International Journal of Humanities and Social Sciences
p-ISSN: 1694-2620
e-ISSN: 1694-2639
Vol. 10, No. 2 (2018), pp. 95-111, ©IJHSS

Bilingual Medium of Instruction: Effects on Students Conceptual Understanding, Problem Solving Performance and Interest in Mathematics

Jasmin C. Tawantawan and Jocelyn P. Aman
Mindanao State University
Marawi City, Philippines

Abstract
This study investigates the effects of using bilingual medium of instruction (Meranaw-Filipino) on students' conceptual understanding, problem solving performance, and interest in mathematics. It employed quasi-experimental design. Participants of the study consisted of two intact classes of Grade 7 students matched based on their Mathematics 7 grades during the second grading period of the school year 2016 – 2017. The researcher constructed three research instruments such as Conceptual Understanding Test (CUT), Problem Solving Performance Test (PSPT), and Mathematics Survey (MIS). Findings revealed an increase of the number of students from the experimental group from low to moderate in terms of their level of conceptual understanding and from interested to very interested level in mathematics. In the aspect of problem solving performance, both groups shows no increase, however there is a significant difference between the control and experimental groups of students' conceptual understanding, problem solving performance and interest in mathematics before and after intervention in favor of the experimental group. Students' perceived that they had better comprehension; learned fast, and were more interested in learning mathematics using bilingual medium of instruction in teaching mathematics. This suggests that the use of the bilingual medium of instruction was found to be beneficial in improving students' conceptual understanding, problem solving performance, and interest in mathematics than using English only as medium of instruction in teaching. Thus, the school administrator should encourage their teachers the use of bilingual as medium of instruction in teaching mathematics.

Keywords: instruction, bilingual, understanding, performance, interest.

Introduction

The medium of instruction is important in getting across to the leaner's, the concepts, precepts, principles and theories underlying a certain subject or course of study. This is why under the present K+12 curriculums, it is encouraged that a teacher must be multi-linguistic which always pushed challenges to students. Thus, in mathematics as subject encourage that a teachers must use bilingual as a medium of instruction in the teaching process. However, such strategy in the use of bilingual as a medium of instruction has not been explored specially on its effect to the learner's conceptual understanding, problem solving performance as well as on their interest.

The result of the Third International Mathematics Science Study (TIMSS, 1995) showed that the Philippines were among the lowest performing countries in mathematics (Nebres, 1997, cited in Aman, 2006). The TIMSS assessed the mathematics and science achievement of middle schools and secondary schools which was participated by 45 countries. Similar disappointing results were obtained in TIMSS-Repeat in 1999, and Trends International Mathematics and Science Study in 2003 and 2007. According to Launio (2015) the use of English as a medium of instruction in teaching mathematics is one of the reasons for the poor performance of our students in mathematics. He also stressed out that mathematics is one academic area of concern that appears to have a language-related on students' performance. However, according to Crisostomo (2000) in his article in the Philippines Star (newspaper local) that the top performing countries (Korea, Taipei, Singapore and Hong Kong) in Mathematics in the TIMSS use their mother tongue except for Singapore that uses bilingual medium of instruction in teaching mathematics and science. Thus, this study wanted to find out the effect of bilingual in teaching and learning mathematics.

According to the study of Dixon (2015) Singapore is known of its Bilingual Education System that has been hailed a great success due to its first-place mean score in mathematics and second-place in science compared to 38 countries on TIMSS-R in 1999. Also, in the study of Launio (2015), it shows that there was a progress on the students' mathematics performance taught in bilingual medium of instruction (English supplemented with Hiligaynon) than in English only. Similarly, a study by Cuervo (1991) showed that bilingual instruction helps students develop their understanding of particular concepts in solving problems in mathematics thereby promotes better performance in mathematics test. As a result, studies shows that the students learn better when taught in bilingual.

