Presentation Title	**"Making a Difference through School-based Curriculum Innovation" Paper 2: Early Intervention and Teaching Strategies for Pupils with Learning Difficulties in Literacy and Numeracy**
Format	**Symposium [1.08]**
Sub-theme	**Curriculum Development and Innovation by Schools and Teachers**

Early Intervention and Teaching Strategies for Pupils with Learning Difficulties in Literacy and Numeracy

Rahimah ABDUL RAHIM
Punggol Primary School

Julaiha JAMIL
Punggol Primary School

Mary THOMAS
Punggol Primary School

Madinah GHAOS
Punggol Primary School

Abstract

Pupils in the Learning Support Programme plus Learning Support Mathematics (LSP+LSM) enter Primary 1 with low literacy skills in English and have no foundational numeracy skills and knowledge to access the Primary 1 Mathematics curriculum. Since English is used as a medium to teach Mathematics in Singapore, pupils in the LSP+LSM Programme are mostly disadvantaged in mathematics learning due to their language difficulties in English. While most research findings reveal that there is a strong correlation between literacy and numeracy skills, there is little study on the nature of EL teaching in improving the learning and understanding of mathematics for pupils with low literacy and numeracy skills. This paper will use research data evidence to discuss the extent of the teaching strategies used in English language to help pupils in LSP/LSM to learn Mathematics.

Keywords: Learning Support Programme(LSP), English Language Learners(ELL), Learning Support Maths(LSM), literacy

Introduction

Many educators shared the misconception that Mathematics was less language-dependent than other subjects, as it dealt with only numbers and symbols (Irujo S, 2007; Bresslar et. al, 2009). Hence, it is thought that English Language Learners (ELL) or pupils whose English is a second language would not face any challenges in Maths since the subject only required them to count and not verbalise or communicate in English. However, in contrary, language plays an important role in learning mathematics as teachers use language to explain mathematical concepts and carry out maths procedures while pupils use language to communicate their understanding of the subject.

In 1984, researchers from the Center for Applied Linguistics (CAL) (Crandall, Dale, Rhodes, and Spanos, 1984 in Deborah J,1989) produced evidence that the performance of the pupils in the study were severely impeded by a lack of proficiency in the language of mathematics. It was also found that there were few language-based materials or activities in mathematics classrooms, and fewer opportunities for language arts teachers to become involved in educating these students despite the obvious language deficiencies faced by large numbers of pupils enrolled in mathematics (Deborah J, 1989). Barton and Barton (2005) also found that in all their studies of five different schools offered quantitative or qualitative evidence that ELL pupils suffered a disadvantage of about 10-15 percent in mathematics learning due to language difficulties. Bresslar et. al, 2009 highlighted that researchers of mathematical learning have found that pupils can deepen their understanding of mathematics by using language to communicate and reflect on their ideas and cement their understandings. In fact, classroom talk would result in misconceptions of Mathematics to surface which in turn, help teachers to recognise what pupils do and do not understand (Bresslar et. al, 2009). It is believed that when pupils talk about their mathematical thinking, it can help them improve their ability to reason logically (Chapin & Johnson in Bresslar et. al, 2009). Irujo (2007) also mentioned that another area of language difficulties that has received a good deal of research attention is word problems. ELL faced a major challenge in attempting word problems as they were required to be able to understand the language in the problem, interpret that language so they could identify the math relations and understand what the problem was asking, and convert the language and the math relations to abstract symbols. These pupils who had difficulty understanding word problems often adopt strategies of problem solving that may or may not work. It is common that these pupils often had the tendencies to pay more attention to the mathematical content of the problem than to the verbal content. They looked for key words (*total* or *all together* means addition; *how many more* or *how many left* means subtraction), or guess what operation to use based on the relative size of the numbers in the problem (Iroju, 2007).

In Singapore, relatively an average of 12 to 14 percent of Primary 1 pupils in a school is weak in literacy skills (English) and 5.5 percent weak in numeracy skills. (MOE Press Release, 2008, Jan 29). Thus, as part of the Ministry of Education's (MOE) efforts to level up learning opportunities for pupils from the time they enter Primary 1, pupils who are weak in literacy skills undergo the Learning Support Programme for English (LSP) and pupils who need additional support in numeracy skills undergo the Learning Support Programme for Mathematics (LSM) (MOE Press Release, 2008, Jan 29). The LSP and LSM are early intervention programmes implemented in all primary schools at Primary 1 to provide additional support for children who enter Primary 1 with very weak oral language and beginning literacy skills in English and who do not have foundational numeracy skills and knowledge to access the Primary 1 Mathematics curriculum. In this paper, the phrase 'pupils

in LSP' and English Language Learners(ELL) are used interchangeably as they referred to the same group of pupils who are weak in English language.

