An Exploratory Study on the Effect of Teaching and Learning of Mathematics Using English

by

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ABSTRACT

The 21st century, characterized by advances in knowledge and technology, calls for a revamp in mathematics education. The teaching and learning of Sciences and Mathematics using English (PPSMI) is one of such recent policies that have stirred a wave of deliberations among educators and the general public. Does the medium of instruction bring about a profound effect on mathematics education? This paper reports the findings of a study exploring the effect of this policy on students' ability in learning mathematics at the secondary level. The analysis reveals that majority of the participating students were unable to master the basic mathematics skills at the satisfactory level. However, students from urban schools were better at mastering these skills under PPSMI. The findings also indicate that students' characteristics, students' perceptions of learning mathematics through English and teachers' perceptions of teaching mathematics through English affected the performance of students in mathematics under PPSMI.

INTRODUCTION

Twenty-first century is marked for the advances in knowledge and technology. These advances call for a revamp in mathematics education, which is about facing novel real-world problems, nurturing creative thinking skills and cultivating productive ways of learning. In attempting to innovate teaching and learning in order to prepare a new generation for the demands of this new era, many programs have been introduced.

Even though technology has come on the stage of mathematics education for a long time, it was not until the 1990s technology starts making an impact on mathematics curriculums. Huge information about mathematics in English is available through the internet. In order to tap into the potential of such information to foster success in mathematics education, students must be proficient in English language. This was one of the reasons for our government implementing the policy of teaching mathematics and sciences using English three years ago. Since then, the implementation of this policy has stirred a wave of debate among all walks of life on its effectiveness.

Different parties have different ulterior motives while reacting to the issue of introducing English as the teaching medium for mathematics. Some fear that this policy is a measure to weaken and erode the vernacular schools. Others are concern that such policy might affect the credibility of Bahasa Melayu as the national language. Even though our government has warned parties concerned not to politicize this issue, the resistant is still growing. It is being argued that proficiency in English cannot come simply through teaching some subjects in English. It should emanate from a philosophy paying attention to the needs of students from different cultures. There is vast evidence indicating that students who have gone through our education system gain much useful knowledge and skills, as compared to those who have gone through an English education system.

It is now entering the third year implementing English as the medium of instruction for mathematics. All parties need to put aside their divided stands on this issue and gear their energies to research on the impact of this policy on its consumers. A study entitled “An exploratory study on the effect of teaching and learning mathematics using English” was carried out in April 2004. This paper presents some of the findings of this project.

LITERATURE REVIEW

Education in Malaysia has gone through tremendous changes over the years. One of the major changes, implemented in January 2003, is the teaching and learning of Science and Mathematics in English for Standard One, Form one and Lower Six classes. The implementation of this policy is deemed to be timely taking into consideration of the growing importance of technology. It is estimated that majority of the information in the electronic system are in English (Crystal, 1997).

Implementation

The implementation of the teaching and learning of mathematics using English is a phased implementation, starting with Standard One and Form one from the year 2003 and moving progressively through so that the full implementation for primary level and secondary level will be completed in 2008 and 2007 respectively.

A number of measures need to be taken to iron out problems that can hinder the successful implementation of this policy. Malaysian Ministry of Education made the following preparations:

(1) Special computer courseware for teaching
(2) Reference books in English
(3) Teaching materials in English
(4) Modules and activity kits
(5) Computers and LCDs for teaching
(6) In-service training courses for teachers
(7) Incentives for teachers.

On top of these, research need to be carried out to identify problems and the necessary actions to improve the implementation.

Medium of Instruction

Language plays an important role in mathematics. Secada and Carey say that understanding mathematics is problematic for Limited English Proficiency students as they are affected not only by content mastery, but also by the classroom discussions. Students need to learn the particular use of mathematical words, especially where these are words in use in everyday situations but have more specific meanings in mathematics. It is also important to remember that language needs to be linked to first-hand experience if it is to be understood and retained. Duffin (1987) says: "If children cannot talk to their teacher and each other, they cannot make progress in mathematics" (p. 47). In other words, communicative competencies in the language of mathematics are at the core of the mathematical learning process and hence prerequisite to developing mathematical thinking in students. According to Olivares (1996), these competencies can be divided into three types: discourse competency, socio-linguistic competency and strategic competency.

