IGNITING PASSION IN MATHEMATICS THROUGH MULTIPLE INTELLIGENCES

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Abstract

This paper documents the journey which West View Primary School went through in implementing the teaching of Mathematics using Multiple Intelligences. The ideation and evaluation processes led to an innovative prototype which not only met the learning needs of pupils but also served as a tool for the capacity building of teachers. The prototype was trialled on Primary 4 pupils in 2008, and implemented to Primaries 1, 4 and 5 levels in 2009. As part of our school's TLLM *Ignite!* project in 2008, we have carried out an action research on a study that aims to investigate how the incorporation of teacher-developed activities based on the theory of Multiple Intelligences (MI) impacts pupils' engagement, motivation, attitude and achievement in the learning of Mathematics. It also aims to find out if the length of exposure to MI makes a difference. A total of 140 low-ability and average-ability Primary 4 pupils and three teachers were involved in this project. In the first semester, a project group of 68 pupils went through a three-week MI intervention in their learning of "Fractions" and 72 pupils who were taught in the traditional way served as a comparison group. In the second semester, both groups were taught "Decimals" through MI over six weeks. Post intervention data indicated improved attitude and an increase in pupil motivation and engagement. Pupils taught through MI also produced higher achievement scores in their post intervention tests. Results also suggest that a longer exposure to MI has a positive impact. Teachers have also gained professionally from this project. The success of the project led to a refinement of the prototype and an emergent model for MI-based lessons in the teaching of Mathematics in West View Primary School.

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Introduction

Mathematics has always been an unpopular subject among the majority of pupils in the school. Pupils tend to dislike Mathematics as they are not able to achieve their desired academic scores in the subject. Some pupils even develop fear and anxiety in the subject as they believe they will never be able to do well in it. Through the TLLM *Ignite!* project, the school hopes to develop in pupils a love for Mathematics and to help them see that it can be fun. It is hoped that they will overcome their fear of the subject and be motivated to excel in it. The project also hopes to help pupils perform better in the subject. We believe that pupils have different dominant intelligences, and they can be better engaged if we use multiple bridges to reach out to them in the teaching of Mathematics.

According to the Singapore Mathematics Syllabus for primary schools (MOE, 2001), "the primary aim of the Mathematics curriculum is to enable students to develop their ability in mathematical problem solving. The attainment of problem solving ability is dependent on five interrelated components – Concepts, Skills, Processes, Attitudes and Metacognition. Students' attitudes towards Mathematics are shaped by their learning experiences. Making the learning of Mathematics fun, meaningful and relevant goes a long way to inculcating positive attitudes towards the subject." Hence, by addressing the attitudinal aspect in the learning of Mathematics, through the teacher-developed activities based on the theory of MI, pupils will be fully engaged in their learning, understand concepts better and most importantly, enjoy the learning of Mathematics.

The traditional approach for learning in Mathematics creates passive learners. In order for pupils to take an active role in Mathematics, it is important to engage the learners

(Bednar, Coughlin, Evans, & Sievers, 2002). Engaged learning is an active involvement in the learning process (Soh & Tan, 2008). According to Fredricks, Blumenfeld and Paris (2004), "pupil engagement is a multi-faceted construct that includes affective, behavioural and cognitive dimensions". Affective engagement refers to pupil's emotional reactions and feelings, behavioural engagement is described as being task-oriented and cognitive engagement includes motivation and effort. All the three dimensions are interrelated and are equally important in engaged learning. Examples of strategies to engaged learning include cooperative learning activities, hands on experiences, opportunities for exploration and discovery, and teaching to the MI.

Howard Gardner (1991) believed in different learning styles and identified eight intelligences. According to Gardner, all individuals have a blend of the eight following intelligences: verbal-linguistic – the intelligence of words, logical-mathematical – the intelligence of numbers and reasoning, visual-spatial – the intelligence of pictures and images, musical-rhythmical – the intelligence of tone, rhythm and timbre, bodily-kinesthetic – the intelligence of the whole body and the hands, interpersonal – the intelligence of social interactions, intrapersonal –the intelligence of self-knowledge and naturalistic – the intelligence of the world and nature around us. Chapman (1993) stated that each person is born with all eight intelligences, but because of cultural differences some intelligences develop more than others do. Jensen (2007) also claimed that intelligences are cultivated more than they are inherited, and different cultures tend to reinforce certain intelligences.

