be assisted is desirable to help them to improve.

Objectives of the study

Under the new education system, all trainee teachers in Brunei are supposed to have a knowledge of and skills in educational testing and psychometrics, two subjects that require the use of quantitative reasoning. Skills derived from learning these disciplines are important and essential in assessing students efficiently and processing the quantitative marks competently in schools under the ongoing Brunei educational reforms. Unfortunately, some student teachers are uneasy about learning statistics. Taking these issues into consideration, the present study addressed the two research objectives listed below:

- Determine the relationship between personality preferences and quantitative reasoning.
- Determine the relationship between personality types and quantitative reasoning.

Method

The methodology for the present study incorporated a field survey design, random sample, three instruments, ethical procedures, and quantitative data analyses as separately described below.

Design

The field survey design was used because it was easier to access the sample under this strategy

compared to employing the postal, telephone or online survey methods. In addition, respondents would be assisted in completing the instruments correctly to increase the number of usable protocols.

Sample

Altogether, the present study used a pooled sample of 205 Brunei trainee teachers attending the module on educational testing / assessment (psychometrics) as part of the Master of Teaching (MTeach) degree program at the University of Brunei Darussalam (UBD). About 70-80 students were enrolled in this program every semester. To have enough number of participants for the study, three groups of MTeach students were recruited from three different semesters (hereafter referred to as Cohorts 1-3). All the student teachers in these three semesters were administered the research instruments. We obtained 67 properly completed questionnaires from Cohort 1, the pilot sample. Of these, 43 (64%) were females and 24 (36%) males aged between 21 and 47 (Mean = 24.766; SD = 3.108). Suitably completed questionnaires for the main study were collected from 61 students in Cohort 2 and 77 in Cohort 3. The combined 138 participants drawn from Cohorts 2 and 3, who constituted the entire main study sample, consisted of 108 (78%) females and 30 (22%) males. Their age ranged from 21 to 50 (Mean = 25.565; SD = 3.662). The participants were specializing in a wide range of subjects taught in the Brunei government early childhood, primary, and secondary schools. Each participant possessed an initial undergraduate degree in her / his subject of specialization.

Instruments

The three instruments administered to all the 205 participants were the 94-items Myers-Briggs Type Indicator, MBTI full scale (Myers, 1962; Briggs-Myers & Briggs, 1985); the 60-items NEOFF inventory (Costa & McCrae, 2003); and one 50-items researcher-constructed performance psychometrics (quantitative reasoning - QR) test.

The MBTI is a peer of the Minnesota Multiphasic Personality Inventory-Revised, MMPI-2 (Butcher et al., 2001) and the NEO-Personality Inventory-Revised, NEO-PI-R (Costa & McCrae, 1992). Together, these three instruments are the world's most widely used measures of personality. As described in an earlier study (Mundia, 2015), the MBTI is a self-



report instrument whose 94 items measure four bipolar personality domains: extroversion-introversion (21 items), sensing-intuition (26 items), thinking-feeling (23 items), and judging-perceiving (24 items). Each semantic term in the four paired words is called a personality preference (PP). Sixteen (16) combinations of the PPs taking four at a time and arranged from left (highest score) to right (lowest score) are known as personality types (PTs). The technical manual for the MBTI (Myers, 1962; Briggs-Myers & Briggs, 1985) has detailed profile descriptions of all the eight PPs and sixteen PTs. According to Mundia (2015) several personality preference subscales of the MBTI (e.g. extraversion, introversion, thinking, and judging) correlate with relevant, corresponding and similar subscales in other major personality instruments such as the NEO-PI-R (Costa & McCrae, 1987), the Eysenck Personality Questionnaire-Revised, EPQ-R (Eysenck & Eysenck, 1991), MMPI-2 (Butcher et al., 2001), and the 16-Personality Factors, 16PF (Cattell, Cattell, & Cattell, 1994). In view of this, the MBTI was said to have adequate external criterion-related validity (Mundia, 2015). However, some researchers (e.g. Boyle, 1995) claim that the MBTI has some psychometric limitations involving its short-form (e.g. scoring procedures, item homogeneity, and validity). To avoid these and other difficulties, the present study used the long-form version of the MBTI described above which was more reliable and valid.