English language is used as a medium to teach pupils in the LSP+LSM Mathematics. This inevitably posed a major obstacle to this group of pupils in learning any subject in particular Mathematics as their language profile (non-English speaking background) hampered them from learning and understanding Mathematical concepts effectively. Bresser et. al (2009) believed that every part of learning is language dependent where teachers need language to explain a concept and arouse pupils' interest while pupils need language to verbalize or write to show their understanding of a mathematical concept. It is also highlighted that when a learner is carrying out all of cognitive work in a second language, limitations in language can lead to limitations in learning. These pupils need to communicate in English language to construct understandings of mathematical ideas and develop connections between their informal knowledge and the abstract symbolism of mathematical concepts (Bresser et. al, 2009).

Apart from this, when pupils attempt any word problems, they need to process the sentences and rely on them so as to convey clear and unambiguous meaning (Halliday, 1978; Dale & Cuevas, 1987 in Latu; Iroju, 2007). They also need to know the meaning of these words, phrases and sentences and how to use them (Cronk et. Al, 2008). It is crucial that these pupils must know how to read even before they could understand how to process these sentences. Latu (1995) pointed that a pupil will get very frustrated and developed low self esteem when he or she could not achieve success in Mathematics due to reading problem. Thus, in summary, the criteria to be able to learn mathematics well is firstly, a pupil must have the basic literacy skills i.e. knowing how to read and secondly to be able to communicate and use the English language, which the LSP+LSM pupils are lacking.

Thus, the challenge of teaching Maths to the LSP+LSM pupils lies not only in making Maths lessons comprehensible to them but also in ensuring that they have the language both oral and literacy skills needed to understand instruction and express their grasp of maths concepts both orally and with written language. Therefore, this group of pupils have dual task of learning that is a second language which is English and Maths content simultaneously (Bresser et.al, 2009). Virginia Department of Education (2004) had drafted a Learning Enhanced Scope and Sequence for their ELLs which integrate language and content in the planning of Maths lesson. Bearing in mind that this group of pupils was still acquiring academic English, it is important that teachers, when planning their teaching instructions, integrate academic vocabulary and grammatical structures while simultaneously building Mathematical concepts. According Hill and Flynn(2006), p22 in Bresser et. al (2009), *it is critical to set both content and language objectives for English Language Learners. Just as language cannot occur if we only focus on subject matter, content knowledge cannot grow if we only focus on learning the English Language*.

Thus, while most of these literatures proposed teaching instructions that focused on language and content, it also essential to know to what extent these instructions help pupils with learning difficulties in literacy and numeracy. Thus, this paper will discuss on finding the effectiveness of incorporating the teaching strategies used in English language to help pupils in LSP/LSM to learn Mathematics.

Method

Subject

The project group comprised of pupils from the P1 LSP+LSM 2009 cohort while the control group comprised of pupils from the P1 LSP+LSM 2008 cohort. Both groups shared a similar profile of pupils who are weak in both literacy and numeracy; scoring level 0 to 2 in the School Readiness Test (SRT). All the LSP+LSM pupils were selected in this research which formed only 19 pupils for both groups. A teacher participated in this study and she was trained in teaching pupils with learning difficulty in literacy and numeracy by MOE. She has been teaching for 6 years and had 4 years teaching experience with pupils with learning difficulties.

Design

The study made use of the post-test only equivalent groups design and pre-and post test single design. In Design 1, project group is compared with the control group while in Design 2, pre and post test is used to determine the improvement made in the project group.

Design 1

Post-Test only equivalent group design for project and control group.