The life skills cited by the Department of Education or DepEd (2012) in its basic education curriculum in mathematics are critical thinking and problem solving. The K to 10 Mathematics Curriculum provides a solid foundation for Mathematics up to Grades 11 to 12. More specifically, it provides necessary concepts and life skills needed by Filipino learners as they proceed to the next stage in their life as learners and as citizens of our beloved country, the Philippines.

In response to the pressing need to enhance mathematics performance among Filipino students, this study aims to contribute in finding effective ways of developing conceptual understanding, problem solving performance and interest among Filipino students using bilingual medium of instruction in teaching mathematics.

Method

Participants

The subject participants of this study were the two intact classes of Grade 7 students of MSU-Balindong CHS who were officially enrolled for the school year 2016-2017. Students' grade in second grading in Mathematics 7 for the school year 2016-2017 were used as basis for matching to ensure that the two groups were comparable. Students with no matches were excluded in the data analysis.

Design

This study employed quasi-experimental research design to investigate the effects of bilingual medium of instruction on students' conceptual understanding, problem solving performance and interest in mathematics. The quantitative aspects employed using two intact groups to determine the students' significant difference in terms of their conceptual understanding, problem solving

performance, and interest in mathematics. Specifically the matching – only, pre-test – post-test control group design was applied (Fraenkel & Wallen, 2011). The qualitative aspects focused on evaluating students' perceptions on bilingual medium of instruction in teaching and learning mathematics. The evaluation was done through one-on-one interview and students' journal. The one-on-one interview and students' journal in the used of the bilingual medium of instruction by the teacher-researcher in teaching mathematics was conducted to experimental group only. It validated and compared results from the CUT, PSPT and MIS.

Materials

The instruments used in this study were the teacher-made questionnaire such as the Conceptual Understanding Test (CUT), Problem Solving Performance Test (PSPT), Mathematics Interest Survey (MIS), Interview Guide, Observation Checklist, and Students' Journal.

Procedure

The data gathering were in three phases, the pre-intervention phase, the intervention phase and post-intervention phase.

Pre-intervention Phase: In the pre-intervention phase, the constructed research instruments on Conceptual Understanding Test (CUT) and Problem Solving Performance Test (PSPT) were presented to the research adviser and experts in mathematics for corrections, suggestions, face and content validation. The revisions of the said research instruments were done by incorporating the corrections and suggestions from the experts. Then the Conceptual Understanding Test (CUT) was pilot tested to Grade 8 students at MSU-Balindong CHS covered the topic domains such as basic concepts and terms in geometry, angles, polygons, triangles, quadrilaterals, circles and statistics to test its reliability using Cronbach Alpha.

The Mathematics Interest Survey (MIS) was adapted and modified from the different studies from the internet and presented to the research adviser and experts for corrections, suggestions, face and content validation. When all research instruments were content validated and face validated, the lesson plans in the study followed next. The lesson focused on the following topic domains and was presented in a different manner. The bilingual instruction was introduced to the experimental group but not to the control group. The lesson plan for the experimental group was presented to the research adviser and three senior faculty members who were teaching mathematics using Meranaw or Filipino language as medium of instruction in teaching mathematics for corrections and suggestions on the translation of the language instruction for the lesson plan.

The Intervention Phase: The two intact classes were taught with same topic domains at the same pace, received the same amount of activities, individual seat work, board work, assignments, short and long quizzes and examinations. The teacher-researcher strictly followed the prepared lesson plan for Grade 7 whereas the teacher-observers were also strictly observed and monitored in the medium of instruction used by the teacher-researcher. The teacher-researcher used bilingual medium of instruction in the experimental group, whereas the traditional medium of instruction was used in the control group in teaching the topic domains. The events in the class were using video-cam and audio recording to capture the classroom proceedings during the session.

Post-intervention Phase: After the intervention, post-test on CUT was administered on March 5, 2017, whereas PSPT and MIS were administered on March 6, 2017 to the two groups with the same procedure in conducting the pretest. Then selected students from experimental group were

chosen for a follow-up interview. The one-on-one interview used video-cam, audio record and then it was transcribed to validate.

