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A Comparison of Learning Styles and Study Strategies Used by Low and High Math Achieving Brunei Secondary School Students: Implications for Teaching

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Abstract

The survey assessed the learning styles and study strategies used by 135 randomly selected Brunei secondary school students and compared them by educational level, math ability, and gender. Junior students (Forms 1-3) rely heavily on the use of the written-expressive learning style than their senior counterparts (Forms 4-5). In addition, the more able math students dominantly use the auditory-language learning style than their less able peers. Furthermore, high math achievers were better and more efficient users of the text book reading, note-taking, and memory study strategies than low achievers. Moreover, female students were more effective and superior users of the visual-language and auditory-visual-kinesthetic learning styles including the text book reading, note-taking, memory, test preparation, and concentration study strategies. These are perhaps some of the reasons why females perform better at math than males. Overall, the findings seem to have wide-ranging implications for teaching students with high support needs in mathematics.

Keywords: secondary school students, learning styles, study strategies, mathematics achievement

1. Introduction

Mathematics is one of the subjects that challenge Brunei secondary school students along with science and English. These three constitute key subjects used in the selection criteria of students for admission into Brunei tertiary institutions as well as for award of scholarships. Unfortunately, performance in mathematics is often poor particularly among male students. The causes of this low performance in mathematics are not well known. However, Anthony (1996) noted that math students do not perform well when they use inappropriate learning strategies. In Brunei, recent past research efforts to know more about this problem have focused on a wide-range of issues (that touch on mathematics in one way or the other) including the preparation of teachers to meet the challenges of inclusive education (Tait & Mundia, 2012); comparison of Brunei pre-service student teachers' attitudes to inclusive education and specific disabilities (Haq & Mundia, 2012); policy changes in Brunei teacher education (Mundia, 2012a); assessment of mathematics learning difficulties (Mundia, 2012b); problems in learning mathematics (Mundia, 2010a); implementation of SPN21 curriculum (Mundia, 2010b); and implementation of inclusive education (Mundia, 2009).

2. Objectives of the Study

The purpose of the present study was to determine the extent or degree to which secondary school students' scores differ (by educational level, math ability, and gender) on nine leaning style variables and six study strategy domains. The findings helped to identify some of the factors that help to explain the differences in students' math achievement.

3. Method

The study used field survey approach to investigate the problem. This research strategy differs from the telephone, online and postal survey techniques in that the researcher has to go into the fields (relevant educational institutions in the present study) to collect the data. The rationale and justification for employing this

research strategy was two-fold. First, we wanted to involve as many secondary school students in the study as possible. Second, it was then possible to give on-the-spot assistance to respondents who needed help to complete the data collection instruments correctly thereby increasing the number of usable returns.

4. Sample

Participant schools and students were selected randomly. Initially, a total of 157 questionnaires were distributed to chosen students but only 135 submitted properly completed and usable protocols. Of the remaining 22, three did not return the questionnaires and were deemed as having declined to participate in the study while 19 were excluded from the study for endorsing item scales with central and extremity response biases including having many missing values. The participants' bio-data (gender, educational level, and age) are presented in Table 1.

Table 1. Demographic information (N=135)

Variable	Group	Frequency	Percentage
Gender	Females	77	57
	Males	58	43
Education	Year 8	15	11
	Year 9	59	44
	Year 10	40	30
	Year 11	21	15
Age		Mean	SD
	All	14.650	1.088
	Females	14.650	1.121
	Males	14.660	1.052
	Year 8	13.200	0.775
	Year 9	14.370	0.945
	Year 10	15.100	0.709
	Year 11	15.620	0.865

5. Instruments

We used three instruments to collect research data and these were: (1) the researcher-constructed demographical questionnaire that collected bio-data (gender, educational level and age); (2) the 4-point Likert-type Center for Innovative Teaching Experiences (CITE) Learning Styles Instrument comprising nine 5-item subscales (Babich, Burdine, Albright, and Randol, 1976); and (3) the 51-item College Level Study Skills Inventory (CLSSI) consisting of six subscales each with 5-point nominal rating values attached to the items (Congos, 2011).