A mathematical discourse serves two functions. First, it provides the descriptive information to solve an activity. Second, it gives the directive to act on this information. From the socio-linguistics point, the cultural context directs the meaning of the message. Hence, not having the cultural experience that goes with the terms in an activity will results in misunderstanding from students. Strategic competency is tied to the ability of students decoding a mathematical message.

Students come to school with varied language experience. Some students use Standard English. Others may use a local dialect or speak a different language at home. There will be some children who speak very little even though they may talk a lot at home. Others may present articulations, which are unclear. One of the tasks of teachers is to extend their use of language. Vygotsky (1978) says: "Speech not only facilitate the child's effective manipulation of objects but also control the child's own behavior". (p. 26)

For effective speaking and listening, students need to be able to:

(1) Use the vocabulary and grammar of Standard English.
(2) Formulate, clarifies and express their ideas.
(3) Adapt their speech to a widening range of circumstances and demands.
(4) Listen, understand and respond appropriately to others.

METHOD

This research is predominantly quantitative, attempting to gather information to answer all the objectives of this study. The objectives are to identify the ability of Form One students learning Mathematics through English, to examine the Form One students' perception of learning Mathematics through English, to examine the teachers' perception of teaching Form One Mathematics through English, and finally to identify the factors affecting effective teaching and learning of Form One Mathematics through English.

Sample of the Study

The population of this research was divided into four zones. The selection of the schools for the first three zones from Kuching and Samarahan Divisions were done based on the school's performance in GPS (Average School Grade) of Lower Secondary School Assessment (PMR) 2003. The fourth zone consisted of all the secondary schools in Sri Aman and Betong Divisions (see Table 1).

Multi-stage sampling method was used to select the minimum sample of Form One students required from these schools. First, the numbers of sample schools were selected from each zone using stratify sampling. Then systematic sampling was used to determine the sample students involved in this study. All the mathematics teachers who were teaching Form One from these sample schools were invited to response to the questionnaire for teachers. As the result, a total of 903 students and 101 teachers from 32 schools in Kuching, Samarahan, Sri Aman and Betong divisions were involved in this study.

Instrumentation

3 sets of instruments were designed and being used by the researchers in this study:

(a) Students' Mathematics Paper (A and B)
2 set of similar mathematics questions in Bahasa Melayu and English to be answered by the participating students – aiming to identify students' ability in learning Mathematics through English.

(b) Students' Questionnaire
1 set of questionnaire for students to response – aiming to gather more information related to students' characteristics and perceptions of learning Mathematics through English.

(c) Teachers' Questionnaire
1 set of questionnaire for teachers to response – aiming to gather information related to teachers' characteristics and perceptions on teaching Mathematics through English.

Analysis of Data

The data collected from this study was analyzed using SPSS version 12.01. Frequency distribution was used to identify the ability of participating students answering these mathematics questions. Inferential analysis such as ANOVA was used to identify the significant differences that exist between the different measures in the questionnaire with the ability of students at a significant level of 0.05. On top of these, factor analysis was performed to reduce and group the items that measure students' and teachers' perceptions accordingly and significantly. Finally, regression analysis was done to identify factors that influence the effectiveness of teaching Form One Mathematics through English. All the discussions above were descriptive in nature.

FINDINGS AND DISCUSSION

For the purpose of this paper, the findings are presented according to 'Students' Mathematics Ability', 'Students' Perceptions', 'Teachers' Perceptions' and 'Factors Affecting Effective Teaching and Learning'.