Group	Intervention (Treatment)	Post Test
Control Group (P1 2008 Cohort)	----	Test A1
Project Group (P1 2009 Cohort)	X	Test A2

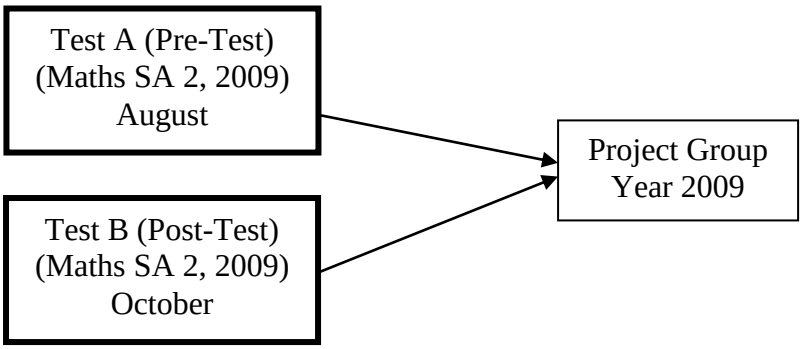
To measure the effectiveness of the intervention, the school's End of Year Maths Exam Paper 2008 (SA 2, 2008) was used as part of the research instrument. For discussion purpose, we named this research instrument as Test A. The project group (2009 cohort) and the control group (2008 cohort) took a similar test paper i.e. Test A1 for Control Group and Test A2 for Project Group. The Control Group took Test A in October 2008 while Project Group took the similar test in August 2009.

Design 2

Pre-and Post Test single group design

Project Group (P1 2009 Cohort)	Pre Test (Test A2)	Post Test (Test B)

The school's End of Year Maths Exam Paper 2009 was used to determine the improvement made by project group during the intervention - Test B. The project group took this test in October 2009. For analysis purpose, we use Test A2 as a pre-test and Test B as a post- test. Test A2 is End of Year Maths Exam Paper 2008 while Test B is End of Year Maths Exam Paper 2009. Both tests were designed based on the Table of Specification crafted by the school which is in line with MOE requirement.



Measure

We used the school's 2008(Test A) and 2009(Test B) End of Year Maths Examination Paper as research instruments to evaluate the effectiveness of the intervention. Both Maths Exam Papers comprised of 45 questions. Items for both papers are of similar quality as the questions were matched against the Blooms Taxonomy Level of Questioning which involved 20 knowledge questions, 15 comprehension questions and 10 application questions (heuristic and thinking skills were included for application questions). The content of the exam papers are divided into 3 sections. Section 1 comprised of 20 multiple-choice; Section 2 comprised of 20 short open-ended questions and Section 3 comprised of 5 word problems. Both tests were designed based on the Table of Specifications crafted by the school which is in line with MOE requirement. Hence, both tests are reliable and valid. These tests were design by Maths teachers. The difficulty level of both papers is generally the same. 10 LSM lessons were observed by officers from MOE. After lesson observations, the MOE officer would provide feedback to LSM teacher. The objective of this lesson observation is to guide her in conducting the lessons and meeting the lesson objectives that is to focused on language and content.

Procedure

The intervention was conducted over a period of 9 months i.e. from January to October 2009. The intervention is carried out for the project group (P1 LSP+LSM 2009 cohort). The intervention focus on two objectives: that was language (oral and literacy skills) and content (Maths). Lesson plans and scheme of work were designed by MOE which were in line with the objectives of intervention. The pupils will need to learn topics like Number Bond, Addition and Subtraction, Graphs, Shapes and Measurement. Teaching strategies used for the teaching of English Language was incorporated in the teaching of mathematics during the LSM lessons. The lessons were conducted in the LSM room. The lessons were taught by the LSM teacher and she is responsible in conducting the tests for the study. Each LSM lesson lasted for 1 hour except for certain days, half an hour.

In every LSM lessons, the LSM teacher would flash Maths vocabulary cards in the beginning of every Maths lessons for about 2 mins. This is called visual drill. Pupils had to read the word cards every day and as pupils read these words regularly, they were expected to read these words with accuracy and speed. The objective of this exercise to get pupils to build fluency in their recognition for Maths words which in turn improve their literacy. Pupils were required to read words like 'count', 'circle', 'add', 'subtract', 'more' and 'less'. Through these visual drills, over-learning took place. Pupils who had poor memory skills will need opportunities to over-learn or practice these targets. Over-learning is usually most effective if carried out using multi-sensory methods for short periods, several times a day

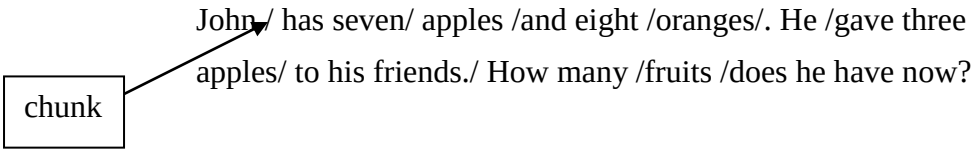
(http://dlda.co.in/html/ourjob.html). After reading those words, teacher would explain or demonstrate the meanings of these words so that pupils would understand the meaning of the words read. Pupils would also review what had been learnt the day before in every LSM lesson so as to retain the words taught and build fluency.