The NEOFFI (Costa & McCrae, 2003) is the short version of the NEO-PI-R (Costa & McCrae, 1987). Its 60 items, each with 5-point Likert scales (1SD-2D-3N-4A-5SA), form five subscales: Neuroticism (12 items), Extroversion (12), Openness (12), Agreeableness (12), and Conscientiousness (12). In the present study, the NEOFFI was solely used for validating the MBTI by correlating the subscales in the two instruments to obtain criterion-related discriminant validity indices.

The 50-items researcher-constructed objective quantitative psychometric test, with a 4-point Likert-type response format (A, B, C, D), was based on an introductory course in psychometrics and assessed several quantitative reasoning (QR) concepts such as descriptive statistics, classical test theory, item analysis, correlation, reliability, validity, and standard scores. The four alternative or multiple-choice responses on each item consisted of one correct answer and three plausible distractors. This test

measured a wide range of high-order skills such as computation, comprehension, understanding, interpretation, synthesis, application, evaluation, and critical thinking. Two experienced school psychologists rated the suitability of the test items on this instrument and the data produced a Kappa coefficient of agreement of 0.739 as an inter-coder reliability index. The same psychologists also reviewed the contents of the test and their paired ratings yielded an inter-judge agreement of 81% as quantitative evidence of the test's content validity.

Based on a trial sample (N = 67) the instruments yielded the significant test-retest correlation reliability indices (with a one month in-between time interval) presented in Table 1. The MBTI personality preferences subscales and the QR test were reasonably stable and consistently produced nearly the same results when administered to the same participants on two occasions.

The inter-correlations of MBTI and NEOFFI subscales in Table 2 show that the subscales had adequate discriminant validity. All the obtained correlations (both positive and negative) were low or small. For example, the extroversion subscales of the two instruments correlated low though positively and significantly [$r(67) = 0.312, p < .01$] and the two subscales shared only 9.734% of the common variance between them. This provided evidence that the two extroversion subscales were not exactly the same although they measured an identical concept. Similarly, the extroversion and introversion subscales within the MBTI were associated significantly but negatively [$r(67) = -0.371, p < .01$], an indication of inter-subscale discriminant validity and proof that the instruments were conceptually distinct measures of different personality domains (extroversion versus introversion dispositions). Similar interpretations can be applied to all other inter-subscale correlations in Table 2 as quantitative evidence of discriminant validity.

Procedures

This study did not receive a research grant and was privately funded by the researchers. Prospective participant trainee teachers were informed about the purposes of the investigation and the ethical rules for being involved in the study. Coercion and deception were not used in the recruitment process. Only student teachers who voluntarily agreed to participate and signed a consent form were recruited into the study. All



the data collection instruments used were written in simple English and were thus not translated into Bahasa Melayu, language of the majority people in Brunei Darussalam. However, respondents who needed clarifications on certain items were assisted accordingly. Data were analyzed and the results reported at the group level to conceal the identity of individual participants.

Data analysis

The MBTI and NEOFF were scored as per instructions in their technical manual to generate raw scores. The obtained raw scores on the psychometrics test were changed to percentage scores. Previous research based on Brunei student and non-student samples indicated that high and low scorers on psychometric tests often behaved differently (see Metussin, 2015; Mundia et al., 2017; Mundia & Salleh, 2017). For purposes of addressing this concern, we dichotomized each MBTI personality preference variable and the psychometric test scores at the median to obtain two groups (high scorers above the median value coded 1 and low scorers below the median coded 0). Based on the main study sample, the median scores for the eight (8) personality preference variables were: extroversion (10.000); introversion (15.000); sensing (15.000); intuition (11.000); thinking (15.000); feeling (8.000); judging (17.000); and perceiving (10.000). Figure 1 is a pictorial representation of the number of high and low scorers on the MBTI personality preferences. It can be seen from this visual illustration that thinking had the highest number of high scorers followed by perceiving and intuition. Extroversion, introversion and intuition had almost the same numbers of high and low scorers, respectively. The median score for the QR test was 60.172 (also based on the main research sample). Depending on the required statistics, data (continuous or categorical) were then analyzed by appropriate procedures such as descriptive statistics, correlation, and logistic regression (ordinary, adjusted and risk) using SPSS Version 22.