Results and Discussions

Table 1: Frequency and percentage distribution of students' level of conceptual understanding in mathematics before and after intervention

Raw Score	**Level of Conceptual Understanding**	**Control Group N=26**		**Experimental Group N=26**	
		Before	After	Before	After
		Number (%)	Number (%)	Number (%)	Number (%)
24 – 30	High	0 (0%)	0 (0%)	0 (0%)	0 (0%)
15 – 23	Moderate	0 (0%)	3 (11.5%)	0 (0%)	12 (46.2%)
0 – 14	Low	26 (100%)	23 (88.5)	26 (100%)	14 (53.8%)
	Total	26 (100%)	26 (100%)	26 (100%)	26 (100%)

As shown in Table 1, before the intervention, all of the students from both groups have low level of conceptual understanding in mathematics. However, after the intervention the results show that 12 (46.2%) or almost half of the students from the experimental group increase their level of conceptual understanding in mathematics from low to moderate while only 3 (11.5%) from the control group. This increase in the number of the students in the moderate level of conceptual understanding in mathematics is in favor of the experimental group might be attributed to the used of bilingual medium of instruction in teaching mathematics. This suggests that teaching mathematics using bilingual medium of instruction help, facilitate, and promote the conceptual understanding among students since the teacher discussed the lesson using bilingual which is so understandable. Thus, the students can participate and communicate well using their first language (Meranaw) or second language (Filipino) during class activities and discussions.

According to Lessow-Hurley (2000; cited in Fernandez, 2003) bilingual are effective because "concepts and skills that are learned in the first language transfer to the second language" a strong first language serves as a base for second language acquisition, and instruction in the students' home language and culture promotes higher levels of self-esteem, which in turn, promote higher achievement. Thus, the bilingual medium of instructions has a positive effect on the level of conceptual understanding of the students in mathematics.

This findings are consistent in the study of Launio (2015) entitled "Instructional Medium and its Effect on Students' Mathematics Achievement" where students' mathematics performance before the intervention was low but progressed to average after they were exposed to bilingual instruction. Thus, teaching mathematics in bilingual is better than teaching the subject in English only. Similarly, in the study of Yang (2015) shows those students exposed using bilingual show better performance.

Table 2: T-test and significance (p) values on the comparison of control and experimental groups of students' Conceptual Understanding Test (CUT) mean score in mathematics before and after intervention

	Group	Number of Students (N)	Mean Score	SD	t-value	p-value	Remark/s
Before	Control	26	8.12	2.50	-0.94	0.35	Not Significant
	Experimental	26	7.46	2.52			
After	Control	26	11.04	3.27	4.44	0.00	Significant
	Experimental	26	14.38	2.02			

As shown in the Table 2, before the intervention, the t-test value is - 0.94 with a significance p-value of 0.35 which is greater than 0.05 level of significance which implies no significant difference. The result of the Levene's Test for independent samples wherein the mean scores and standard deviation of control group $(\bar{x} = 8.12, SD = 2.50)$ and experimental group $(\bar{x} = 7.46, SD = 2.52)$ were almost the same before the intervention. This implies that the two groups at the start of the intervention were comparable in terms of their conceptual understanding. Generally, this is expected because the students have no prior knowledge on the topic domains that were schedule to be discussed during the intervention or third grading period as can be seen in the k+12 curriculum guide provided by the Department of Education (DepEd). Also, both groups of students were handled by the same teacher in the same school, the same learning materials, the same teaching strategies, and the same learning environment.

However, after the intervention based on the above results show, the t-test value is 4.44 and p-value 0.00 is less than 0.05 level of significance. This implies that two groups differ significantly on conceptual understanding. The means score of control group $(\bar{x} = 11.04, SD = 3.27)$ and experimental group $(\bar{x} = 14.38, SD = 2.02)$ after intervention shows increased. Hence, the used of bilingual medium of instruction in teaching mathematics did significantly increase their conceptual understanding in mathematics of the experimental group. This significant difference may be explained by using bilingual medium of instruction were students from the experimental group understood well the lesson, the experimental group was able to gain superior in mathematics literacy faster than the control group who studied mathematics in a foreign language (English). Using bilingual in interacting with other students in mathematics class, the experimental group may have understood the concepts well. Since, they are familiar with the terms and they are able to interact with other students. This is supported by Cummins (2000) believes that bilingual education promotes both language learning and academic achievement.