Gardner stated that an instructional technique or program that is heavily reliant on one of the intelligences minimizes opportunities for pupils who may not possess a propensity to learn in this way. These students, who may not achieve in the traditional way, may become lost to both the school and the community at large. Creating opportunities for all pupils, by enriching the classroom through MI develops pupils and brings out their strengths. Pupils

should be taught based on their ability and ways of learning. Active and involved teaching is a step towards pupils' academic success. Teachers generally carry the belief that all pupils are capable of achieving. MI considers this and indicates the tools, teaching strategies that will bring forth such success.

If the MI approach of learning is used, content areas may become meaningful and valuable for pupils. Gardner suggested there are many ways to motivate children, depending on how they learn. More meaningful material can spark pupils' natural curiosity about the world around them. In order to arouse curiosity, Robinson, Silver and Strong (1995) suggested that two things need to be accomplished: make learning a mystery to be solved by the pupils, and have content relate to their lives. Pupils become bored if a teacher becomes apathetic with the subject matter, when pupils receive work that is not meaningful to them, or if curriculum lacks variety. The use of MI helps teachers to tap on different pupils' intelligences and interests. The intention to use MI is to use more ways rather than one traditional method to reach out to pupils in their intelligences. Presentations through various modalities provide pupils with numerous opportunities to learn through their strengths. Daily activities should be planned around all the intelligence areas. The logical-mathematical intelligences is not a strength in many pupils. Teaching Mathematics to the other intelligences will strengthen their logical-mathematical intelligence (Bednar et al., 2002). Pupil motivation and achievement will increase when teachers determine what makes pupils tick.

The teacher's role in an MI classroom consists of constantly shifting methods of presentation from linguistic to naturalistic. Teachers are going beyond the text to reach the needs of all pupils. There are many ideas on how to implement MI strategies. Possible teaching strategies for naturalistic intelligence, for example, would include allowing pupils to use their five senses in their learning such as using manipulative or models, allowing learning through real-life scenarios and including nature in teaching. Music is a venue through which

mathematics can be effectively taught. Different types of music, such as popular jingles, raps, or marches, facilitate recall through mnemonics. Puzzles provide a unique alternative to mathematical instruction. Puzzles aid in numbers and operation sense, help pupils use patterns to problem solve, and develop critical thinking skills. Games are a fun way to teach Mathematics. Interpersonal intelligence can be addressed through working in groups. Pupils need work that will give them opportunities to interact with others. Pupils who work with others become more involved and energetic. Teachers should always link their instructional objectives to the eight MI. The exceptional teacher can combine these intelligences in unique ways to create memorable learning experiences.

Hoerr (2002) stated that the effectiveness of MI is supported by the findings of a study conducted by Harvard's Project Zero. In interviewing the principals of 41 schools using MI, 78% of them said that their schools had realized gains on standardized achievement scores and 63% attributed the growth to practices inspired by MI theory. Not surprisingly, the use of MI paid other benefits in these schools as well: 78% of the schools reported improved performances by students having learning difficulties, 80% reported improvement in parent participation, and 81% reported improved student discipline.

Pokey (2007) stated that MI can make the greatest contribution to education. He suggested that teachers expand their repertoire of techniques, tools, and strategies beyond the typical linguistic and logical ones. Stanford (2007) stated that by incorporating MI into the classroom, pupils can experience success and academic growth. Research suggests that teaching to the MI is very beneficial for educating the whole learner. Teaching to the MI improved assignment completion, class participation and engagement of learners (Cluck & Hess, 2003). There is a general trend toward an increase in student motivation and positive attitude through the use of MI. Pupils who are exposed to MI also show considerable increase in academic performance compared to those taught using the traditional method.

Given the numerous benefits in using MI, we have used MI in the planning and implementation of our Mathematics lessons on "Fractions" and "Decimals" in 2008. The primary purpose of the research was to find out if the use of MI in the teaching of Mathematics will result in pupils' increase in motivation and engagement and will have a positive impact on their attitude and achievement in the subject. Thus we would like to find out answers to the following research questions:

1. Is there an increase in the level of engagement among primary four pupils who are taught Mathematics using the MI strategies?
2. Do primary four pupils who are taught Mathematics using MI achieve a higher review test scores than pupils who are not taught using MI?
3. Does a longer exposure to MI strategies have a positive impact on primary four pupils' engagement, motivation, attitude and achievement in their learning of Mathematics?

