SECONDARY SCHOOL MATHEMATICS, GENDER, AND MUFY MATH PERFORMANCE: A SUNWAY CAMPUS CASE STUDY

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ABSTRACT

The purpose of this study is to examine the Malaysian students' performance in Fundamental Mathematics A in the Monash University Foundation Year (MUFY) programme. This study compared Malaysian students' secondary school mathematics background and gender to their performance in the MUFY Fundamental Mathematics A. The sample consisted of 125 Malaysian students who took the MUFY Fundamental Mathematics A in January, March, July and August of 2009. The data revealed that the grades of Mathematics at the Sijil Pelajaran Malaysia (SPM) or Malaysian Certificate of Education level were significantly related to the grades of the MUFY Fundamental Mathematics A. Furthermore, students with SPM Additional Mathematics performed better than their classmates who did not take the subject in the MUFY Fundamental Mathematics A. Also, female students were found to perform better than their male counterparts in the MUFY Fundamental Mathematics A.

Key words: secondary school Mathematics, post-secondary Mathematics, correlation, gender

INTRODUCTION

The admission requirements for the MUFY are a minimum of five credits in the SPM examination including credits in English and Mathematics, and conditional offers are made to students based on their forecast results. Generally, students who meet the minimum requirements in SPM Mathematics are considered to be able to cope with the Math subjects offered by MUFY. However, there are exceptions to the rule given that a few students who obtained a credit in SPM Mathematics failed the MUFY Fundamental Mathematics A, which is equivalent to the Australian Year 11 Mathematics, and which is perceived as the more manageable Math offered by MUFY. Accordingly, this raised the question on whether the minimum requirement in Mathematics set by MUFY is sufficient to determine the students' ability to cope with the Math offered by this pre-university programme.

In order to understand the problem further, the SPM Mathematics and Additional Mathematics syllabi are compared with the syllabus of the MUFY Fundamental Mathematics A (shown in Table 1).

Table 1. Syllabi of SPM Math and Additional Math and MUFY Fundamental Mathematics A

SPM Mathematics	The syllabus has three main areas, namely: 1) Number – whole numbers, fractions, decimals, percentages, negative numbers, multiples and factors, squares, square roots, cubes and cube roots, standard forms, and number bases; 2) Shape and space – basic management, lines and angles, polygons, perimeter and areas, geometrical construction, loci in two dimensions, circles, geometric solids, Pythagoras' Theorem, trigonometry, bearings, angle of elevation and angle of depression, lines and planes in three dimensions, plan and elevation, earth as a sphere, and transformation; 3) Relationship – indices, algebraic expressions, algebraic formulae, linear equations, linear inequalities, quadratic expressions and equations, coordinates, the straight line, graphs of functions, gradient and the area under a graph, ratios and proportions, variations, matrices, sets, mathematical reasoning, statistics, and probability.
SPM Additional Mathematics	The syllabus has two learning packages: Core and Elective. The Core Package, which is compulsory for all students, comprises five components, namely: 1) Geometry – coordinate geometry, and vectors; 2) Algebra – functions, quadratic equations, quadratic functions, simultaneous equations, indices and logarithms, progressions (arithmetic and geometric), and linear law; 3) Calculus – differentiation, and integration, 4) Trigonometry – circular measures, and trigonometric functions; 5) Statistics – measures of central tendency and dispersion, permutations and combinations, and probability. Students need to choose only one application package from the Elective Package based on their inclination and field of interest: 1) Science and Technology Application Package – solutions of triangles and motion along a straight line; or 2) Social Science Application Package – index number and linear programming.
MUFY Fundamental Mathematics A	The syllabus has six topics, namely: 1) Number systems – natural numbers, integers, rational numbers, irrational numbers, directed numbers, commutative law, associative law, distributive law, order of operations, and factors and multiples; 2) Fractions, decimals and percentage;

	3) Algebra – linear equations, quadratic equations, indices, and logarithms; 4) Ratio and proportion; 5) Sequence and series – arithmetic and geometric; 6) Business mathematics – simple interest, effective rate of interest, compound interest, depreciation, and reducing balance loans.