The findings confirmed the study of Satiuto (1998) which the results show that the students exposed to bilingual achieved better than students exposed to the trilingual and also in the study of Nillas (2002) shows that teaching in bilingual gave better results in mathematics achievement than teaching entirely in English.

Table 3: T-test and significance (p) values on the comparison of the control and experimental groups of students' mathematics Conceptual Understanding Test (CUT) mean gain scores

Group	Number of Students (N)	Mean Gain Score	SD	t-value	p-value	Remark/s
Control	26	2.92	3.33			
				4.67	0.00	Significant
Experimental	26	6.92	2.80			

As shown in Table 3, based on the above results in the mean gain score of the control group $(\bar{x} = 2.92, SD = 3.33)$ and experimental group $(\bar{x} = 6.92, SD = 2.80)$ indicates that it vary from one another. The result shows that experimental group posted significantly higher mean gain scores than the control group. In comparing the mean gain scores of the two groups, it can be seen that the t-value of 4.67and p-value of 0.00 is less than 0.05 level of significance this means that both groups differ significantly on conceptual understanding before and after the intervention. From the result, this implies that one may infer that the high mean gain score of experimental group (6.92) as against the mean gain score of the control group (2.92) may be due to the introduction of the new medium of instruction in teaching mathematics.

This result affirmed the study of Myers and Milne (2008) on effects using bilingual on the mathematics achievement of various groups of language minority students. It was found that there was significant difference between the mathematics achievements of the students using bilingual and that of students using English only. Also, in the study of Wolfaardt (2005) shows those students exposed using bilingual shows better performance than the traditional.

Table 4: Frequency and percentage distribution of students' level of problem solving performance in the control and experimental groups before and after intervention

Raw Score	Level of Problem Solving Performance	Control Group N=26		Experimental Group N=26	
		Before	After	Before	After
		Number (%)	Number (%)	Number (%)	Number (%)
31 – 40	High	0 (0%)	0 (0%)	0 (0%)	0 (0%)
20 – 30	Average	0 (0%)	0 (0%)	0 (0%)	0 (0%)
0 – 10	Low	26 (100%)	26 (100%)	26 (100%)	26 (100%)
	Total	26 (100%)	26 (100%)	26 (100%)	26 (100%)

As shown in the Table 4, all (100%) of the students from both groups have low level of problem solving performance in mathematics before and after the intervention. As far as the distribution of the students in three levels of problem solving performance, the control and experimental groups posted the same numbers and percentage per level. Although, students from the experimental group have low level in terms on their problem solving performance shows that their mean score posted higher than the control group as shown in the Table 5 after the intervention and samples of students' problem solving performance were also given in the figure 4. The progress on the students' problem solving performance after the intervention may attribute to the use of bilingual medium of instruction in teaching and learning mathematics since the given activities and learning materials were also translated in bilingual that helped the students to understand and apply the concepts that they learned in solving mathematical problems. This suggest that bilingual medium of instruction in teaching mathematics assist students' problem solving performance in learning mathematics which results an increase on students' mean scores.

The study findings validate the study of Valladoid (2001) entitled "the Effects of Bilingual Education on Students' Achievement as they progress through a bilingual program" shows there were no progress on bilingual program students on their mathematics performance level before and after the intervention compared to the traditional program students but shows significant difference in their means.