Pupils would also learn how to spell the Maths vocabulary words using the Look, Cover, Write and Check strategy where pupils use multi-sensory method to learn how to spell. Pupils with learning difficulties learnt best using multi-sensory method. Multi-sensory teaching was simultaneously visual, auditory and kinesthetic tactile to enhance memory and learning. Links are consistently made between visual (what we see), auditory (what we hear) and kinesthetic-tactile (what we feel) pathways in learning to read and spell (http://www.interdys.org/ ewebeditpro5/upload/Multisensory_Teaching.pdf).

After reading these word cards, the LSM teacher would then teach the content for that lesson. LSM teacher used lots of manipulatives, realia, concrete materials and hands on activities to teach pupils the mathematical topics. For example, pupils were given colourful counters, macaroni or colourful magnets to learn counting and number bonding. Pupils with learning difficulties will often need concrete apparatus to support their learning, to build confidence and understanding (http://dlda.co.in/html/ourjob.html).

LSM teacher also sang nursery rhymes and songs to teach topics like counting numbers, addition and subtraction. For example, the pupils were taught how to make finger puppets using English songs '10 little Indians' when learning topic on Counting Numbers 0 to 10. They also read a nursery rhyme Old Mother Hubbard to learn the topic on numbers. Singing and reading nursery rhyme with Mathematical content help to simplify pupils' understanding of a concept. In addition, to reinforce the mathematical language that they have learnt in class, LSM teacher also used the Shared Book Reading approach that focused on stories which involved Maths to help pupils to build understanding of mathematical concept. Pupils enjoyed reading stories and from here they will understand Mathematical concept incidentally when the LSM teacher explained a concept taught in the book.

When teaching word problems, chunking of sentences proves to be very effective in helping pupils in LSP+LSM to understand what is expected of them to solve the word problems. Sentences in the word problems were chunked. The example is shown below:-



Chunking is a method of presenting information which splits concepts into small pieces or "chunks" of information to make reading and understanding faster and easier (http://en.wikipedia.org/wiki/Chunking(writing). LSM teacher would demonstrate to pupils how to chunk the sentences of the word problems. She would verbalize as she chunk the sentences. For example, she would asked pupils questions, "Who has apples?" and pupils will answer "John". Then she would proceed asking how many apples does he have?" Pupils will answer her appropriately. This method helped pupils to understand the problem sums better as their learning was being scaffolded. Eggen and Kauchack (2004) also highlighted the concept of *scaffolding* or an instructional assistance, where a teacher provides the support to the student and tapers off this support when it becomes unnecessary, do help to promote

learning and development. The concept of *scaffolding* is closely related to Vygotsky Zonal Proximity of Development that emphasised the importance of social interaction where teacher and pupils interact with each other to level up pupil's learning.

The LSM teacher also adopted the Think Aloud strategy for both pupils and teachers where both teacher and pupils verbalize or say aloud the steps used in problem solving. In addition to the thinking aloud strategy, pupils show their understanding of a problem sums through diagram and illustration which help teachers to check pupils' understanding of mathematical concept taught. Immersing pupils with lots of prints is equally important in developing pupils' literacy skills. Creating a print rich classroom by displaying Mathematical vocabulary words on the walls would help pupils learnt Maths vocabulary.

Analysis

Two main statistical procedures, Independent t-test and Cohen's Standardized Mean Difference (SMD) was used as a main statistical procedure to analyse the findings obtained from the study. Excel formula was used to calculate the mean, standard deviation and t-test. Independent t-test was employed to evaluate the significance of intervention between two different groups; project and control group. It determines how likely the difference between the means of two unrelated groups is occurred by chance. We calculate the p value for the t-test where p has the probability of chance occurrence, normally set at $p<=0.05$. (Cheng S K and Tan C, 2008)

When	Difference between the means of the 2 groups
p <= 0.05	DO differ significantly (Difference is unlikely to occur by chance)
p > 0.05	DO NOT differ significantly (Difference is likely to occur by chance)

Cohen's Standardized Mean Difference (1988 in Cheng S K and Tan C,2008) was employed to measure the magnitude of the Effect Size (ES) of the intervention, using the following statistical formula:

$$\textbf{Effect Size (ES)} = \frac{\text{Mean (project)} - \text{Mean (control)}}{\text{Standard Deviation (control)}}$$

The value of effect size can be interpreted by using Cohen's criteria, which classifies the effect from negligible to very large based on the effect size value.