Method

The study involved four intact Primary Four classes. The project group had 68 pupils, 30 from a low-ability class and 38 from an average-ability class. The comparison group had 72 pupils, 32 from a low-ability class and 40 from an average-ability class. The distribution of the pupils in the four classes is shown in Table 1.

Table 1 : Distribution of pupils by class

Ability Group	Low-Ability Group		Average-Ability Group	
Class	Project	Comparison	Project	Comparison
No. of pupils	30	32	38	40
No. of girls	16	18	17	18
No. of boys	14	14	21	22

Table 2 : Mean score of 2007 Mathematics overall marks

Ability Group	Low-Ability Group		Average-Ability Group	
Class	Project (N=30)	Comparison (N=32)	Project (N=38)	Comparison (N=40)
Mean (SD)	33.3 (12.1)	30.8 (12.9)	63.5 (9.7)	64.6 (10.7)
Difference	2.5		1.1	
Effect Size	0.19		0.10	

Table 2 shows the mean score of their 2007 Mathematics overall marks. The Standard Mean Differences (Effect Size) between the project and comparison classes from both groups is almost zero, thus the project groups and comparison groups are comparable in Mathematics achievement.

Measures

MIDAS Questionnaire

To measure the MI profile of all the pupils and teachers involved, the school had engaged a professional vendor, Multiple Intelligences Research and Consulting, Inc., to administer the MI psychometric instrument "Multiple Intelligences Developmental Assessment Scales" (MIDAS) which had well-established reliability scores. It is a research based self-report with a proven track record of producing a valid and reliable profile.

PETALS^{TM} Questionnaire

To measure pupils' engagement, motivation and attitude towards the learning of Mathematics, pupils took part in a survey using the PETALS^{TM} Engagement Indicator Questionnaire. The questionnaire had six components, namely Pedagogy, Experience of

Learning, Tone of Environment, Assessment for Learning, Learning Content and Engagement. The engagement component comprised three sub-components, namely Affective Engagement, Behavioural Engagement and Cognitive Engagement. The survey questionnaire also included a descriptive component where pupils described their Mathematics class in their blog.

Achievement Tests

At the end of the first three-week intervention period, pupils took a 25-item short answer review test on "Fractions". Each question carries 1 mark, giving a total score of 25 marks. The total score is then converted into percentage. At the end of every sub-topic on "Decimals" within the second six-weeks' intervention period, pupils set for a 25-item short answer review test which has a maximum total of 25 marks. There are four review tests on "Decimals", making a total of 100 marks in all.

Qualitative Data

Pupils' interview and teachers' observation and reflection journals and focus group discussion were also used as instruments for the qualitative data collection.

Procedure

The study was quasi-experimental in design and since the two classes within the low-ability group and the average-ability group were comparable and Mathematics is a content-based subject, equivalent group post-test only design was adopted. One teacher taught both the comparison classes from the low-ability group and the average-ability group and another

teacher taught both the project classes from the low-ability group and the average-ability group.

All the pupils and teachers involved in the project underwent MI diagnostic test prior to the intervention period. The teachers were briefed on the findings and how it can help them to improve the way they learn and the way they help the pupils to learn. The project group teacher was given the results of her class MI profile which showed the detailed intelligence variability within the class. This would help her to design and customize her Mathematics lessons to cater to the dominant multiple intelligences of the pupils in her two project classes.

Table 3 shows the results from the MIDAS Questionnaire which summarizes the MI profile of all the pupils involved in the project. It indicated that pupils generally have all the eight multiple intelligences in almost equivalent dominance. The naturalistic intelligence was the strongest intelligence overall. Musical-rhythmic, visual-spatial and linguistic intelligences were the next closest. The weakest intelligence is naturalistic intelligence. All of the pupils' intelligences were above the 50^{th} percentile.

Table 3: Main Scale Means (N= 140)

Scale	Natural	Musical	Spatial	Ling	Logical	Kin	Inter	Intra
Mean	55.9	54.1	53.8	53.8	53.1	52.9	52.0	50.8
SD	16.4	14.0	14.7	14.2	13.4	14.7	15.0	14.4

Table 4 shows the MI profile of each of the project and comparison classes. The results revealed that the project class from the low-ability group is most dominant in visual-spatial, followed by bodily-kinesthetic, naturalistic and musical intelligences. The project class from the average-ability group is most dominant in naturalistic, followed by linguistic, logical-mathematical and musical intelligences. The comparison class from the low-ability group is most dominant in musical, followed by visual-spatial and naturalistic intelligences.