Table 5: T-test and significance (p) values on the comparison of control and experimental groups of students' Problem Solving Performance Test (PSPT) mean score in mathematics before and after intervention

	Group	Number of Students (N)	Mean Score	SD	t-value	p-value	Remark/s
Before	Control	26	1.92	1.35	-2.01	0.04	Significant
	Experimental	26	1.08	1.57			
After	Control	26	6.38	2.23	6.49	0.00	Significant
	Experimental	26	11.38	3.15			

As shown in the Table 5, before the intervention the above results show the t-value = -2.01 and p-value of 0.04 of the two groups which is less than 0.05 level of significance. However, although it is less than at 0.05 level of significance the result in their problem solving performance mean scores is not statistically significant. Since the difference of (0.8462) as can be seen from their means, the control $(\bar{x} = 1.92, SD = 1.35)$ and experimental $(\bar{x} = 1.08, SD = 1.57)$groups before the intervention are significantly the same this is supported by the result in the Levene's Test for independent samples. This implies that the problem solving performance of the students was comparable before the intervention. This may indicate that these students do not have necessary knowledge on the Problem Solving Performance Test (PSPT) which is characteristics of the given test. It may be added that their ability to solve problems in mathematics involving higher order thinking skills is limited.

These findings are in consonant with the study of Espada (2012) that although the experimental group obtained a higher mean than the control group it was still below the passing mean; thus, the results could be comparable since they specify that the entry points of both groups before the treatment were of the same level (low average). Thus, the conduct of the experiment was devoid of bias.

However, after the intervention, the t-test value is 6.49 and p-value is 0.00 of the two groups is less than 0.05 level of significance. This implies that two groups differ significantly on problem solving performance. Thus, the null hypothesis which states that "there is no significant difference between the control and experimental groups of students' mathematics Problem Solving Performance Test mean gain scores before and after intervention" is rejected. The means score of control group $(\bar{x} = 6.38, SD = 2.23)$ and experimental group $(\bar{x} = 11.38, SD = 3.15)$ after intervention shows also an increased and in favor of the experimental group exposed using bilingual medium of instruction. This further implies that two groups differ significantly in their mean scores and did significantly increase the problem solving performance in mathematics of the students. This significant difference of the students' problem solving performance may be explained by the day-to-day language social interaction of the students with other people that uses Meranaw or Filipino which able them to strengthen the used of their mother tongue. They become more cooperative, attentive, and active during class

activities. According to Bernardo (2000) studies show that student who actively engaged in problem information, are better learners because they understand more the lesson and they were able to solve the mathematical problems. This is supported by Cummin's (2000) theory that bilingual medium of instruction help students improve learning and knowledge of first language which provides a firm for second language acquisition. Hence, the bilingual medium of instructions affects the problem solving performance of the students in mathematics.

The result is in line with the study of Gibson (1991) that there was improvement on students' performance on conceptual understanding and problem solving performance in modeling multiplication and its application to word problem in mathematics using bilingual.

Table 6: T-test and significance (p) values on the comparison of the control and experimental groups of students' Problem Solving Performance Test (PSPT) mean gain scores

Group	Number of Students (N)	Mean Gain Score	Standard Deviation	t-value	p-value	Remark/s
Control	26	5.31	2.29			
				5.69	0.00	Significant
Experimental	26	9.46	2.93			

As shown in Table 6, based on the above results, mean gain score of the control group is $(\bar{x} = 5.31, SD = 2.29)$and experimental group $(\bar{x} = 9.46, SD = 2.93)$ implies that it differ from one another. This also implies that the difference between mean gain scores on problem solving performance in mathematics of the students is statistically significant in line of the new medium of instruction used in teaching mathematics. In comparing the difference of mean gain score of both groups, the result shows the t-test value of 5.69 and p-value of 0.00 is less than 0.05 level of significance which implies significant difference. Thus, there is a significant difference in the mean gain scores on problem solving performance in mathematics of the students from both groups before and after the intervention. This implies that the bilingual medium of instruction in teaching mathematics have a good potential to develop the problem solving performance of the students as compared to the English only as medium of instruction. This further implies that language proficiency is a factor that affects the performance of the students, even if the students had potentials in mathematics, they were likely to fail because the language barrier has created a wide gap between them and the concepts/skills being studied. According to Elkins (1997; as cited in Pascasio, 1997) vernacular education is only one aspect of bilingual education, but ample evidence shows that teaching in the vernacular is highly effective and can be a useful bridge to bilingualism with all its resulting benefits. Hence, the bilingual medium of instructions affects the problem solving performance mean gain scores of the students in mathematics. Thus, bilingual medium of instruction in teaching mathematics students perform better than using English only.