ES Value	**Effect**
Above1.00	**Very Large**
.80 to 1.00	**Large**
.50 to .79	**Moderate**
.20 to .49	**Small**
Below .20	**Negligible**

Results

Design 1

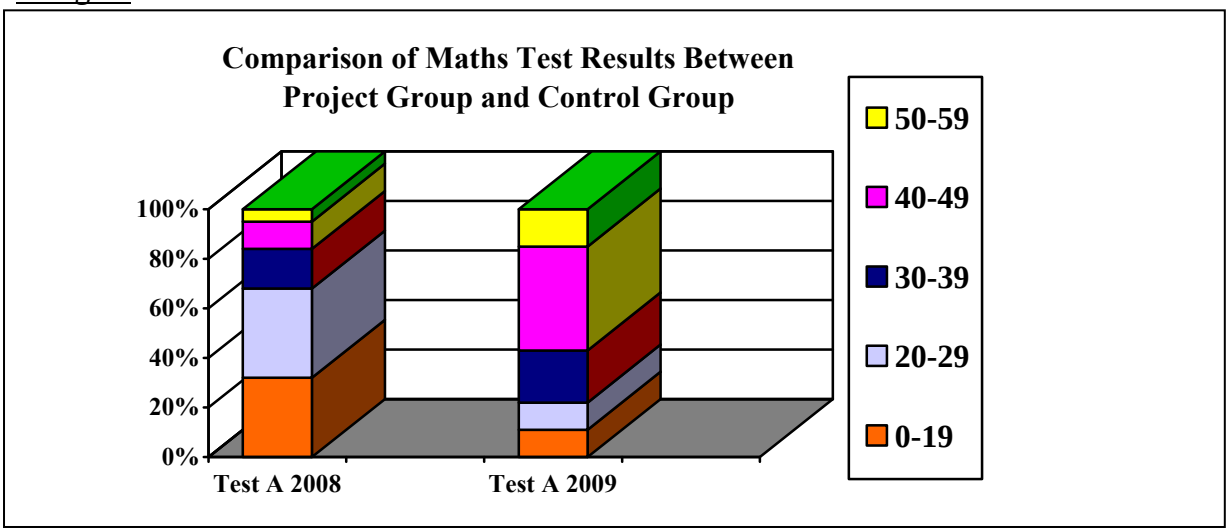


Table 1: Comparison on post test results between Project and Control Group

Marks	Test A1 (Control Group)	Test A2 (Project Group)
0-29 (U Graders)	68%	22%
30-39	16%	21%
40-49	11%	42%
50-59	5%	15%

As shown in Table 1, 68% of pupils from Control Group and 22% of pupils from the Project Group scored between 0-29 marks. 16% of pupils from Control Group and 21% of pupils from the Project Group scored between 30-39 marks. 11% of pupils from Control Group and 42% of pupils from the Project Group scored between 40-49 marks and lastly 5% of pupils from Control Group and 15% of pupils from the Project Group scored between 50 -59. None of the pupils from either group scored more than 60 marks.