Adapted from the Ministry of Education (2004, 2006) and Monash College Pty Ltd (2008)

The syllabus of SPM Mathematics covers the first four topics of MUFY Fundamental Mathematics A except the logarithms. On the other hand, the syllabus of SPM Additional Mathematics has logarithms and sequence, and series, which are part of the MUFY Fundamental Mathematics A syllabus. SPM Mathematics is a compulsory subject taken by all secondary school students while SPM Additional Mathematics is an elective subject (not taken by all students). The central question is : Can students with SPM Additional Mathematics do better in the MUFY Fundamental Mathematics A than students without SPM Additional Mathematics?

Apart from that, in Malaysia, at primary and secondary educational levels, female students were better than male students in Mathematics (Zalizan, Saemah, Roselan & Jamil, 2005). Accordingly, the corresponding question is: Can this finding be extended to the pre-university level in programmes such as the MUFY?

The objectives of the current study are:

1) To determine whether there is a correlation/a relationship between the grades of SPM Mathematics and Fundamental Mathematics A in the MUFY programme.
2) To determine whether students with SPM Additional Mathematics do better in MUFY Fundamental Mathematics A compared to those without SPM Additional Mathematics.
3) To determine whether there is a correlation/relationship between the Malaysian students' performance in MUFY Fundamental Mathematics A and their gender.

LITERATURE REVIEW

Relationship between Mathematics Performances at Different Educational Levels

Many studies have indicated that students' performance at one educational level is highly related to the Mathematics taken at a lower educational level. Through extensive research, Adelman (1999) found that students in the United States who had completed a class in high school Mathematics above algebra II level were twice as likely to complete a bachelor's degree. Adelman (1999) also concluded that the number and intensity of mathematical subjects completed in high school are excellent indicators of success in higher education. This was also supported by Holton (1998). Furthermore, students' exposure to challenging mathematics enhances self-regulatory skills that benefit achievement in all subjects attempted in post-secondary education (Matthews, 2000; Pugh & Lowther, 2004). A group

of researchers from Maryland Higher Education Commission (2009) revealed that the high school GPA was the best predictor of college Math performance. A study conducted in the University of Western Sydney (Rylands & Coad, 2009) concluded that the students' secondary school mathematics background has a dramatic effect on the pass rates of four different Mathematics and mathematically related subjects at university level.

James, Montelle, and Williams (2008) carried out a study at the University of Canterbury in New Zealand to analyse the association between the final secondary school qualifications in Mathematics with calculus of incoming students, and their results in the first-year mathematics subjects at the university since 2005. They found that the Mathematics results of the National Certificate for Educational Achievement (NCEA) taken during the final secondary year were a strong indicator of success in tertiary Mathematics study. Henning (2007) concluded that the educational path prior to entering college determined the performance in college Mathematics. Students emerging from the new curriculum Grade 12 Math for College and Apprenticeship (MAP4C) failed their first semester Math at nearly three times the rate of all other course groupings combined. On the other hand, students emerging from any of the university-stream high school Grade 12 Math courses or the college-stream Maths for Technology (MCT4C) were best prepared for college Math in Manufacturing Sciences Division post-secondary programmes. Undergraduate and graduate students at Cameron University took the D'Amore Test of Elementary Arithmetic. The test showed that students who had taken college Math courses had significantly higher scores than those who had not taken them (Weinstein & Laverghetta, 2009).

A study carried out by Noor Azina and Azmah Othman (2006) at University Malaya found that Mathematics performance at the SPM level was one of the influential factors for academic achievement at the Faculty of Business and Accountancy though this finding did not apply to students studying at the Faculty of Arts and Social Science, and the Faculty of Economics and Administration.

Gender Difference on Mathematics Performance

There were mixed conclusions on gender difference on mathematics performance. Some studies showed that there were no statistical significance between male and female students in terms of mathematics performance, but some studies revealed otherwise.