The findings affirmed the study of Cuervo (1991) which shows that bilingual instruction helps students developed their understanding of particular concepts in solving problems in mathematics that promote better performance in mathematics.

Table 7: Frequency and percentage distribution of students' level of mathematics interest in the control and experimental groups before and after intervention

Raw Score	Level of Mathematics Interest	Control Group N=26		Experimental Group N=26	
		Before	After	Before	After
		Number (%)	Number (%)	Number (%)	Number (%)
96 – 120	Very Interested	5 (19.2%)	4 (15.4%)	7 (26.9%)	12 (46.2%)
60 – 95	Less Interested	21 (80.5%)	22 (84.6%)	19 (73.1%)	14 (53.8%)
0 – 59	Not Interested	0 (0%)	0 (0%)	0 (0%)	0 (0%)
	Total	26 (100%)	26 (100%)	26 (100%)	26 (100%)

As shown in the Table 7., before the intervention only few of the students in the experimental (7 or 26.9 %) and control groups (5 or 19.2%) were very interested in terms of their levels of mathematics interest and more than half of the students in the experimental group (19 or 73.1%) and control group (21 or 80.8%) were less interested. However, after the intervention the results show an increase in the number of students in the experimental group (12 or 46.2%) and decrease in the control group (4 or 15.4%) in very interested in terms of their levels of mathematics interest whereas in less interested shows increase in the control group (22 or 84.6%). This increase in the number of the students in the experimental group in more interested level attributed to the use of bilingual medium of instruction in teaching and learning mathematics. It could be explained by students' active participation and motivation. Since they were given a chance to interact with other students and express their ideas using the language they prefer either Meranaw or Filipino and also the learning material were translated into bilingual for them to understand well the lesson. According to Cummins' Cognitive Academic Language Proficiency (CALP) as cited by Baute (2013) refers to formal academic learning. This includes listening, speaking, reading and writing about some subject area content material using bilingual. This level of language learning is essential for the students to succeed in school. Also, if a child has no prior schooling or had no support to native language development; it may take seven to ten years for English Language Students to catch up with their peers. This suggests that using bilingual medium of instruction impacts the interest of the students in learning mathematics.

This is consistent in the study Arthur et. al (2014) shows that teacher's method and approach was also found to positively affect students interest in mathematics.

Table 8: Chi-square and significance (p) values on the comparison of control and experimental groups of students' level of mathematics interest before and after intervention

	Group	Number of Students (N)	Pearson Chi-square x^2	p-value	Remark/s
Before	Control	26	2.46	0.19	Not Significant
	Experimental	26			
After	Control	26	2.88	0.03	Significant
	Experimental	26			

As shown in the Table 8, before the intervention the Pearson chi-square $(x^2 = 2.462)$ and the p-value (0.190) is greater than 0.05 level of significance. This implies that they did not significantly differ in terms of their level of interest in mathematics. This further implies that the

two groups are comparable before the intervention. After the intervention, the p-value yielded significant result at 0.05 level (p-value = 0.031). This means comparison in the levels of mathematics interest of the students of the control and experimental groups after the intervention is significant. Therefore, there is a significant difference in the level of mathematics interest of the students in the control and experimental group after the intervention. This significant difference of the students' level of mathematics interest between the control and the experimental groups could be explained through their constructive participation of the students in the used of the medium of instruction. According to the Social Constructivist Theory of Vygotsky, stressed that knowledge socially constructed by interacting with others in a variety of experiences. Collaborative learning is the idea that conversations with older people can help children both cognitively and linguistically.