The comparison class from the average-ability group is most dominant in bodily-kinesthetic, followed by naturalistic and verbal-linguistic intelligences.

Table 4: Mean Score and Standard Deviation of Class MI Profile

Ability Group	Low-Ability Group		Average-Ability Group	
Multiple Intelligence	Project (N=30)	Comparison (N=32)	Project (N=38)	Comparison (N=40)
Musical	56.4 (12.1)	56.9 (14.7)	54.4 (12.4)	55.7 (16.1)
Kinesthetic	56.8 (11.4)	50.1 (14.2)	52.2 (15.9)	57.5 (14.5)
Logical	56.2 (12.4)	44.6 (13.3)	54.5 (14.0)	56.2 (12.8)
Spatial	58.8 (12.3)	52.6 (15.3)	54.2 (16.2)	56.0 (15.1)
Linguistic	53.3 (13.7)	51.0 (17.0)	54.8 (15.1)	57.2 (13.3)
Interpersonal	54.5 (13.1)	49.4 (16.4)	52.4 (17.0)	54.0 (14.3)
Intrapersonal	52.4 (12.1)	45.0 (12.5)	51.2 (16.1)	54.4 (14.7)
Naturalist	56.4 (16.7)	52.1 (16.4)	58.3 (17.9)	57.3 (15.6)

The comparison group teacher was not given the results of his class MI profile. He was to carry out the Mathematics lessons to the two comparison classes using the traditional method of teaching during the three-week intervention period in the first semester. Throughout the duration of this three-week study, both the project and comparison group classes covered the same topic on “Fractions”, utilized the same text, and completed all assignments within the same time frame.

The instruction for the two groups during the three-week treatment, in the first semester, varied in the following ways. The comparison group was taught the traditional method of “drill and practice”. Pupils were taught the objectives through teacher-directed lectures, notes on the whiteboard, practice problems from the textbook, teacher developed

worksheets, and the pupils' workbook which accompanies the text. The project group was taught the MI infused lessons daily where pupils were engaged in activities that encompassed all the eight intelligences. Pupils were taught using colourful and attractive visuals on power-point slides, and they were engaged in activities such as completing logic problems, reciting rhymes, raps and jingles and singing songs on mathematical concepts, constructing models, posters and number lines, playing board games, "Bingo" and "Uno", handling real life authentic manipulatives and working in pairs and groups, brainstorming and presenting their project work apart from completing all assignments from teacher prepared worksheets and the workbook. They were also made to reflect on the day's lesson in their journal.

The ten MI infused lessons on "Fractions" which covers "Mixed Numbers", "Improper Fractions", "Conversion of Fractions", "Addition & Subtraction", and "Fraction of a Set" were crafted by the project group teacher and another primary four Mathematics teacher who carried out the MI infused lessons with her primary four class as a pilot study. The comparison group teacher was not involved in the crafting the MI lessons so as to reduce threats to internal validity of the research project. At the end of the three-week treatment sessions, both groups were administered a topical review test on "Fractions". The results from this post assessment would determine if the project group achieves a higher mean score than the comparison group. Fifteen pupils were selected at random from the project group to be interviewed to get their feedback on their MI infused lessons at the end of the three-week intervention.

In the second semester, both the project and comparison groups were taught "Decimals" through MI infused lessons for a period of six weeks. The comparison group teacher was given the results of his class MI profile which showed the detailed intelligence variability within the class prior to the six-week MI intervention. This would help him to design and customize his Mathematics lessons on "Decimals" to cater to the dominant

multiple intelligences of the pupils in his two comparison classes. For the second semester, the project group teacher, the pilot group teacher and the comparison group teacher crafted sixteen MI infused lessons on "Decimals" which covers "Tenths, Hundredths and Thousandths", "Comparing Decimals", "Rounding Off", "Fractions and Decimals", "Addition and Subtraction", and "Multiplication and Division". During the six-week treatment sessions, both groups were administered a series of four topical review tests on "Decimals". The results from these review assessments would reveal if the project group achieve a higher mean score than the comparison group due to the longer exposure to MI. Five pupils were selected at random from each class to be interviewed to get their feedback on their MI infused lessons at the end of the six-week intervention. A focus group discussion among the project teachers were also conducted to get their feedback on the whole project.