Students' Mathematics Ability

There were three sections in the Mathematics Questions Papers: problems on basic skills, word problems in Bahasa Melayu and word problems in English. All these problems involved similar topics of Form One Mathematics. The scores of the participating students were summed up accordingly and their achievements were categorized into good, moderate and weak. Results from Table 2 shows that 61.0% or 542 students from this study were unable to master the basic mathematics skills at the satisfactory level. Out of this number, 30.1%, 58.0%, 68% and 68.8% were from schools in Zone 1, Zone 2, Zone 3 and Zone 4 respectively. These percentages show that only students from Zone 1 were doing well with 69.9% of them achieved at least moderate level.

As compared to the achievement for basic mathematics skills, students seemed to perform better in solving mathematics word problems in Bahasa Melayu. Table 3 shows that 43.3% of the students were achieving below moderate and this is lower than the performance in basic mathematics skills (61.0% in Table 2). The percentages of students who scored at least moderately for Zone 1, Zone 2, Zone 3 and Zone 4 are 72.3%, 64.5%, 51% and 49.1% respectively. It is interesting to note that students, especially from Zone 2, Zone 3 and Zone 4, were performing much better in this category with a different in percentage of 22.5%, 19% and 18% respectively.

Table 4 indicates that the percentage of students who achieved below moderate (49.4%) for mathematics word problems in English is higher as compared to the achievement of mathematics word problems in Bahasa Melayu (43.3%), but is still far better than the achievement of mathematics basic skills (61.0%). Students who scored at least moderate level for mathematics word problems in English were 76.7%, 58.4%, 40% and 41.8% for Zone 1, Zone 2, Zone 3 and Zone 4 respectively. These results reflect that student's mathematics performance in English word problems were better than their performance in mathematics basic skills. However, students from Zone 1 also performed better for word problems in English as compared to word problems in Bahasa Melayu. Since all the students in Zone 1 were from urban schools, we can conclude that these students faced fewer problems in learning mathematics under PPSMI.

ANOVA test results in Table 5 further support the findings that there are significant differences of students' ability in basic mathematics skill, mathematics word problems in Bahasa Melayu and English by zone (ρ=0.001, 0.001, 0.001; $\alpha < 0.05$).

Students' Perceptions

The researchers conducted an exploratory factor analysis on students' responses, aiming to identify the important components of all the items in the Students' Questionnaire. For this purpose, the researchers utilized a principal components extraction method using Equamax factor rotation. Initial results reveal that there are four components with eigenvalues of 1.634 and above, which account for 53.03% (Table 6) of the sample variance. These four components can be named as 'Importance of English and Mathematics', 'Attitude towards Mathematics', 'Attitude towards learning Mathematics' and 'Readiness in learning Mathematics through English'. Further analysis shows that component 4 contributes the most sample variance (16.25%). This shows that the items under component 4 are highly correlated among each other and as a result they are interrelated in measuring the perceptions in this component.

The reliabilities for these four components are alpha = 0.766, 0.625, 0.684 and 0.559 respectively. These indicate that the reliabilities of all the items within the components are high and the responses obtained are consistent and representative. The items listed under each component describe the students' perception in learning mathematics through English.

Table 7 shows that the mean score of component 4 is the lowest as compared to the other components. In fact, the mean scores of all the items in this component, with the highest mean score of 3.06 for item 25, are lower than the other items in this questionnaire. In other words, students perceived that they were not ready to learn mathematics through English. The lowest mean score of 2.12 for item 23 where students disagreed that mathematics will become tougher if taught through Bahasa Melayu further support this conclusion. Even though students perceived that they were not ready to learn mathematics through English, they were very positive towards learning of mathematics (component 3) by giving it the highest mean score of 4.03.

Teachers' Perception

Similar to Students' Questionnaire, the researchers conducted an exploratory factor analysis on Teachers' Questionnaire and initial results reveal that there are four components with eigenvalues 1.396 and above, which account for 56.7% (Table 8) of the sample variance. Further analysis shows that these four components can be categorized into 'Attitude towards English', 'Attitude towards Mathematics', 'Attitude towards teaching Mathematics in English', and 'Readiness in teaching Mathematics through English'. Table 8 also shows that component 1 contributes the most sample variance (24.5%).