The CITE Learning Styles Instrument (Burdine et al, 1976) is intended to help teachers to determine the learning styles preferred by their students. According to Burdine et al (1976) it is divided into the following three main areas:

- Information gathering includes auditory language, visual language, auditory numerical, visual numerical, and auditory-visual language, auditory numerical, visual numerical, and auditory-visual-kinesthetic combination.
- Work conditions focus on whether a student works better alone or in a group.
- Expressiveness considers if a student is better at oral or written communication.

The adjusted total scores on the Learning Styles Inventory fall into one of three categories: major, minor, and negligible. Burdine et al (1976) define these categories as follows in terms of the adjusted total scores:

- Major (33-40): The student prefers this mode of learning, feels comfortable with it, and uses it for important (to the student) learning. A student does not necessarily have one and only one preferred style.
- Minor (20-32): The student uses this mode but usually as a second choice or in conjunction with other learning styles.
- Negligible (05-19): The student prefers not to use this if other choices are available. The student does not feel comfortable with this style.

The CLSSI (Congos, 2011) is divided into the following 6 subscales: Text book reading (8 items); Note-taking (5); Memory (9); Test preparation (13); Concentration (10; and Time management (6). Each item is rated on a 5-point Likert-type scale ranging from 1 = Almost never, through 3 = About half of the time, to 5 = Almost

always. This questionnaire was found suitable for use with secondary school students in Brunei. Interpretations and meanings attached to subtest cut-off (criterion/critical) scores are as follows.

- Textbooks: less than a score of 30 suggests that changes in textbook reading skills are likely to increase grades.
- Note-taking: less than a score of 20 suggests that changes in note-taking skills are likely to increase grades.
- Memory: less than a score of 30 suggests that changes in memory skills are likely to increase grades.
- Test preparation: less than a score of 40 suggests that changes in test preparation skills are likely to increase grades.
- Concentration: less than a score of 35 suggests that changes in concentration skills are likely to increase grades.
- Time management: less than a score of 20 suggests that changes in time management skills are likely to increase grades.

We also collected the respondents' continuous assessment math grades for the previous academic term from school records. In predictions of academic success, previous research has used either grades or grade point averages (GPA) as measures of academic achievement or performance. Two illustrative examples here are Broussard (2002) who used grades as an indicator of academic achievement and Rickets (2003) who employed GPA as an index of academic performance. Although these grades were obtained from different assessment tasks, they were (regardless of the subject, educational level, and school) standardized in the whole Brunei education system under the ongoing school-based assessment procedures (where A = 80-100%; B = 70-79%; C = 60-69%; D = 50-59%; E = 40-49%; and F = 0-39%). The distribution of math grades in the present study for all the 135 participants across the four levels of secondary education (Form 2 to Form 5) ranged from A to F. The letter grades were then converted to their numerical equivalents (e.g. A = 5; B = 4; C = 3; D = 2; E = 1; and F = 0). Being sensitive data and for ethical reasons, the grades were analyzed and reported only at the group level. In the present study, high (top) math achievers were students who obtained A-B grades (coded 3 for analysis purposes) while low (bottom) achievers were those who got E-F grades (coded 1). The majority of the participating students scored in the middle of the range with C-D grades (coded 2). The descriptive statistics and reliability coefficients for the two questionnaires' subscales are presented in Table 2.

Table 2. Descriptive statistics and reliability of the instrument (N=135)

Scale	Subscale	Items	Mean	SE Mean	SD	Alpha
Learning Styles	Visual-Language	5	14.660	0.187	2.172	0.792
	Visual-Numerical	5	14.730	0.207	2.407	0.653
	Auditory-Language	5	13.830	0.224	2.608	0.700
	Auditory-Numerical	5	14.210	0.230	2.672	0.840
	Auditory-Visual-Kinesthetic	5	15.160	0.174	2.027	0.695
	Social-Individual	5	15.190	0.229	2.658	0.793
	Social-Group	5	15.530	0.232	2.701	0.842
	Expressiveness-Oral	5	13.950	0.202	2.351	0.772
	Expressiveness-Written	5	13.930	0.204	2.371	0.819
Study Strategies	Text book reading	8	25.590	0.420	4.884	0.677
	Note taking	5	16.310	0.408	4.742	0.818
	Memory	9	30.410	0.526	6.109	0.787
	Test preparation	13	41.830	0.560	6.504	0.821
	Concentration	10	35.410	0.447	5.199	0.791
	Time management	6	18.330	0.678	7.877	0.808