PETALS^{TM} online data collection was also administered before and after the intervention period. The data collected would document qualitative as well as quantitative evidence of student engagement, motivation and attitude in the learning of Mathematics. Post-test results of the project group would reveal if there is an increase in the level of engagement among pupils who are taught Mathematics using the MI strategies and if the longer exposure to MI has a positive impact on pupils' engagement, motivation and attitude in the learning of Mathematics.

All lessons in all the four comparison and project classes were video-recorded for documentation and analysis. Most of the lessons were also observed by the research activist and the project consultant.

Results

Table 5: Mean comparison on pretest and post-test survey of the project group (N=68)

Measure	Mean (SD)		Effect Size
	Pretest	Post-test	
PETALS™ Scale			
Pedagogy	69.6 (16.6)	76.1 (15.8)	0.39
Experience of Learning	64.0 (19.3)	68.8 (18.5)	0.25
Tone of Environment	70.7 (13.7)	70.8 (19.5)	0.01
Assessment for Learning	67.1 (15.6)	73.8 (17.7)	0.43
Learning Content	66.3 (19.2)	75.6 (17.7)	0.48
Engagement Scale			
Affective Engagement	76.4 (17.7)	81.1 (15.0)	0.31
Behavioural Engagement	75.4 (15.1)	78.1 (18.2)	0.18
Cognitive Engagement	72.4 (16.9)	77.0 (15.8)	0.27

Table 5 shows results of engagement level among the two project groups from the PETALS™ online data collection which was administered before and after the intervention period. The results revealed a small to moderate effect size for Pedagogy, Experience of Learning, Assessment for Learning and Learning Content. The effect size for the three Engagement subscales is small. Assuming that the MI intervention was the cause, the differences tend to suggest that the MI intervention had a small to moderate impact on all aspects of pupils' engaged learning. The intervention, however, had a higher impact especially on Assessment for Learning, and Learning Content.

Table 6 : Reliability of PETALS™ Scale scores and mean comparisons

Measure	Cronbach's alpha	Mean (SD)		Effect Size
		Project (N=68)	Comparison (N=72)	
PETALS™ Scale				
Pedagogy	0.79	76.1 (15.8)	69.5 (17.8)	0.37
Experience	0.81	68.8 (18.5)	58.6 (20.6)	0.50
Tone	0.81	70.8 (19.5)	67.9 (16.9)	0.17
Assessment	0.73	73.8 (17.7)	65.0 (16.5)	0.53
Learning	0.83	75.6 (17.7)	64.8 (18.3)	0.59
Engagement Scale				
Affective	0.92	81.8 (15.0)	71.0 (17.9)	0.60
Behavioural	0.90	78.1 (18.2)	66.6 (17.3)	0.66
Cognitive	0.92	77.0 (15.8)	62.2 (20.6)	0.72

Table 6 shows the mean comparisons of engaged learning between both the comparison and project groups from the PETALS™ Engagement Indicator Questionnaire at the end of the nine-week MI intervention. The Cronbach alpha estimates were computed based on pupils' scores. All the alpha coefficients were high, varying between 0.79 and 0.92, indicating a high degree of internal consistency of the scale scores.

The results of mean comparisons in Table 6 shows a moderate effect size for Experience of Learning, Assessment for Learning, Learning Content and a small effect size for Pedagogy and Tone of Environment. The effect size for the three Engagement subscales is moderate to large.

Table 7 : Mean comparison on "Fractions" review test

Ability Group	Low-Ability Group		Average-Ability Group	
Class	Project (N=30)	Comparison (N=32)	Project (N=38)	Comparison (N=40)
Mean (SD)	34.6 (19.8)	22.6 (16.9)	71.5 (14.8)	62.1 (17.1)
Difference	12.0		9.4	
Effect Size	0.71		0.55	

Table 7 shows the results from the review test on "Fractions" administered at the end of the three-week MI intervention in the first semester. The project group from the low-ability group obtained a mean of 34.6 (19.8) and the comparison group 22.6 (16.9). There is a difference of 12.0 in favour of the project group. The corresponding effect size of 0.71 is of medium magnitude by Cohen's criteria. The project group from the average-ability group obtained a mean of 71.5 (14.8) and the comparison group 62.1 (17.1). There is a difference of 9.4 in favour of the project group. The corresponding effect size of 0.55 is of moderate magnitude by Cohen's criteria. Thus, it may be concluded, with some degree of reservation, the MI intervention has a significant impact on the higher achievement among the project group pupils who were taught "Fractions" through MI strategies as compared to the comparison group pupils who were taught "Fractions" through the traditional way. Results indicated that the MI intervention seemed to have a greater impact on the low-ability pupils.