Moreover, social interaction allows learners to construct their own knowledge and view themselves as member of a community as they interact with others. Constructivist learning also involves providing experiences that induce cognitive conflict, and hence encourages learners to develop new knowledge schemes that are better adopted to experiences. Thus, the experimental group was very interested in learning mathematics using bilingual medium of instruction because it allows them to talk about their prior knowledge and understanding that may lead them to address the things that they don't understand on the topic discussed. Thus, the bilingual medium of instructions affects the interest of the students' level of mathematics interest. This suggests that using bilingual medium of instruction in teaching mathematics enhances their interest in learning mathematics since they can express their thoughts and can communicate using the language they prefer.

The finding is in consonant with the study of Heinze et. al. (2005) his study focused on students' mathematics achievement and their interest in mathematics as well as on the relation between these two constructs. His study revealed that teaching approach affects the interest of the students and could be regarded a predictor for mathematics achievement.

Students' Perceptions in the Use of Bilingual Medium of Instruction in Teaching and Learning Mathematics

Experimental group of Students' perceptions on teaching mathematics was using bilingual. The findings depict that most of the students have expressed their feelings regarding the use of bilingual medium of instruction as revealed in their students' journal and one-on-one interviews. The students revealed different responses form as written in their students' journal and one-on-one interviews. The following are extracts from the transcribed unedited interviews of the students and were categorized as follows: (1) students have better comprehension using bilingual; (2) students become fast-learner using bilingual; and (3) students become very interested in mathematics class using bilingual. English translations of their responses were provided.

Students have better comprehension using bilingual

E22: Gusto ko po yong pag gamit ng Meranaw at Filipino kasi po mas madali ko po maintindihan ang tinuturo ni teacher. *(I like the used of Marano at Filipino because I understand better what our teacher taught us.)*

E7: Mapiya so bilingual ka pusabotun ta piyapiya so discussion kay matao ako mranaw ago tagalog. *(Bilingual is nice because I understand Meranaw and Filipino language so I also understand the discussion using bilingual.)*

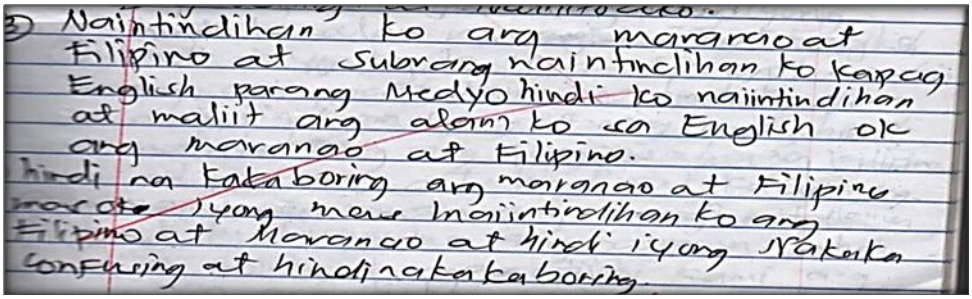

3) Naintindihan ko ang maranao at Filipino at subrang naintindihan ko kapag English parang Medyo hindi ko naiintindihan at maliit ang alam ko sa English ok ang maranao at Filipino. hindi na nakaboring ang maranao at Filipino kaysa iyong mere naiintindihan ko ang Filipino at Maranao at hindi iyong nakakaconfusing at hindi nakakaboring.

Figure 1: Sample of Students' Journal Entry (E22, 02/05/2017)

Students from the experimental group revealed on their one-on-one interviews and journal (Figure 1), accordingly, they perceived that they had better comprehension using bilingual medium of instruction in understanding mathematical concepts unlike using English only. They also perceived that using bilingual was neither boring nor confusing. Since the students were encouraged to ask and answer questions using the language they prefer and make the class more active and attentive. It also allows students to talk about their prior knowledge and understanding that may lead them to address the things that they do not understand.

The results of this study support the statements of Cummins (2000), Senapati et. al, (2012), and Pascasio (1997) that bilingual education promotes both language learning and academic achievement. Similarly, in the study of Valladoid (1991) revealed that students exposed in bilingual medium of instruction performed better than exposed in traditional medium of instruction. This means that bilingual medium of instruction might be one tool in helping students to perform better in mathematics.