Results

The findings presented below are arranged according to the objectives of the study.

Relationship between MBTI personality preferences and quantitative reasoning

To determine the relationship between the MBTI personality preferences (PPs) and quantitative reasoning (QR) we obtained three types of odds ratios, ORs (ordinary, adjusted and risk) that are reported in Table 3. Ordinary (crude or unadjusted) ORs in the present study were obtained by entering simultaneously one response variable with one explanatory variable at a time in a logistic regression model in which both variables were dichotomous but not ordinal. This procedure does not correct confounding. On the other hand, adjusted (non-spurious, attenuated or corrected) ORs were obtained by entering several dichotomous independent variables (IVs) in a backward elimination logistic regression model with a binary (not ordinal) dependent variable (DV). This technique determines the specific relationship between one IV and one DV while controlling for (or holding constant) the effects of the other IVs entered in the same model.

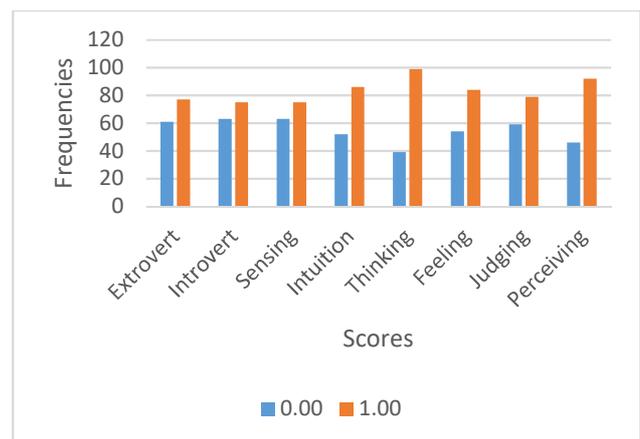


Figure 1. Number of high and low scorers on MBTI personality preferences.

Evidence in Table 3 showed that high scorers on all the eight personality preference (PPs) variables had relatively higher ordinary and adjusted odds ratios for success on the QR test compared to low scorers. However, none of the eight personality preferences was significantly related to QR but some of them established trends or patterns worth considering in this study (see Table 3).

Table 1. Reliability of the instruments (N =67).

Scale†	Items	Test-retest r
<i>MBTI^a</i>		
Extroversion (E ₁)	21	0.854**
Introversion (I)	-	0.733**
Sensing (S)	26	0.829**
Intuition (N ₁)	-	0.792**
Thinking (T)	23	0.893**
Feeling (F)	-	0.808**
Judging (J)	24	0.825**
Perceiving (P)	-	0.702**
Psychometrics test‡	50	0.781**
<i>NEOFFI^b</i>		
Neuroticism (N ₂)	12	0.830**
Extroversion (E ₂)	12	0.890**
Openness (O)	12	0.867**
Agreeableness (A)	12	0.851**
Conscientiousness (C)	12	0.905**

** : p < .01 (two-tailed)

MBTI^a: Myers-Briggs Type Indicator: E₁-I (21 items); S-N₁ (26); T-F (23); J-P (24)

NEOFFI^b: NEO Five Factor Personality Inventory

†: Mean scores and standard deviations for all personality subscales are presented in Table 2

‡: Mean = 60.133; SD = 15.630 (from first administration of the test-retest analysis)

Table 2. Discriminant validity of the subscales used (N = 67).