Table 8 : Mean comparison on "Decimals" review test

Ability Group	Low-Ability Group		Average-Ability Group	
Class	Project (N=30)	Comparison (N=32)	Project (N=38)	Comparison (N=40)
Mean (SD)	61.1 (17.4)	46.1 (16.1)	84.7 (7.5)	76.4 (13.6)

Difference	15.0	8.3
Effect Size	0.93	0.61

Table 8 shows the results from the review test on "Decimals" administered throughout the six-week MI intervention in the second semester. All the four classes were taught "Decimals" using MI strategies over a period of six weeks. Thus the project group were exposed to MI for a longer period of time compared to the comparison group. Table 8 showed the project group from the low-ability group obtained a mean of 61.1 (17.4) and the comparison group 46.1 (16.1). There is a difference of 15.0 in favour of the project group. The corresponding effect size of 0.93 is of large magnitude by Cohen's criteria. The project group from the average-ability group obtained a mean of 84.7 (7.5) and the comparison group 76.4 (13.6). There is a difference of 8.3 in favour of the project group. The corresponding effect size of 0.61 is of moderate magnitude by Cohen's criteria. Thus, it may be concluded, with some degree of reservation that a longer exposure to the MI intervention has a positive impact on the higher achievement among the project group pupils who were taught through MI strategies for nine weeks as compared to the comparison group pupils who were taught through MI strategies for only six weeks. Results also indicated that the MI intervention has a greater impact on the low-ability pupils.

Table 9: Comparisons on motivational and attitudinal level means

No.	Item	Project group	Comparison group	Effect size
F1	I am excited about learning.	85.8 (17.4)	72.5 (22.1)	0.60
F2	I am interested in what is being taught.	84.1 (20.5)	69.6 (23.2)	0.61
F3	I like the subject.	83.1 (20.0)	74.1 (24.4)	0.37
F4	I like doing the activities.	83.2 (21.7)	75.9 (23.2)	0.31

F5	I want to learn more about this subject.	81.7 (18.0)	73.5 (24.7)	0.33
F6	I look forward to the lesson.	84.9 (22.2)	74.2 (21.1)	0.51
F7	I like learning because what I learn in class is useful.	79.0 (24.3)	70.0 (27.2)	0.33
F8	I will keep on trying even if the task is difficult.	79.8 (20.0)	69.7 (24.2)	0.42
F9	I like the challenging work given to us.	79.6 (22.5)	66.0 (27.5)	0.49
F10	I like learning because I can choose the task that I do best.	77.0 (22.6)	64.3 (25.8)	0.49

Table 9 shows the motivational and attitudinal levels of the comparison and project groups for the same lessons taught after the nine-weeks of MI intervention. For all the ten items, the project group scored higher than the comparison group did. The five items F1, F2, F6, F9 and F10 have moderate effect sizes while the remaining five items have small effect sizes. This suggests that a longer exposure to the MI intervention has a positive impact on the motivational and attitudinal levels of the project group pupils who were taught through MI strategies for nine weeks as compared to the comparison group pupils who were taught through MI strategies for only six weeks. Results also suggest that the pupils were more influenced by exciting, interesting and challenging lessons.

In addition to the quantitative data, feedback from the project group affirmed the improvement in attitude and the high motivation experienced by pupils from the MI infused lessons. To illustrate, below are four excerpts from the interviews and blogs written by the project pupils:

- *"We sang a lot of songs about decimals and fractions. It is very fun and interesting learning decimals and fractions. Our teacher teaches us different types of methods and using [attractive] power point [slides] to teach our class. I love Maths! It is really fun to learn! All the questions [are] like solving mystery cases! We also played Maths games to learn. Our teacher teaches us Maths in very fun ways. I love to play more Maths games and learn more about Maths! The Problem Sums are really challenging! Maths is Fun!"*

- *"….The songs help us to remember [mathematical concepts]. The games are fun and enjoyable. It is easier for us to learn (Maths) because we enjoyed the lessons…"*

- *"…We can learn a lot through playing games. The games are very fun and yet very challenging… The many fun activities make me like Maths more… I [am] always eager to wake up every morning [to] go to school and learn more about Maths…"*

- *"We did a lot of activities, we sang songs, played many Maths games and do a lot of activities… It was an easy and fun way to learn. Now my Maths is improving. I am looking forward to my END YEAR EXAM MARKS!"*