Design 2

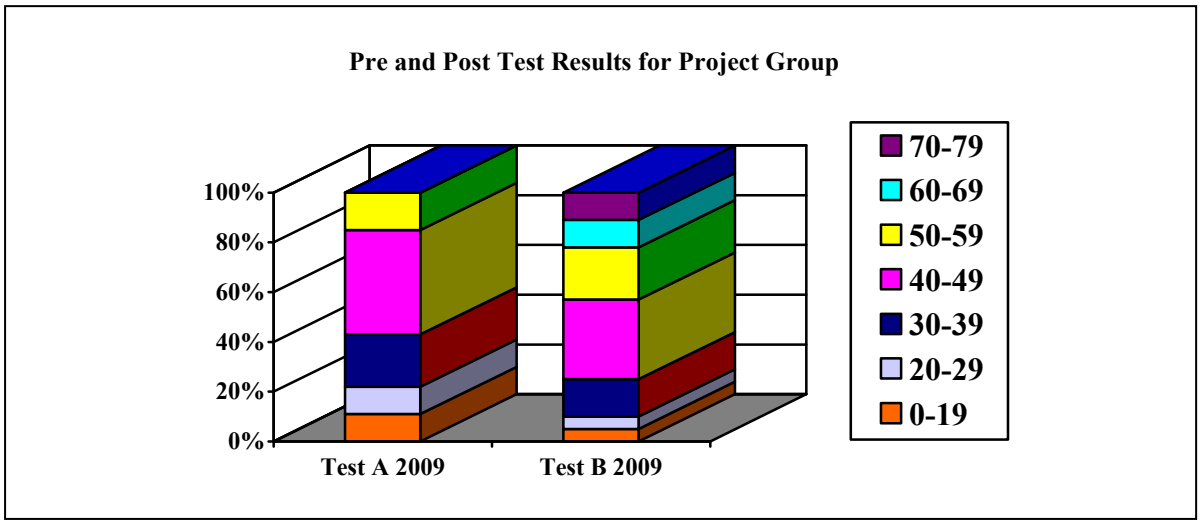


Table 2: Marks Obtained by Project Group in the Pre and Post Test

Marks	**Test A2 (Pre-Test)**	**Test B (Post-Test)**
0-29 (U graders)	22%	10%
30-39	21%	15%
40-49	42%	32%
50-59	15%	21%
60-69	0	11%
70-79	0	11%

As shown in Table 2, 22% of pupils from the Project Group scored 0-29 marks in the pre test and 10% in the post test. 21% of pupils scored 30-39 marks in the pre test and 15% in the post test. 42% of pupils scored 40-49 marks in the pre test and 10% in the post test. 15% of pupils scored 50-59 marks in the pre test and 21% in the post test. In the pre test, none of the pupils in this group scored between 60 -79 marks. However, in the post test, a total of 22% scored within this mark range.

The table below shows p values from the t-test. The p values from the t-test show that the difference between the project group and control group is 0.0055, meaning this difference is unlikely to occur by chance. As such, we consider the difference to be significant. This means that the intervention has resulted in higher scores.

Table 3: Measurements using Independent t-test

	Project Group	**Control Group**
Mean	38.6	25.9
Standard Deviation	11.8	13.9
P value	0.0055	
Significance (p<= 0.05)	Yes	

Effect Size

Table 4: Measurements using Cohen's Standardized Mean Difference (SMD)

	Project group (N=19)	**Control group (N=19)**	**Effect size**	**Remarks**
Test A (2008 End of Year Maths Examination Paper)	Mean = 38.6	Mean = 25.9	-	-
	SD = 11.8	SD = 13.9	0.91	Large

The table above shows the effect size of the intervention strategies on the pupils. The results of measurements using Cohen's Standardized Mean Difference (SMD) to calculate the effect of the intervention strategies in this study (Table 4) showed a large effect size of 0.91.

Discussion and Recommendation

From the result and the analysis, the project group performed better than the control group on a similar test (Maths SA 2 2008). The percentage of U graders (29 marks and below) has decreased from 68% to 22%. The drop in percentage for U-graders is very important in Singapore context as pupils who scored U-grade in Primary School Leaving Examination (PSLE) in Primary Six will not be allowed to be promoted to secondary school and has to be retained in the primary school. Thus, it is crucial to reduce the number of U graders in the school. The percentage of pupils scoring 30-39 marks and 40-49 marks has increased. There is an improvement of 5% for those who scored 30 -39 marks and 31% improvement for those who scored 40-49 marks. The percentage of pupils scoring more than 50 marks also improved by 10%.

In October 2009, pupils from the project group took the End of Year Maths Examination Paper 2 (Test B). They had made further improvement in their Maths results. In comparison with Test A2, the percentage of pupils scoring 0-29 marks (U-Grade) in Test B further dropped by12%. This is another achievement made and had proven that the intervention strategies did help to improve the Maths results of the pupils in LSP+LSM. The percentage of pupils scoring more than 50 marks has also increased from 15% to 43%. Out of this, 22% of them scored between 60-79 marks range. This proved that the project group has managed to produce quality passes as compared to the control group.