The correlations in Table 3 may be interpreted in many ways. The low and non-significant correlations suggest that the scales are measures of different constructs and do not replicate each other. For these scales, the correlations provide good quantitative evidence for the scales' discriminant validity. The low but significant

correlations imply that the scales (to a small extent) might be overlapping and measuring the same construct but the amount of duplication or common variance (r^2) is little and negligible. The paired scales can thus be said to have satisfactory discriminant validity and low convergence validity. The questionnaire scores and test grades used in the present study were considered to have had good ecological validity in that students obtained them in their respective schools. There was no evidence suggesting that students responded to questionnaire items cautiously and defensively. In addition, students obtained math test grades as part of continuous assessment. Such assessments exert less pressure, anxiety, tension, and stress to students compared to the abrasive demands of the final examinations.

Table 3. Convergence and discriminant validity of the instruments (N=135)

Scales	Subscales	1	2	3	4	5	6	7	8
Learning Styles	1. Visual-Language	1							
	2. Visual-Numerical	0.366**	1						
	3. Auditory-Language	0.083	0.203*	1					
	4. Auditory-Numerical	0.101	0.249**	0.428**	1				
	5. Auditory-Visual-Kinesthetic	0.304**	0.321**	0.389**	0.258**	1			
	6. Social-Individual	0.331**	0.259**	0.083	0.161	0.219*	1		
	7. Social-Group	0.119	0.156	0.384**	0.055	0.246**	-0.086	1	
	8. Expressiveness-Oral	0.178*	0.116	0.177*	0.128	0.044	0.215**	0.069	1
	9. Expressiveness-Written	0.404**	0.361**	0.272**	0.264**	0.395**	0.308**	0.355**	0.026
Study Strategies	1. Text book reading	1							
	2. Note taking	0.484**	1						
	3. Memory	0.472**	0.619**	1					
	4. Test preparation	0.471**	0.546**	0.629**	1				
	5. Concentration	0.341**	0.437**	0.535**	0.632**	1			
	6. Time management	0.395**	0.621**	0.486**	0.597**	0.561**			

* $p < .05$ (2-tailed)

** $p < .01$ (2-tailed)

6. Data Analysis

The quantitative data were analyzed by both descriptive statistics (frequencies, percentages, mean and standard deviation) and inferential statistics (t-tests for independent samples incorporating ANCOVA F, Pearson's correlation, and One-Way ANOVA including Eta squared values). The rationale and justification for using these techniques is two-fold. First, the procedures were deemed to be appropriate for addressing the research objectives. Second, the data were obtained from a random sample and there was no evident violation of the statistical assumptions.

7. Procedures

Prior to collecting the data, the participants were told about the purpose and objectives of the study. No deception was involved in the study. In addition, the participants were told both verbally and in writing about the ethical conditions or requirements for being involved in the study. The discussion on this topic centered on issues of voluntary participation, privacy, anonymity, confidentiality, physical and psychological harm, debriefing, and informed consent. Students were given ample time to reflect on and withdraw from the study if they felt uncomfortable with the research's purpose and objectives. The participants voluntarily agreed to participate in the study. With regard to English language problems, the meanings of difficult English words, sentences and phrases on the instruments were verbally explained to the participants. Furthermore, students at the participants' university take most courses in English language and have participated in many research studies that required them to complete self-report scales / questionnaires in English. The researchers therefore deemed it not necessary to translate the instruments into Bahasa Melayu (Brunei's mother tongue and official language).

The study met the ethical requirements for using human participants in research stipulated by the participants' university, the Government of Brunei, and the Helsinki Declaration.

8. Results

The findings of the study are presented below according to the three main objectives of the investigation.

Differences in learning styles and study strategies by participants' educational level.

According to Table 4, junior high school students in Forms 2-3 scored significantly higher on the use of the expressive-written learning style than their senior counterparts (Forms 4-5 students). No other significant differences by educational level were obtained on the variables listed in Table 4.