Feedback from the project teachers further affirmed the improvement in attitude and the high motivation observed in pupils through the MI infused lessons. To illustrate, below are four excerpts from the project teachers' reflection journals and the focus group discussion:

- *"The class was highly enthusiastic which was a dramatic change from their usual behaviour in class. I can see that some of them really looked forward to the lessons. They were engaged and enjoyed working in groups…It was really comforting to see a normally distracted pupil engaged for the first time …"*

- *"Pupils were definitely more engaged - more activities, more interaction, more hands-on. As lessons were interesting, pupils' attitude towards Maths became better. This positive attitude helped them to remain engaged even when doing non-exciting tasks such as LONG DIVISION!"*

- *"We all want our pupils to learn well. From this experience, we see that interesting lessons really make a difference! Pupils are more interested in Maths, and they enjoy school more. In this aspect, we have achieved what we set out to do. We have succeeded in improving pupils' attitudes and increased their interest in Maths!"*

- *"I have seen for myself how planning a lesson that involves multiple intelligences actually makes the lessons more exciting for the pupils. Pupils can relate better, recall the learning points better, and on the whole, they are more motivated, even to do homework. By getting pupils involved through activities, songs, stories, and using powerpoint slides packed with cute pictures and animations, pupils actually looked forward to learning. This is true "Teach Less, Learn More" in action."*

Discussion and Conclusion

Based on the analysis of the data presented, it is seen that the MI intervention in the area of Mathematics has made positive contributions for the pupils' engagement, motivation, attitude and achievement towards the learning of Mathematics. The thoughts penned down by pupils' in their reflection journal and teachers' observation on their pupils' behaviour during lesson support the statistical findings. It has been observed that the project group pupils during lesson participate actively in practices like writing journals, reciting rhymes, raps and jingles and singing songs on mathematical concepts, constructing models, posters and number lines, playing games among groups, brainstorming and presenting solutions to logic problems.

The findings obtained from this study, resembles other studies which evaluate MI instructional approach for the pupil success and attitudes. In a study by Cluck and Hess (2003) results showed improved assignment completion, class participation and engagement of learners using MI. A similar study by Bednar, Coughlin, Evans and Sievers (2002) on kindergarten, third, fourth and fifth grade pupils, results showed an increase in pupil motivation and positive attitude through the use of MI. In another study by Douglas, Burton and Reese-Durham (2008) on eighth grade Mathematics pupils, results showed considerable increase in academic performance on pupils taught through MI compared to those taught using the traditional method. The results of this study are also consistent with the larger scale research conducted by the creator of MI and its principles, Howard Gardner which demonstrates the effectiveness of MI with the noted improvements in standard achievement scores, performance of students having learning difficulties, parent participation, and student discipline. Due to the length of the current research conducted, three of the four improvements were observed: improved academic performance, greater impact on the low-ability pupils and behaviour improvements namely on pupils' attitude and motivation in

learning of Mathematics. Discipline problems tend to disappear, as reflected by the project teachers, when pupils are excited about learning in a fun filled lesson.

Moving forward

Overall, a two-pronged approach would be adopted in 2009. A school culture would be gradually developed by equipping all teachers with practical working knowledge of using MI through a Key Learning Programme (KLP). At the same time, there would be a catalyst group, comprising the specific project teams formed at P1, P4 and P5, that would systematically use MI to teach Mathematics for selected topics.

The TLLM Ignite! project for the Primary 1 (P1) pupils is implemented as there is a strategic fit between the Ignite! Project and the SEED programme. The SEED programme is designed to cater to the needs of the lower Primary Level pupils as it aims to involve young children in lessons through hands-on activities and personal experiences. Hence, *Ignite!* will complement and enhance the SEED programme as most of the younger children love games, hands-on activities, poems and music. This displays their need for lessons that cater to their multiple intelligences - namely, bodily-kinesthetic and musically-rhythmic activities.

The topic chosen for the project is on "Addition and Subtraction within 20". The entire P1 Mathematics curriculum lies heavily on the stratum of the 2 fundamental Mathematics operations - Addition and Subtraction. As such, the most important and difficult topic is on Addition and Subtraction within 20 as it involves the concept of renaming and regrouping. Students' ability to do well in other P1 Mathematics topics will depend hugely on their conceptual understanding of this particular topic.