Subscales†	E ^a	I	S	N ₁	T	F	J	P	N ₂	E ^b	O	A	C
Extroversion (E ^a)	1												
Introversion (I)	0.371*	1											
Sensing (S)	0.18	0.038	1										
Intuition (N ₁)	-0.069	0.326*	0.548*	1									
Thinking (T)	0.248*	-0.012	0.280*	-0.169	1								
Feeling (F)	0.154	0.155	0.037	0.108	0.471*	1							
Judging (J)	0.2	-0.144	0.266*	0.371*	0.134	0.074	1						
Perceiving (P)	0.098	0.341*	-0.074	0.388*	0.017	0.186	0.672*	1					
Neuroticism (N ₂)	0.114	0.082	0.367*	-0.066	-0.062	0.191	0.044	0.061	1				
Extroversion (E ^b)	0.312*	-	-0.019	0.022	0.141	0.003	-0.008	0.039	0.236*	1			
Openness (O)	0.147	0.102	0.061	0.191	0.189	-0.13	-0.086	0.230*	0.063	0.142	1		
Agreeableness (A)	-	0.131	0.006	0.019	-0.065	0.075	-0.124	-0.032	0.001	0.14	0.006	1	
Conscientiousness (C)	0.058	0.004	-0.133	0.228*	-0.054	0.018	0.146	-0.064	0.166	0.228*	0.207	0.11	1
Mean	10.7	15.55	14.683	11.033	14.7	8.383	15.533	11.516	34.22	39.337	40.155	44.532	42.818
Standard deviation	5.518	5.478	6.266	4.104	5.746	3.664	6.575	6.355	5.253	4.099	3.558	9.254	3.358

†: Inter-correlations based on first administration of the instruments in a test-retest analysis

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

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

E_a, N₁ in MBTI scale

E_b, N₂ in NEOFFI scale



Table 3. Relationship between personality preferences and quantitative reasoning (N = 138).

Variable (Categorical Group)	Odds Ratios*		Risk (Coded 1)	Risk (Coded 0)	Risk (0/1)
	Ordinary	Adjusted			
Gender (females, coded 1, n = 108)	1.16	1.084	1.074	0.926	0.862
Extroversion (high scorers, coded 1, n = 77)	1.179	2.171	1.228	0.789	0.642
Introversion ((high scorers, coded 1, n = 75)	1.369	1.987	1.158	0.846	0.73
Sensing (high scorers, coded 1, n = 75)	1.461	1.723	1.149	0.835	0.727
Intuition (high scorers, coded 1, n = 86)	1.546	1.077	1.221	0.789	0.647
Thinking (high scorers, coded 1, n = 99)	1.633	1.709	1.243	0.762	0.613
Feeling (high scorers, coded 1, n = 84)	1.192	1.36	1.085	0.911	0.839
Judging (high scorers, coded 1, n = 79)	1.395	1.644	1.167	0.837	0.717
Perceiving (high scorers, coded 1, n = 92)	1.245	1.369	1.106	0.889	0.803

*95% CI values omitted

Table 4. Relationship between personality types and quantitative reasoning (N = 138).

Variable	B‡	SE	Wald X ²	df	Sig.	OR	95% CI	
							Lower	Upper
Personality types†			5.594	15	0.986			
ESTJ (coded 1, n = 10)	0.405	0.904	0.201	1	0.654	1.5	0.255	8.817
ESTP (coded 2, n = 6)	0.405	1.041	0.152	1	0.697	1.5	0.195	11.536
ESFJ (coded 3, n = 7)	1.322	1.057	1.565	1	0.211	3.75	0.473	29.752
ESFP (coded 4, n = 7)	0.118	1	0.014	1	0.906	1.125	0.158	7.986
ISTJ (coded 5, n = 19)	0.3	0.792	0.143	1	0.705	1.35	0.286	6.379
ISTP (coded 6, n = 9)	1.658	1.029	2.595	1	0.107	5.25	0.698	39.476
ISFJ (coded 7, n = 10)	0.811	0.913	0.789	1	0.374	2.25	0.376	13.465
ISFP (coded 8, n = 8)	-0.105	0.975	0.012	1	0.914	0.9	0.133	6.08
ENTJ (coded 9, n = 3)	1.099	1.384	0.63	1	0.427	3	0.199	45.244
ENTP (coded 10, n = 3)	-0.097	0.422	0.009	1	0.968	0.7	0.104	5.022
ENFJ (coded 11, n = 5)	0.811	1.118	0.526	1	0.468	2.25	0.251	20.131
ENFP (coded 12, n = 7)	0.693	1	0.48	1	0.488	2	0.282	14.198
INTJ (coded 13, n = 9)	0.629	0.931	0.456	1	0.5	1.875	0.302	11.626
INTP (coded 14, n = 13)	0.56	0.852	0.431	1	0.511	1.75	0.329	9.298
INFJ (coded 15, n = 12)	0.742	0.872	0.725	1	0.395	2.1	0.381	11.589
Constant	0.405	0.645	0.395	1	0.53	0.667		