Table 4. Means, standard deviatons and F-values for learning styles and study strategies by education level (N=135)

Scale	Form 2 (n=15)		Form 3 (n=59)		Form 4 (n=40)		Form 5 (n=21)		F	P	Eta
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	(df=3;134)	(2-tailed)	Squared
Visual-Language	15.000	2.000	15.030	2.289	14.230	2.190	14.190	1.778	1.587	0.196	0.035
Visual-Numerical	15.130	2.532	14.920	2.111	14.330	2.633	14.710	2.610	0.629	0.597	0.014
Auditory-Language	14.130	2.924	14.320	2.201	13.280	2.864	13.290	2.795	1.703	0.169	0.038
Auditory-Numerical	14.930	3.453	14.360	2.234	13.580	2.800	14.520	2.892	1.282	0.283	0.029
Auditory-Visual-Kinesthetic	15.270	2.154	15.440	1.923	15.030	2.281	14.570	1.660	1.041	0.377	0.023
Social-Individual	14.800	2.757	15.390	2.600	15.300	2.301	14.710	3.408	0.460	0.711	0.010
Social-Group	15.730	2.492	16.170	2.357	14.900	3.233	14.760	2.322	2.503	0.062	0.054
Expressiveness-Oral	13.730	2.549	14.270	2.227	13.600	2.600	13.860	2.081	0.711	0.547	0.016
Expressiveness-Written	14.200	2.426	14.560	2.011	13.350	2.527	13.050	2.578	3.390	0.020*	0.072
Text book reading	26.000	4.855	26.150	4.544	24.400	5.391	25.950	4.769	1.129	0.340	0.025
Note taking	15.330	6.043	16.490	4.066	16.130	5.302	16.860	4.597	0.349	0.790	0.008
Memory	30.870	6.140	30.150	5.626	29.500	6.797	32.520	5.927	1.202	0.312	0.027
Test preparation	42.930	8.413	42.760	7.689	40.950	8.626	40.100	6.441	0.877	0.455	0.020
Concentration	35.800	5.596	34.610	6.772	35.980	6.993	36.330	5.444	0.551	0.648	0.012
Time management	17.670	6.195	18.420	4.324	18.630	5.736	17.950	5.929	0.164	0.920	0.004

* $p < .05$ (2-tailed)

Differences in learning styles and study strategies by participants' mathematics ability.

From Tukey HSD post hoc tests, evidence in Table 5 revealed that the more able math students (top or high scorers) significantly use the auditory-language learning style than their less able peers (bottom or low scorers) and scorers in the middle of the range. No other significant differences among participants were found on the learning styles by math ability. However, Tukey HSD post hoc tests also indicated that students with middle range abilities in mathematics significantly endorsed the use of text book reading, note-taking, and memory study strategies than the other two categories of students (low and high scorers) in Table 5.

Table 5. Means, standard deviatons and F-values for learning styles and study strategies by math ability (N=135)

Scale	Bottom (n=15)		Middle (n=54)		Top (n=30)		F	P	Eta
	Mean	SD	Mean	SD	Mean	SD	(*df*=2;134)	(2-tailed)	Squared
Visual-Language	14.59	2.342	14.91	2.165	14.33	1.882	0.714	0.491	0.011
Visual-Numerical	14.39	2.333	14.8	2.475	15.2	2.398	1.096	0.337	0.016

Auditory-Language	13.29	2.753	13.8	2.218	14.8	2.809	3.264	0.041*	0.047
Auditory-Numerical	13.86	2.987	14.44	2.246	14.4	2.836	0.711	0.493	0.011
Auditory-Visual-Kinesthetic	14.78	2.138	15.43	1.869	15.33	2.073	1.461	0.236	0.022
Social-Individual	15.18	2.347	15.37	2.87	14.9	2.82	0.3	0.741	0.005
Social-Group	14.9	2.879	15.91	2.579	15.9	2.482	2.227	0.112	0.033
Expressiveness-Oral	13.86	2.514	13.96	2.163	14.07	2.463	0.072	0.931	0.001
Expressiveness-Written	13.78	2.648	14.09	2.113	13.87	2.374	0.231	0.794	0.003
Text book reading	24.47	5.308	26.8	4.7	25.3	4.036	3.136	0.047*	0.045
Note taking	15.1	4.725	17.74	4.327	15.8	4.951	4.532	0.013**	0.064
Memory	28.9	5.815	32.13	6.109	29.87	6.01	3.982	0.021*	0.057
Test preparation	40.33	7.959	43.5	7.348	41.37	8.336	2.226	0.112	0.033
Concentration	24.86	6.986	36.17	6.354	35	5.987	0.602	0.549	0.009
Time management	17.59	5.1	18.98	4.981	18.4	5.739	0.945	0.391	0.014

* p < .05 (2-tailed)

** P < .01 (2-tailed)

Females scored significantly higher on the visual-language and auditory-visual-kinesthetic learning styles than their male counterparts (see Table 6). Females also scored significantly higher on five of the six study strategies presented in Table 6 than males (text book reading, note-taking, memory, test preparation, and concentration). The findings in Table 6 appear to have identified some of the reasons supporting the general notion why female students perform better in math than males.