In one recent study, researchers obtained useable data from 10 states in the United States representing the testing of more than 7 million youth (Hyde, Lindberg, Linn, Ellis & Williams, 2008). Averaged across these states, gender differences in Mathematics performance were close to zero in all grades, including high school. A study in two countries, Hong Kong and the United States, examined male and female students' performances on mathematics in the Program for International Student Assessment (PISA) 2003 (Liu & Wilson, 2009). PISA is an assessment that focuses on 15-year-olds' capabilities in reading literacy, mathematics literacy and science literacy. The study revealed that the male students in both countries demonstrated superior performance, particularly in complex multiple choice items while female students scored higher on probability, algebra, and reproduction items.

There were also mixed results for a study done in the United States and China (Tsui, 2007). The mean Scholastic Aptitude Test (SAT)-Math score among US male high-school seniors was consistently higher than the mean of their female counterparts while in China there were no gender differences in the mean of college entrance examination Mathematics scores among high-school seniors.

In Malaysia, the national examination results at all levels, namely Primary School Evaluation Test (UPSR), Lower Secondary Assessment Test (PMR) and SPM, from 1996 to 2000 showed that female students performed better than male students across almost all school subjects (Zalizan et al., 2005). In a case study on diploma students at a local public university, the female students were found to perform better than male students in all the four Mathematics subjects (Tang, Voon & Nor Hazizah, 2009).

METHODOLOGY

The data was obtained from MUFY student records database for 125 Malaysian students (59 females and 66 males) who took Fundamental Mathematics A in January, March, July and August of 2009. Among these Malaysian students, 116 completed SPM, 5 completed the General Certificate of Education (GCE) and 3 completed the International General Certificate of Secondary Education (IGCSE) and only 1 completed the General Certificate of Secondary Education (GCSE).

The grade system of the MUFY subjects is shown in Table 2. On the other hand, the grade system of the SPM examination is assigned a letter and a point to each range (A1, A2, B3, B4, C5, C6, D7, E8, F9), with A1 as the highest range and F9 as the lowest range.

Table 2: The Grade System of MUFY subjects

Grade	Score
High Distinction	80% or above
Distinction	70% to 79%
Credit	60% to 69
Pass	50% to 59%
Fail	49% or below

Data from 116 Malaysian students who completed the SPM examination were used to examine the first two objectives in this study. For the third objective, it was evaluated by using data of all Malaysian students in this study. The SPSS software was used to analyse the quantitative data and to assess the objectives of the study by using the Pearson's chi-square test and one way ANOVA.

RESULTS

Preliminary Analysis

The summarised data in Figure 1 shows that about 34% of Malaysian students obtained High Distinction for the MUFY Fundamental Mathematics A and about 6% of this group failed the subject.

Figure 2 shows that about 40% of the Malaysian students who completed SPM scored A1 for SPM Mathematics, about 15% of them scored A2, about 5% of them with grades of below C6 but no students failed this subject.

Figure 3 shows that about 76% of Malaysian students took SPM Additional Mathematics. The grade distribution for students with SPM Additional Mathematics is shown in Figure 4. The SPM Additional Mathematics grades are more uniformly distributed than SPM Mathematics and MUFY Fundamental Mathematics A. It also discloses that grades D7 and E8 of SPM Additional Mathematics have the highest percentage at about 19% each. About 3% of the students failed SPM Additional Mathematics.