†: INFP = reference/comparison group (coded 16, n = 10)

‡: Model R Squares = 0.074 (Cox & Snell), 0.099 (Nagelkerke); Hosmer and Lemeshow X² (df = 8) = 4.113, p = 0.775

Table 5. Key words in profile descriptions of MBTI personality preferences and types.

Personality preference	Key words	Personality type	Key words
Introversion	Long attention span and thoughtful actions	ISTP	Inquisitive; cause-effect relationships
Extroversion	Observant, imitating and modeling	ESFJ	Conscientious; collaborative
Sensing	Enjoy doing things in established routines	ENTJ	Critical; positive; assertive
Thinking	Like analyzing, reasoning, forecasting	ISFJ	Responsible; patient; considerate
Feeling	Focus on affects in relationships	ISTJ	Pragmatic; credible; realistic
Intuitive	Welcome new ideas and pursuits / initiatives	ESFP	Approachable; flexible; agreeable
Judging	Execute planned activities without deviations	ISFP	Aloof; sensitive; avoidant
Perceiving	Open-minded; agreeable; procrastinating	ENTP	Automatic thoughts; controversial

In the present study, we were not only interested in statistical significance but also in statistical patterns or trends as well as matters of practical significance. The obtained ordinary and adjusted ORs in our study were interpreted in the same fashion. Since all the B regression coefficients were positive, the high scorers (group coded 1) were said to be more likely to perform relatively better on the quantitative reasoning (QR) test compared to low scorers (reference group coded 0). For example, using adjusted ORs we can say that the high scorers on extroversion were almost 2.2 times more likely to

do well on the QR test compared to the low scorers, n = 61 (B = 0.775, p> .05; OR = 2.171, 95% CI = 0.980 - 4.807). Of the 77 high scoring extroverts, 59 were females while 18 were males. Similarly, high scorers on introversion were also about 2 times more likely to perform well on the QR test compared to the low scorers, n = 63 (B = 0.687, p> .05; OR = 1.987, 95% CI = 0.900 - 4.386). Among the 75 high scoring introverts, 60 were females and 15 were males. Although the differences were not substantial and statistically insignificant as stated above, high scorers on extroversion, introversion, sensing, thinking, and



judging set a trend or pattern of having the highest adjusted odds ratios for success on the QR course or test compared to low scorers on the same variables. Besides statistical significance, these statistical trends and issues of practical significance were equally of interest and importance to the researchers of the current study. These and other similar trends / patterns of differences in performance between high and low scorers were very informing and worth noting in the present study and suggested the need for further large-scale mixed-methods research on this issue. Studies that do not yield statistical significance but demonstrate valuable trends or patterns and practical significance are often useful to researchers as they may provide the rationale and justification for further investigation of the issues concerned.