Table 6. Means, standard deviatons, and T- values by gender (N=135)

Scale	Females (n=77)		Males (n=58)		ANCOVA	T	P
	Mean	SD	Mean	SD	F	(*df*=133)	(2-tailed)
Visual-Language	15.080	2.031	14.100	2.245	0.371 *ns*	2.637	0.009 **
Visual-Numerical	15.060	2.430	14.290	2.325	0.159 *ns*	1.861	0.065
Auditory-Language	13.700	2.686	14.000	2.573	0.253 *ns*	- 0.657	0.512
Auditory-Numerical	14.310	2.706	14.090	2.644	0.201 *ns*	0.484	0.629
Auditory-Visual-Kinesthetic	15.570	1.888	14.620	2.093	0.954 *ns*	2.764	0.007 **
Social-Individual	15.380	2.601	14.950	2.737	0.034 *ns*	0.926	0.356
Social-Group	15.690	2.871	15.310	2.465	0.708 *ns*	0.804	0.423
Expressiveness-Oral	13.840	2.385	14.090	2.319	0.345 *ns*	- 0.591	0.556
Expressiveness-Written	14.130	2.262	13.660	2.503	1.382 *ns*	1.153	0.251
Text book reading	26.310	5.084	24.620	4.468	0.549 *ns*	2.014	0.046 *
Note taking	17.030	4.648	15.360	4.738	0.043 *ns*	2.042	0.043 *
Memory	31.400	6.070	29.090	5.957	0.004 *ns*	2.212	0.029 *
Test preparation	43.030	7.026	40.240	8.692	3.036 *ns*	2.058	0.042 *
Concentration	36.440	4.857	34.050	8.042	16.488 **	2.141	0.034 *
Time management	19.050	4.724	17.360	5.668	3.727 *ns*	1.887	0.061

* p < .05 (2-tailed)

** P < .01 (2-tailed)

ns = Not significant

9. Discussion

The present study found the more able math students as stronger users of the auditory-language learning style than their less able peers. The study also found high math achievers were better and more efficient users of the text book reading, note-taking, and memory study strategies than low achievers. These are then clearly the critical areas of psychological and academic interventions to which more attention and effort need to be directed to improve math performance and achievement among less able students.

In addition there was evidence from the present study that gender was a predictor of math achievement: B = -0.670, $p < .05$ [Model: F (df = 3, 134) = 4. 445, $p < .01$). Further evidence from the present study also indicated that females (Mean = 2.430, SD = 1.618) scored significantly higher than males (Mean = 1.760, SD = 1.760) in mathematics [t (df = 133) = 2.293, $p < .05$]. The implications of these findings are that males need to be provided counseling, mentorship, and pastoral care services on learning styles (see Table 6) in which females scored high (visual-language, and auditory-visual-kinesthetic) and study strategies (also Table 6) where females were superior (text book reading, note-taking, memory, test preparation, and concentration).

10. Conclusion

Based on the findings from the present study, we conclude that coaching students in the effective use of learning styles and study strategies that are empirically identified by research to be useful might be beneficial to raise math achievement among less able students of both genders. The key variables according to this research are auditory-language, visual-language, and auditory-visual-kinesthetic (learning styles) and text book reading, note-taking, memory, test preparation, and concentration (study strategies). These variables need to be incorporated in both counseling and educational interventions when helping students with learning difficulties.

11. Limitations

The present study was informed by three main limitations. First, as a survey the results cannot establish cause-effect relationships in variables investigated. Second, a qualitative interview component is missing but was necessary to triangulate findings from the quantitative survey. Third, no attempt was made to obtain criterion-related validity of the scales used due to concerns that participating students were too busy with exam preparations towards the end of the semester and did not have a lot of time to complete many questionnaires at the time of data collection.

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