From the t-test result, the p-value does differ significantly where the difference is unlikely to occur by chance. It also means that the intervention implemented on the LSP+LSM pupils does produce significant changes in the performance between the project and control group. In addition, the large Effect Size on the intervention proved that the strategies implemented on the LSP+LSM pupils in the project group did left a large impact on them. This success has paved way for a new direction to support other pupils (not in LSM+LSP) who are weak in oral literacy and numeracy skills.

While this study provides evidences that the incorporation of strategies and activities used for the teaching of English language in the teaching of Maths has enhance the learning of pupils in LSP+LSM, one important contributing factor is the spirit of camaraderie among the teachers who work closely together to improve the teaching and learning. The success also would not be possible without the support of the school management and parents. This research path the way to help more pupils in other class who are struggling in language and mathematics Hence, for future direction, all P1 teachers are encouraged to adopt the intervention strategies and implement them during remedial class.

Conclusion

In conclusion, the research study has proven that the incorporation of strategies and activities used in English language in the teaching of Mathematics managed to enhance the learning for pupils in LSP and LSM programme. The project group has performed better than the control group where more pupils passing in Maths in the project group as compared to the control group. Pupils in the project were able to produce quality passes such as pupils scoring 60s and 70s as compared to the control group. Thus, based on the research data, it is evident that helping pupils in LSP+LSM to improve their oral and reading skills by incorporating strategies use in English in the teaching of Maths has help to support their learning and understanding in Mathematics.

Reference

Alliance for Excellent Education(2005). Six key strategies for teachers of English Language Learners.
Retrieved from http://www.all4ed.org/files/archive/publications/SixKeyStrategies.pdf

Barton P N & Barton B (2005).The Relationship Between English. Language and Mathematics Learning for Non-native Speakers. In *Teaching and Learning Research Initiative Unitec 2005.*
Retrieved from www.tlri.org.nz/assets/pdf/9211_summaryreport.pdf

Bresser R, Melanese K & Sphar C (2008 & 2009). *Supporting English Language Learners in Math Class.* Maths Solution.

Cronk C, Hakansson S. W., Murrey D, Jacobs J.E. and Cruz R.S.(2008,Mar 6). Effective Strategies for teaching mathematics content to English Learners. *CABE Conference 2008*
Retrieved from http://www.cmpso.org/downloads/conferences

Cheng S K and Tan C (2008). *Workshop on Action Research. Transforming Teachers to Action Researchers*. Educational Leadership 21.

Deborah, J. (Nov/ 1989). Teaching Mathematics to Limited English Proficient Students. *ERIC Digests.* ERIC Clearinghouse on Languages and Linguistics Washington DC
Retrieved from http://www.ericdigests.org/pre-9214/english.htm

Eggen, P & Kauchak, D (2004), *Educational Psychology. Windows on Classrooms.* 6th Edition. Pearson Education Inc, Upper Saddle River, New Jersey.

Irujo, S. (Mar/Apr 2007). Teaching math to English Language Learners: Can research help? *ELL Outlook*.
Retrieved from http://www.coursecrafters.com/ELL-outlook/2007/ mar_apr/ ELLOutlook ITIArticle1.htm

Latu, V. F. (2005,July 28, Melbourne, Victoria). Language Factors that affect Mathematics Teaching and Learning of Pasifika Students. In *Mathematics Education Research Group of Australasia. Conference.*
Retrieved from www.nzcer.org.nz/pdfs/BES009.pdf

Learnig Disability Centre (2006). Remedial Intervention.In *DLDA.*
Retrieved from http://dlda.co.in/html/ourjob.html

The International Dyslexia Asscociation (2000). Multisensory Teaching. Factsheet.
Retrieved from http://www.interdys.org/ewebeditpro5/upload/Multisensory_Teaching.pdf

Ministry of Education. Press Releases (Jan 2008). Enhanced Learning Support Programme has Benefited Pupils.
Retrieved from http://www.moe.gov.sg/media/press/2008/01/enhanced-learning-support-prog.php. http://www.ncela.gwu.edu/webinars/event/9/

Virginia Department of Education (April 2004). Mathematics: Strategies for Teaching Mathematics to LEP Students. A Supplemental Resource to the K-12 Mathematics Standards of Learning Enhanced Scope and Sequence.
Retrieved from www.cityschools.com

Author

Rahimah, Madinah, Mary Thomas and Julaiha
Punggol Primary School