The reliabilities for these four components are alpha = 0.692, 0.681, 0.674 and 0.561 respectively. These indicate that the reliabilities of all the items within the components are high and the responses obtained are consistent and representative. The items listed under each component describe the teachers' perception in teaching mathematics through English.

Table 9 indicates that teachers were having low perception on teaching mathematics through English (component 3) with a mean score of 2.34. They perceived that limited English proficiency is one of the reasons why students cannot follow the mathematics lessons (item 19). As a result, teachers need to explain the lessons in Bahasa Melayu (item 18) because mathematics is easier if taught in Bahasa Melayu (item 14). However, a moderate number of teachers perceived that they were ready to teach mathematics through English (component 4) with a mean score of 3.48. Majority of the teachers agreed that students' achievement in mathematics would improve if they do a lot of revision after school (item 11) with the highest mean score of 4.59. As a whole, teachers showed good attitude towards mathematics (a mean score of 4.30) and English (a mean score of 3.98)

Factors Affecting Effective Teaching and Learning

All the variables under this study for factors affecting effective teaching and learning of mathematics through English can be divided into five categories. These are 'students' characteristics', 'students' basic mathematics skills', 'students' perceptions', 'teachers' characteristics' and 'teachers' perceptions' as shown in Table 10. Out of the 19 variables listed in the table, only 4 variables are found to be significant in predicting students' ability in mathematics: UPSR mathematics results (students' basic mathematics skills), students' attitude towards mathematics (students' perceptions), teachers' attitude towards teaching mathematics through English and readiness in teaching mathematics through English (teachers' perceptions). These variables are the important elements that contribute to the participating students' achievement in mathematics.

CONCLUSION

In gene ral, the participating students performed best for word problems in Bahasa Melayu. However, most of the Form One students from urban schools faced fewer problems in learning mathematics under PPSMI. This could be due their higher proficiency in English language as their parents are more conscious about the education of their children and there is better opportunity to learn English either in schools or outside of schools as compared to the low English proficiency of students from rural schools.

Students perceived that they were not ready to learn mathematics through English. However, they were very positive towards learning of mathematics. The participating teachers perceived that limited English proficiency is one of the reasons why students cannot follow the mathematics lessons. As a result, teachers need to explain the lessons in Bahasa Melayu because the message can then be delivered successfully. A moderate number of teachers perceived that they were ready to teach mathematics through English. Majority of the teachers agreed that students' achievement in mathematics would improve if they do a lot of revision after school. As a whole, teachers showed good attitude towards mathematics and English.

The regression analysis of this study indicates that UPSR mathematics results (basic skills), students' attitude towards mathematics (students' perceptions), teachers' attitude towards teaching mathematics through English and readiness in teaching mathematics through English (teachers' perceptions) are the four key determinants that can bring success to PPSMI.

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APPENDICES

Table 1: Distribution of Samples by Division and Zone

Division	Zone	No. of schools	GPS	Number of Samples
Kuching/Samarahan	Zone 1	4	< 2.76	105
	Zone 2	8	2.77 – 3.22	270
	Zone 3	4	> 3.23	96
Sri Aman / Betong	Zone 4	16	2.83 – 3.42	432
	Total	32	Total	903

Table 2: Distribution of Students' Mathematics Ability (Basic Skills) by Zone

Zone		Mathematics Achievement (Basic Skill)						Total	
		Weak		Moderate		Good			
		N	%	n	%	N	%	N	%
Kuching	Zone 1	31	30.1	39	37.9	33	32.0	103	100
	Zone 2	152	58.0	73	27.9	37	14.1	262	100
	Zone 3	72	68.0	24	22.6	10	9.4	106	100
	Total	255	54.1	136	28.9	80	17.0	471	100
Sri Aman / Betong	Zone 4	287	68.8	84	20.1	46	11.0	417	100
Grand total		542	61.0	220	24.8	126	14.2	888	100