Figure 1. The Grade Distribution of MUFY Fundamental Mathematics A

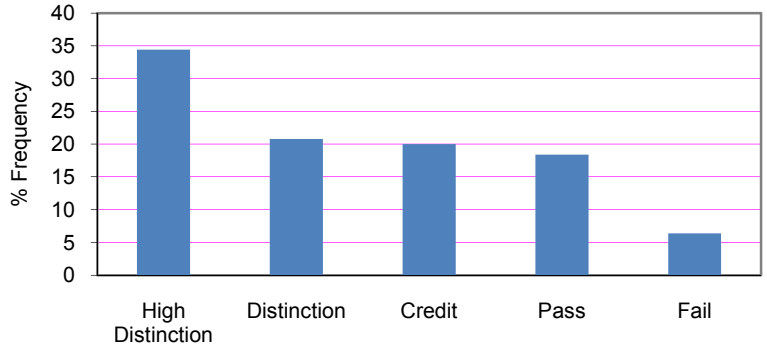


Figure 2. The Grade Distribution of SPM Mathematics

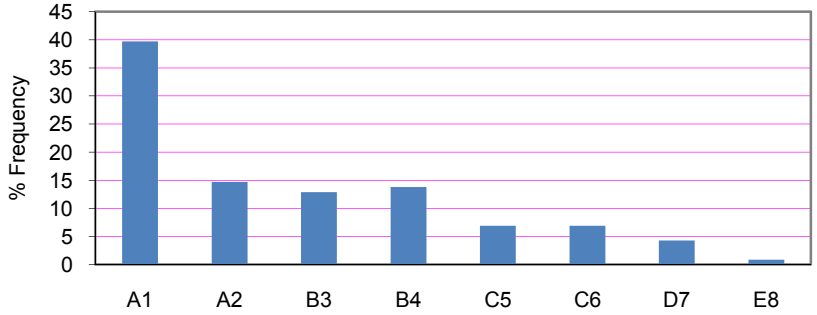


Figure 3. Students with and without SPM Additional Mathematics

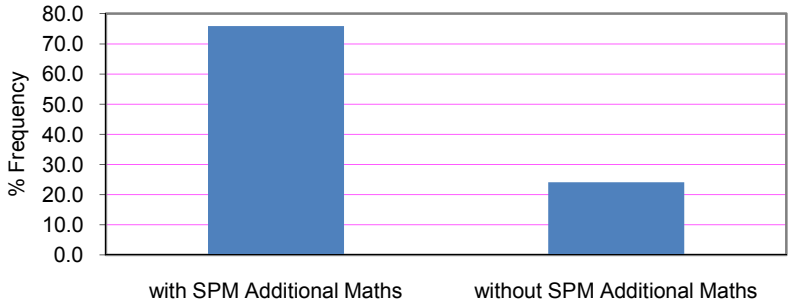
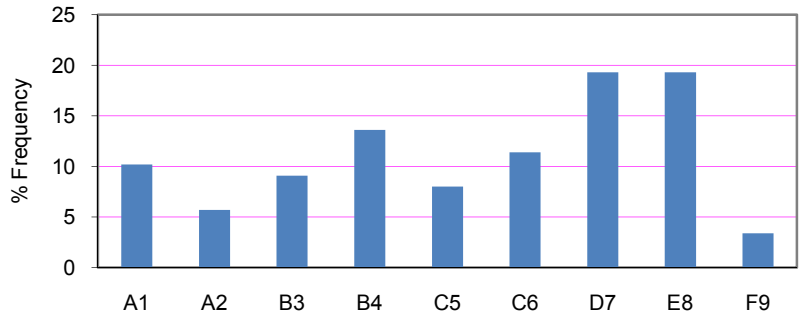


Figure 4. The Grade Distribution of SPM Additional Mathematics



The Relationship between SPM Mathematics and MUFY Fundamental Mathematics A

Cross tabulation between SPM Mathematics and MUFY Fundamental Mathematics A is shown in Table 3. It reveals that students with better grades in SPM Mathematics achieved better grades in the MUFY Fundamental Mathematics A. The relationship between poor SPM Mathematics grade and poor performance in MUFY Fundamental Mathematics A is not clear.

Some cells are with zero count in Table 3 especially at the last row and the last few columns. From the statistical point of view, these zero counts indicate that the test does not meet one of the assumptions of Pearson's chi-square (Lieberman, 1971). In order to reduce the number of zero counts, the SPM grades are merged as follows: A1 and A2 are combined as A, B3 and B4 as B, C5 and C6 as C, D7 and E8 as D and F9 as F. A new cross tabulation is generated as shown in Table 4, and it also provides a summary of the Chi-square test on the merged data. After the grades are merged, the pattern of the relationship between these mathematics subjects at two different educational levels is clear. The Chi-square test suggests that there is a significant relationship between SPM Mathematics and MUFY Fundamental Mathematics A as the p-value is less than 0.01, where the significance level is set at 0.01.