The risk odds ratios (also presented in Table 3) were computed by the Cochran-Mantel-Haenszel method in SPSS Version 22. This technique generates estimates of association between an exposure and an outcome after adjusting for or taking into account confounding. In the present study, the method was used with a dichotomous outcome DV (QR test scores) and dichotomous risk factors or IVs (MBTI personality preferences). As was the case with the ordinary and adjusted ORs, none of the obtained risk ORs was statistically significant. Consistent to what we stated above, we were not only interested in statistical significance in the present study but also in trends / patterns and practical significance that emerged from the findings. There is a difference in the way risk and other types of ORs are interpreted. Without going into detailed technical differences, a look at the risk odds ratios for success on the QR test in Table 3 indicates that the low scorers (coded 0) had the lowest ORs for success on all PPs variables compared to high scorers (coded 1). This implied or suggested that low scorers were relatively more vulnerable and at-risk of performing poorly on the QR course or test compared to high scorers. The far-right column of Table 3 shows the relative risk ratios (RRs, 0/1) for low scorers (coded 0) compared to high scorers (coded 1). For example, the risk of poor performance on the QR course or test was 86.2% for the male gender, $n = 30$ [OR = 0.862, 95% CI = 0.384 – 1.937; Pearson / Likelihood Ratio X² (df = 1) = 0.129, $p = 0.719$ two-tailed] while it was only 13.8% for females. Similar interpretations can be made on other variables. In this way, a trend or pattern emerged that indicated that low

scorers on thinking ($n = 39$) and extroversion ($n = 61$) had the lowest relative risk ratios for failing the QR course or test compared to low scorers on the other personality preference variables (see Table 3). Thinking requires the ability to use higher-order skills (such as analysis, synthesis, application, evaluation, and critical thinking) while extroversion requires the ability to use help-seeking strategies (such as cooperative learning, collaborative learning, group work, and peer tutoring).

Relationship between MBTI personality types and quantitative reasoning

To determine the relationship between MBTI personality types (PTs) and quantitative reasoning (QR) we performed a binary logistic regression analysis. The results are presented in Table 4. This intercept model accounted for between 7.4% – 9.9% of the common variance between the IVs (16 categories of PTs) and the DV (dichotomized QR test scores). The model was acceptable as indicated by the non-significant Maximum Likelihood X² fit index shown at the bottom of Table 4. All the 16 MBTI personality types were represented in the sample. The majority of the participants were ISTJs ($n = 19$) followed by INTPs ($n = 13$) while the smallest groups were the ENTJs and ENTPs (each with $n = 3$). No single PT emerged as the best predictor of QR. In addition, none of the PTs was significantly related to QR but the findings, again, revealed interesting trends / patterns and practical significance which were equally important to investigators of the present study.

Based on the magnitude or size of the obtained ORs, we arbitrarily organized and placed the PTs into five categories, hereafter referred to as groups. Four of these five groups had relatively high odds ratios (ORs) for QR. The size and trend or pattern of ORs in each group of PTs did not differ much. Group 1 consisted of the three main PTs that had the best potential to predict achievement in QR (ISTP, ESFJ, and ENTJ) of which ISTP was the dominant personality disposition for QR in terms of the obtained ORs. Compared to the INFP personality type (used as the reference group in this study and coded 16, $n = 10$), the ISTPs were 5.3 times more likely to perform well on the QR course or test ($B = 1.658$, $p > .05$; OR = 5.250, 95% CI = 0.698 – 39.476). All the nine (9) ISTPs in Group 1 were females (group Mean QR test score = 73.857, SD = 12.837). The seven (7) ESFJs in Group 1 consisted of six (6) females and one (1) male (group Mean