Table 3: Distribution of Students' Mathematics Ability (Malay Version) by Zone

Zone		Mathematics Achievement (Malay Version)						Total	
		Weak		Moderate		Good			
		n	%	n	%	N	%	N	%
Kuching	Zone 1	28	27.7	35	34.7	38	37.6	101	100
	Zone 2	92	35.5	117	45.2	50	19.3	259	100
	Zone 3	52	49.0	45	42.5	9	8.5	106	100
	Total	172	36.9	197	42.3	97	20.8	466	100
Sri Aman / Betong	Zone 4	209	50.9	157	38.2	45	10.9	411	100
Grand total		381	43.4	354	40.4	142	16.2	877	100

Table 4: Distribution of Students' Mathematics Ability (English Version) by Zone

Zone		Mathematics Achievement (English Version)						Total	
		Weak		Moderate		Good			
		n	%	n	%	N	%	n	%
Kuching	Zone 1	24	23.3	40	38.8	39	37.9	103	100
	Zone 2	106	41.6	103	40.4	46	18.0	255	100
	Zone 3	63	60.0	32	30.5	10	9.5	105	100
	Total	193	41.7	175	37.8	95	20.5	463	100
Sri Aman / Betong	Zone 4	238	58.2	123	30.1	48	11.7	409	100
Grand total		431	49.4	298	34.2	143	16.4	872	100

Table 5: The ANOVA test of Students' Mathematics Ability by Zone

Achievement	Zone	Mean Score	Std. Deviation	ANOVA F	ANOVA Sig. (2-tailed)
Mathematics (Basic Skill)	Zone 1 Zone 2 Zone 3 Zone 4	53.30 35.94 32.92 31.53	26.00 24.85 24.98 24.77	21.367	0.001
Mathematics (Malay Version)	Zone 1 Zone 2 Zone 3 Zone 4	54.72 45.21 40.82 37.36	26.44 23.57 21.92 22.96	16.992	0.001
Mathematics (English Version)	Zone 1 Zone 2 Zone 3 Zone 4	55.63 41.62 35.02 34.26	25.24 24.81 23.33 25.15	22.179	0.001

Table 6: Total Variance Explained of Factor Analysis

Component		Rotation Sums of Squared Loadings		
		Eigenvalues	% of Variance	Cumulative % of Variance
1	Importance of English and Mathematics	4.882	14.89	14.89
2	Attitude towards Mathematics	2.271	11.19	26.09
3	Attitude towards learning of Mathematics	1.634	10.69	36.78
4	Readiness in Learning Mathematics through English	2.313	16.25	53.03

Table 7: Students' Perception of Learning Mathematics Through English

Factor	Items	Items Description	Mean Score
Factor 1	1	Learning English language is fun.	3.58
	3	I will continue to learn English even though I left school because I'm Interested in English language.	3.85
	4	I will attend English language class at other places if this subject is not taught in school	3.76
	5	English language is important because it gives me confidence while communicating with teachers or students who are proficient in English.	4.17
	6	English language is important to enable me to learn mathematics.	4.07
	11	I will attend mathematics class at other places if this subject not being though in school.	3.79
	12	Mathematics is important in our daily life.	4.12
		Sample Mean	3.91
Factor 2	10	I will continue to learn Mathematics even though I left school because I'm Interested in mathematics.	3.88
	13	I like to do tasks that involve the use of mathematics knowledge	3.66
	17	Mathematics is easy.	3.25
	18	I'm good in mathematics.	3.16
		Sample Mean	3.49
Factor 3	15	I need to learn mathematics in order to understand other subjects such as sciences	3.79
	20	My mathematics achievement will improve if I do a lot of revisions after school.	4.11
	21	I need to memorize all the formulas and notes in order to get good result.	3.93
	22	Even though I'm not good in mathematics, I will get good result if I work hard.	4.27
		Sample Mean	4.03
Factor 4	23	Mathematics is tougher if taught in Malay language.	2.12
	24	I do not have problem in understanding mathematics through English.	3.03
	25	The teachers are fully converse in English in the mathematics classes.	3.06
	26	As I am weak in English, I could not understand mathematics.	2.77
	28	I'm having difficulties to understand the contents of mathematics in the textbook.	2.97
		Sample Mean	2.66