Table 3. Two-way Tabulation between SPM Mathematics and MUFY Fundamental Mathematics A

MUFY Fundamental Mathematics A	SPM Mathematics								
	A1	A2	B3	B4	C5	C6	D7	E8	Total
High Distinction	28	5	4	3	1	0	0	0	41
Distinction	12	5	1	1	3	1	1	0	24
Credit	5	6	7	3	1	0	2	0	24
Pass	1	1	3	7	2	4	2	0	20
Fail	0	0	0	2	1	3	0	1	7
Total	46	17	15	16	8	8	5	1	116

Table 4 A Summary of Chi-square Test for the Relationship between SPM Mathematics and MUFY Fundamental Mathematics A for Merged Grades

MUFY Fundamental Mathematics A	SPM Mathematics (with Merged Grades)				
	A	B	C	D	Total
High Distinction	33	7	1	0	41
Distinction	17	2	4	1	24
Credit	11	10	1	2	24
Pass	2	10	6	2	20
Fail	0	2	4	1	7
Total	63	31	16	6	116

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	51.854	12	.000
Likelihood Ratio	57.732	12	.000
Linear-by-Linear Association	34.916	1	.000
N of Valid Cases	116		

The Effects of SPM Additional Mathematics on MUFY Fundamental Mathematics A

Students with SPM Additional Mathematics have an average score of 73.66 and a standard deviation of 14.284. Students without SPM Additional Mathematics have an average score of 60.68 and a standard deviation of 16.148. The average and standard deviation for students with SPM Additional Mathematics are higher than that of students without SPM Additional Mathematics.

The SPSS output of the t-test in Table 5 indicates that there is no significant difference between the variances of the two groups on the scores of MUFY Fundamental Mathematics A as the p-value is equal to 0.439, where the significance level is set at 0.01. The difference between the average score for students with SPM Additional Mathematics and the average score for students without SPM Additional Mathematics is -12.981, which is not close to zero. The standard deviation of mean difference between these two groups is 3.200.

The t-test suggests that the average score for students with SPM Additional Mathematics is significantly higher than the average score for students without SPM Additional Mathematics as the p-value is less than 0.01, where the significance level is set at 0.01.

Table 5: A Comparison between Students with and without SPM Additional Mathematics

Group Statistics

	SPM Additional Mathematics	N	Mean	Std. Deviation
MUFY Fundamental Mathematics A	Didn't take the subject	28	60.68	16.148
	Took the subject	88	73.66	14.284

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
MUFY Fundamental Mathematics A	Equal variances assumed	.602	.439	-4.057	114	.000	-12.981	3.200
	Equal variances not assumed			-3.806	41.323	.000	-12.981	3.410

Gender Difference on MUFY Fundamental Mathematics A

Female students have an average score of 74.08 and a standard deviation of 15.405. Male students have an average score of 66.38 and a standard deviation of 15.972. The average score for female students is higher than that of male students, and the standard deviation for male students is slightly higher than that of female students.

The SPSS output of the t-test in Table 6 indicates that there is no significant difference between the variances of female and male students on the scores of MUFY Fundamental Mathematics A as the p-value is equal to 0.714, where the significance level is set at 0.01. The difference between the average score for female students and the average score for male students is 7.706, which is not close to zero. The standard deviation of mean difference between female and male students is 2.814.

The t-test suggests that the average score for female students is significantly higher than the average score for male students as the p-value is less than 0.01, where the significance level is set at 0.01.

Table 6. A Comparison between Male and Female Students in MUFY Fundamental Mathematics A

Group Statistics

	Gender	N	Mean	Std. Deviation
MUFY Fundamental Mathematics A	Female	59	74.08	15.405
	Male	66	66.38	15.972

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means				
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
MUFY Fundamental Mathematics A	Equal variances assumed	.135	.714	2.738	123	.007	7.706	2.814
	Equal variances not assumed			2.744	122.276	.007	7.706	2.808

DISCUSSIONS

The Effects of SPM Mathematics and Additional Mathematics on MUFY Fundamental Mathematics A

The Chi-square test suggests that there is a significant effect of taking a Math subject at Malaysian secondary school on the students' performance in the MUFY Fundamental Mathematics A subject. The conclusion of this study is consistent with the study by Rylands and Coad (2009) who found that secondary school Mathematics background had a huge impact on the pass rates of four different Mathematics and mathematically related subjects at university level. In their study, they focused on the relationship between secondary school Mathematics and university Mathematics whereas this study focuses on the effect of secondary school Mathematics results on the results of a Mathematics subject at the pre-university level.