QR test score = 72.817, SD = 9.257). In terms of gender composition, all the three (3) ENTJs in Group 1 were females (group Mean QR test score = 70.571, SD = 9.606). Similar interpretations could be attached to all variables with positive B regression coefficients in Groups 2-4 presented in Table 4. It is worth noting that these three top PTs were preceded by introversion and extroversion. Group 2 comprised of four PTs (ISFJ, ENFJ, INFJ, and ENFP) with ISFJ being the principal personality mode for QR (due to its shorter and more reliable 95% CI). These PTs were still prefixed by introversion and extroversion. Group 3 was made up of four PTs (INTJ, INTP, ESTJ and ESTP arranged by magnitude of their ORs shown in Table 4). We placed ISTJ and ESFP into Group 4 on the basis of having low ORs. Group 5 included ENTP and ISFP which did not only have the lowest ORs but were also negatively correlated with QR. Compared to the INFPs (reference group coded 16, n = 10), the ENTPs were far less likely to perform well on the QR test (B = -0.097, $p > .05$; OR = 0.700, 95% CI = 0.104 – 5.022). Of the three (3) ENTPs in Group 5, two were females while one was a male (group Mean QR test score = 56.000, SD = 14.422). Similarly, ISFPs in Group 5 were also much likely to underachieve on the QR course or test (B = -0.105, $p > .05$; OR = 0.900, 95% CI = 0.133 – 6.080) compared to the INFPs. The eight (8) participating ISFPs comprised of five females and three males (group Mean QR test score = 59.428, SD = 14.512). In Table 5, we present a brief content analysis of the insightful key words embedded in the profile descriptions of selected PPs and PTs included in Groups 1, 2, 4, and 5 above according to the MBTI technical manual (Myers, 1962; Briggs-Myers & Briggs, 1985). The best way to confirm the obtained trends of ORs and group mean test scores for these personality types (PTs) is to replicate the study using different large samples of student teachers in different countries and cultures.

Discussion

The main findings of the study are briefly discussed below under three separate subheadings.

Gender differences in performance on a QR test

According to adjusted ORs in Table 3, there was no statistically significant difference between females and males in performance on the QR test although females scored relatively higher than males who had a higher relative risk of failing.

This evidence suggested that most participants of both genders were quite capable of doing well on the QR course whose skills were essential in enabling them to conduct educational and psychometric tests efficiently in Brunei schools. This was probably due to the help-seeking efforts of students who were weak in QR-related subjects from their competent peers as well as their networking strategies. However, both help-seeking and networking were not directly measured in the current study and we are merely reporting the implications here. Unlike secondary school students (see Mundia, 2010a; Metussin, 2015), trainee teachers in the present study do not appear to regard quantitative subjects as a big threat or challenge. They are committed and well aware that the QR skills that they study and acquire are central to the success of their teaching careers and the ongoing educational reforms (Mundia, 2010b). Thus, effective strategies for teaching QR skills need to be identified and used by the instructors of QR courses (Lutsky, 2006).

Influence of personality preferences on achievement in QR

Consistent with evidence from previous research (Reevy, 2011; Caprara et al, 2010) which shows that certain behavioral traits such as conscientiousness and openness were significantly related to academic achievement, personality was indeed found to be related with academic success on a QR test in the present study of Brunei student teachers. Conscientiousness and openness correlated positively with extroversion and introversion in the current study but not highly and significantly (see Table 2). Based on the adjusted ORs in Table 3, we see that high scorers on extroversion, introversion, thinking and judging had, respectively, the highest odds ratios for success on the QR test in the present study. Both extroversion and introversion were associated with good achievement on the QR test in the present study but for different reasons. From a speculative point of view, this finding suggested that extroverts could perform well in QR-based subjects like psychometrics and educational testing because they have the ability to consult peers via group / team work (e.g. cooperative or collaborative learning). Thus, extroverts may be externally motivated through such peer tutoring or networking. These attributes were not directly assessed in the current study and need to be investigated in future research. On the contrary,

introverts do well and excel in quantitative subjects such as mathematics, statistics and psychometrics possibly due to possessing high intrapersonal or internal motivation and interest in the subjects. The high internal motivation and interest drive them to keep on confronting the challenging subjects head-on. In short, introverts seem to have a higher degree of persistence, resilience, perseverance, self-regulation and self-direction than extroverts and perhaps most other personality preferences. Again, all these traits were not directly measured in the present study (though implicated) and need to be investigated and clarified in future research.