Table 8: Total Variance Explained of Factor Analysis

Components		Rotation Sum of Squared Loading		
		Eigenvalues	% of Variance	Cumulative % of Variance
1	Attitude towards English	4.094	24.5	24.5
2	Attitude towards Mathematics	2.643	13.2	37.7
3	Attitude towards Teaching Math. through English	2.409	12.0	49.7
4	Readiness in teaching Mathematics through English	1.396	7.0	56.7

Table 9: Teacher' Perception of Teaching Mathematics Through English

Factor	Item	Items Description	Mean Score
Factor 1	1	I like to communicate using English	4.08
	2	I prefer to communicate in English than other language.	2.89
	3	English language proficiency is important because it gives me confidence to talk with fellow colleagues and students who can communicate well in English.	4.29
	4	English is important for teaching mathematic effectively	4.19
	5	Learning English is important because it enables me to acquire further knowledge.	4.46
		Sample Mean	3.98
Factor 2	6	I prefer teaching mathematics than other subjects	4.05
	7	Teaching mathematic is interesting	4.52
	8	In my opinion, mathematics is easy	4.37
	9	I am good in mathematics	4.36
	10	Students without special talent will also be able to achieve good results in mathematics.	3.94
	11	Students' achievement in mathematics will improve if they do a lot of revisions after school	4.59
		Sample Mean	4.31
Factor 3	14	Mathematics is tougher if taught in Malay.	2.48
	16	I use English in teaching mathematics throughout the whole lesson.	3.04
	18	I do not need to explain in Malay in order to enhance students' understanding in mathematics.	1.84
	19	Student's poor proficiency in English is not the reason why they cannot follow my mathematic lesson.	2.00
		Sample Mean	2.34
Factor 4	15	I do not face any problem in teaching mathematic in English.	3.38
	17	I cannot teach mathematics effectively because I'm weak in English	3.57
		Sample Mean	3.48

Table 10: Regression Analysis Summary for Prediction of Mathematics Achievement.

Model		Beta	Sig.	Collinearity	
				Tolerance	VIF
Students' characteristics	Gender	–0.049	0.818	0.450	2.224
	Ethnicity	0.122	0.442	0.353	2.835
	Type of school	–0.079	0.603	0.375	2.676
	English speaking	–0.049	0.844	0.141	7.103
	Education expectation	0.142	0.376	0.0346	2.891
Students' basic Math. skill	UPSR mathematics result	–0.404	*0.047	0.248	4.039
	Mathematics tuition	0.164	0.251	0.448	2.233
Students' perception	Important of English and Mathematics	0.060	0.833	0.105	9.486
	Attitude toward Mathematics	0.489	*0.050	0.164	6.081
	Attitude toward learning of Mathematics	–0.156	0.516	0.153	6.547
	Readiness in Learning Math. through English	–0.308	0.190	0.168	5.948
Teachers' characteristics	Gender	0.121	0.426	0.382	2.619
	Teaching experience	–0.145	0.467	0.223	4.487
	Academic qualification	–0.316	0.122	0.229	4.360
	SPM English result	0.061	0.712	0.323	3.098
Teachers' perception	Attitude towards English	–0.038	0.830	0.280	3.571
	Attitude towards Mathematics	0.130	0.397	0.378	2.644
	Attitude towards teaching Math through English	0.392	*0.032	0.316	3.168
	Readiness in teaching Math through English	0.430	*0.030	0.271	3.694