The Chi-square result for the relationship between SPM Mathematics and MUFY Fundamental Mathematics A is also consistent with the study by James, Montelle, and Williams (2008) who analysed the association between the final secondary school qualifications in Mathematics with calculus of incoming students and their results in the first-year university mathematics. The difference between James et al's study in 2008 and this study is the content of Mathematics at secondary school and the level of education where the studies are done.

Students who did SPM Additional Mathematics at secondary school learned five of the six topics of MUFY Fundamental Mathematics A before they joined the pre-university programme. Students with SPM Additional Mathematics background have an advantage over their classmates who do not have this secondary school background and they are expected to perform better. The data revealed that students who took SPM Additional Mathematics scored higher points in Mathematics at the MUFY programme compared to students who did not take the SPM Additional Mathematics. The SPM Additional Mathematics is considered a challenging subject and is usually taken by students in the Science stream. This finding is consistent with the studies by Matthews (2000) and Pugh and Lowther (2004) who concluded that students' exposure to challenging Mathematics benefits achievement in all subjects attempted in post-secondary education.

Gender Difference

In the literature review, studies at different educational levels in different countries had a wide range of conclusions.

The finding of the study on gender difference in mathematics performance in the MUFY program is not consistent with the study by Hyde et al. (2008) which revealed that gender difference does not affect Mathematics performance for the high school students in the United States. The conclusion of this study is also not consistent with the one carried out by Tsui (2007) which indicates that male students' scores are higher than females' score in the United States' SAT-Math test, and that in China, there is no gender difference in college entrance examination Mathematics scores.

Furthermore, the result of this study is not consistent with the study by Liu and Wilson (2009) that was conducted on PISA's students. Male PISA's students performed better than female students in multiple choice items. However, MUFY's Mathematics Fundamental A does not include multiple choice items and comprises only subjective questions. Liu and Wilson (2009) also examined female students' performance in different areas including algebra and showed that female PISA's students outperformed their male counterparts. Their finding is consistent with this study, where algebra is the basic knowledge in sequence and series, and financial Mathematics in MUFY Fundamental Mathematics A.

In the Malaysian context, this finding is consistent with the results of the study conducted by Zalizan et al. (2005) which indicated that female students perform better than male students in all subjects including Mathematics and Additional Mathematics in the SPM examination. This finding is consistent with the results of the study conducted by Tang et al. (2009) on diploma students at a local public university.

CONCLUSION

The case of a few students with a credit in SPM Mathematics who failed in the MUFY Fundamental Mathematics A cannot be used to generalise the problem. In conclusion, the minimum requirement in Mathematics set by MUFY is sufficient to determine the students' ability to cope with Fundamental Mathematics A at this pre-university level.

Students without SPM Additional Mathematics are at a disadvantage as they did not learn logarithms and sequence, and series at secondary school compared to students with SPM Additional Mathematics, and the finding of this study supports this. Because of this disadvantage, lecturers should pay more attention to students without SPM Additional Mathematics.

The finding by Zalizan et al. (2005) can be extended to the MUFY programme as female students perform better than male students in Mathematics.

RECOMMENDATIONS

Mathematics and Additional Mathematics at secondary school level can be used as an indicator to gauge students' ability to cope with all mathematical subjects in the MUFY programme. Subsequently, a series of measures are needed, which include remedial classes to help students with poor Mathematics background.

The study provides a framework to investigate the performance of students in other mathematics units (Fundamental Mathematics B, Mathematics A and B, Advanced Mathematics A and B) offered by the pre-university program. The findings of this study are only applicable to Malaysian students taking the MUFY Mathematics Fundamental A subject. Future research on the Mathematics performance in the MUFY programme should include international students.

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