Role of personality types in QR

Table 4 shows how some personality preferences interact and work together to produce joint effects (known as the MBTI personality types). Evidence from Table 4 shows that the ISTPs (OR = 5.250) and ESFJs (OR = 3.750) were the two personality types with, respectively, the best skills in QR based on the present study. Both used sensing with either thinking and perceiving or feeling and judgement. Introverts who employed sensing, thinking and perceiving traits were likely to perform well on a QR test followed by extroverts who combined sensing, feeling with judging. Altogether, these two groups of personality types were less likely to experience severe difficulties / problems or to perform badly on a quantitative course (or test). We observed and noted that the ENTPs (OR = 0.700) and ISFPs (OR = 0.900) had, respectively, the lowest odds for success on a QR course or test. Appropriate interventions such as those recommended by Lutsky (2006) are desirable for these two personality types with high support needs. In addition, other interventions focusing on independent study skills, higher-order skills (such as critical thinking, analysis, synthesis, application, and evaluation), as well as help-seeking strategies (such as cooperative learning, collaborative learning, and peer tutoring) are also recommended. These are some of the skills that enable the ISTP, ESFJ and ENTJ personality types to be well predisposed to QR and perform well. Conversely, priority and efforts in future research employing interview probes should be directed at finding out why ENTPs and ISFPs would be less able to do well in studies and on tests involving QR skills.

Implications of the study

The present study was exploratory in nature and entirely based only on trainee teachers in one

country as the title indicates. The sample is neither representative of student teachers elsewhere nor other categories of people. In view of this, the results are not generalizable. It is quite possible that the personality preferences and types of trainee teachers and students training for other careers or professions in other countries and contexts may be related differently to QR. Moreover, although all the findings of the current study are not statistically significant, the study revealed trends whose patterns deserve further investigation. This calls for further research.

Conclusion

Quantitative subjects such as mathematics, statistics, econometrics, and psychometrics should not be frightening to university student teachers. The present study revealed no significant gender difference in performance on a psychometric test. However, two personality preferences (introversion and extroversion) showed a potential trend which indicated that they were less likely to experience serious hardships in studying QR subjects. Similarly, three personality types (ISTP, ESFJ, and ENTJ) revealed a pattern which implied that they were also less likely to encounter big problems in studying quantitative subjects. The two main sources of concern in this study were the ENTPs and ISFPs who were predicted to be less able in QR subjects. Based on the main findings, the present study merited a replication. Using trainee teachers in different contexts, large-scale, mixed-methods, multi-national, and cross-cultural studies of enabling factors in learning QR courses need to be conducted with respect to MBTI personality preferences and personality types to confirm or disconfirm the present findings. We need to know what really helps introverts, extroverts, ISTPs, ESFJs, and ENTJs to understand QR subjects better and perform well on QR tests. Only speculative or suggestive reasons on facilitating factors were provided in the present exploratory study. Equally important, we also need know what exactly inhibits and prevents ENTPs and ISFPs from understanding and mastering QR subjects.

Limitations of the study

The present exploratory study was based on a moderate sample (N = 138) and needs to be replicated using a larger sample and mixed-methods design to confirm / disconfirm the results as well as to compare / contrast the



findings from other countries. Despite this limitation, the study had practical significance and produced results that may be of interest to other researchers in Brunei and other countries.

Declarations

Abbreviations

UBD: University of Brunei Darussalam; SPSS: Statistical Package for Social Sciences; MBTI: Myers-Briggs Type Indicator; NEOFFI: NEO Five Factor Personality Inventory; PP: personality preference; PT: personality type.

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Permission to conduct the study was obtained from the University of Brunei Darussalam Ethics Committee and the participants. Each respondent gave both a verbal consent and written agreement for participating in the study.

Consent for publication and permissions to reproduce material

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Authors' contributions

LM: study concept, design, sourcing instruments, instrument administration, data analysis, table formatting, statistical interpretations, literature review, article writing, addressing legal and ethical implications, in-text references, journal referencing style, spelling and grammar checking, manuscript revisions, corresponding author. SZKT, RJ, SH, SNAL: literature review, interpreting the findings, draft evaluation, addressing legal and ethical implications, journal referencing style, spelling and grammar checking, overall article layout.

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Requests for data

The data cannot be released without permission from the participants. Contact the corresponding author on requests for access to the data.

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