The project started in Term 2 Week 3 this year in 2009. It was implemented for a period of three weeks. Pupils underwent a pictorial Multiple Intelligences (MI) Assessment to identify their dominant MIs. The curriculum has been redesigned and materials and resources

were crafted by the teachers for the project. Through this project, we hope to change pupils' attitudes and cultivate in-depth understanding for this hard-to-grasp concept.

We had also looked into refining the materials that were initially created for the *Ignite!* project when implementing the project for the current Primary 4 pupils. With the positive feedback given by last year's Primary 4 pupils on the MI-based lessons through their entries in blogs and interviews, it is important that we follow up by implementing the *Ignite!* project in Primary 5 as well. The present Primary 5 Mathematics teachers had specially crafted MI-based lessons on "Fractions" and "Decimals" to cater to the dominant intelligences of their pupils to continue to ignite the passion in Mathematics among these 'project' pupils. It is also paramount that we do not dampen our pupils' interest in Mathematics after they were so highly motivated in the subject through the research project involving them in the previous year.

Overall, the implementation of MI infused lessons in 2008 had positive results for both teachers and pupils. It was an enjoyable experience in the eyes of both. There was an increase in engagement, motivation, positive attitudes, and greater passion towards Mathematics among the pupils who were exposed to MI and this is what we would like to achieve for the Primaries 1, 4 and 5 pupils in 2009. Given the numerous benefits in using MI, we hope that teachers in West View Primary School will continue to adopt MI-infused lessons in their teaching not only in other topics in Mathematics, but also in other subject areas such as English, Science, Health Education, Social Studies, Music, Art and Physical Education as well.

In closing, the most beneficial aspect of our research is that it takes into consideration human differences within the classroom and teaches the subject matter in a variety of ways appealing to all learners.

References

1. Bednar, J., Coughlin, J., Evans, E., Sievers, T. May 2002. *Improving student motivation and achievement in Mathematics through teaching to the multiple intelligences.*
2. Brewster, C., Fager, J., (October 2000) *Increasing Student engagement and motivation: From time on-task to homework.* Northwest Regional Educational Laboratory. [Online] Retrieved from http://www.ncrel.org/request/oct00/textonly.htm.
3. Campbell, L., Campbell, C., & Dickinson, D. (1999). *Teaching and learning through the multiple intelligences* (Second ed.). Needham Heights: Allyn and Bacon.
4. Chapman, C. (1993). *If the shoe fit…Howto develop multiple intelligences in the classroom.*Arlington Heights, IL: IRI/Skylight Training and Publishing Inc.p.ix.
5. Cluck, M., Hess, D., *Improving Student Motivation Through the use of the Multiple Intelligences.* May 2003
6. Douglas, O., Burton, K.S., Reese-Durham, N., *The Effects of the Multiple Intelligence Teaching Strategy on the Academic Achievement of Eighth Grade Math Students.* Journal of Instructional Psychology; June 2008. Vol.35 Issue 2, p182-187, 6p
7. Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). *School engagement: Potential of the concept, state of the evidence*. Review of Educational Research, 74: 59 – 109.
8. Gardner, H. (1983). *Frames of mind.* New York: Basic Books.
9. Gardner, H. (1991). *The Unschooled Mind: How children think and how schools should teach.*. New York: Basic Books.
10. Gardner, H. (1993). *The theory in practice.* New York: Basic Books.
11. Gardner, H. (1999). *The disciplined mind: What all students should understand.* New York: Simon and Schuster.
12. Gross-Davis, B. (1993). *Tools for teaching, motivating students.* San Francisco, CA: Jossey_Bass Publishers
13. Hoerr, T. (2002). *Applying MI in Schools*. Retrieved from http://www.newhorizons.org/strategies/mi/hoerr2.htm
14. Mc Combs,B.L. (2002). *Understanding the keys to motivation to learn.* Retrieved from http://www.ncrel.org./products/voteworthy/barbaram.asp
15. Ministry of Education (2001), Mathematics Syllabus, Ministry of Education, Singapore
16. Ministry of Education (2005), A toolkit for engaged learning and teaching. Curriculum Planning and Development Division, Ministry of Education, Singapore

17. Pociask, A., Settles, J., *Increasing Student Achievement through Brain-Based Strategies, May 2007.*
18. Robinson, A., Silver, H.F., & Strong, R., (1995, September). *What do students want and what really motivates them?* Educational leadership. [Online] Available http://www.middleweb
19. Soh, K.C., Tan, C., *Workshop on Action Research:Transforming Teachers to Action Researchers.*Educational Leadership 21. Hong Kong. 2nd edition 2008.

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