Students become fast-learner using bilingual

E15: Type akun so ka pamangdaw sa mranao ago tagalog kasi ma'am mas magaan ta makasuwa ago malubod ta sabotun so kapamangdaw e ma'am na ba laged o ka English bo di ako ron tanto matao ago sabot. *(I like the way taught me using Meranaw and Filipino because ma'am I learned fast and I easily understand the way you taught, unlike English, I'm not fluent and can't really understand it.)*

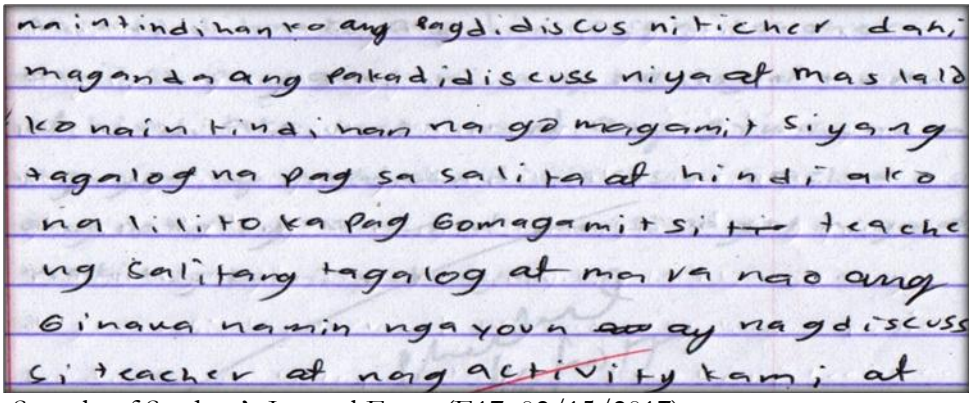

naintindihan ko ang pagdiscus ni teacher dahi magandang pakadidiscuss niya at mas laid ko naintindihan na gagamit siyang tagalog na pag sa salita at hindi ako na liito ka pag gomagamit si teache ng salitang tagalog at marami nao ang ginawa namin nga yoon ay nagdiscuss si teacher at nag activity kami at

Figure 2: Sample of Student's Journal Entry (E17, 02/15/2017)

Additional students from the experimental group revealed in their one-on-one interviews and journal (Figure 2), perceived that using Meranaw and Filipino as medium of instruction enhanced their understanding, they learn fast and were not confused using the bilingual medium of instruction in learning mathematics. Since students were motivated to learn mathematics and can communicate among others students using the language they prefer. It also help the students express their thoughts on what they don't understand. This is supported in the study of Elkins (1997, as cited in Pascasio, 1997) that using mother tongue is one aspect of bilingual education

and shows that using mother tongue is highly effective and helpful bridge to bilingualism. Also, the students can become biliterate is to acquire literacy skills in their mother tongue first.

The result is consistent with the study of Williams et. al (2014) entitled "Teaching math and science in the mother tongue; challenges, strategies, and perceived Effects" which revealed the use of mother tongue as medium of instruction in teaching mathematics students have better comprehension, learn fast, mastery index is higher and have better grades.

Students become more interesting in mathematics class using bilingual

E3: Gusto ko po ang paggamit ng Meranaw at tagalog dahil po mas madali ko po naintidihan ang tinuturo nyo po at lalo po ako ginganahan pumasok kasi hindi po din boring kay gyoto ba pusabotun ta pyapya.*(I like the used of Meranaw and Filipino because I understand better what you've taught us and I am more interested going to class because it is not boring and I understand it well.)*

E4: Mapiya so Meranaw ago tagalog kasi hindi po ako nahihirapan sa discussion ni teacher at pwede po ako mag tanong gamit po ang Meranaw odina tagalog lalo din po ako ginaganahan mag-aral. *(Meranaw and Filipino are nice because I don't have difficulty in understanding the discussion of our teacher and I can ask questions using Meranaw or Filipino. I also become more interested to learn.)*

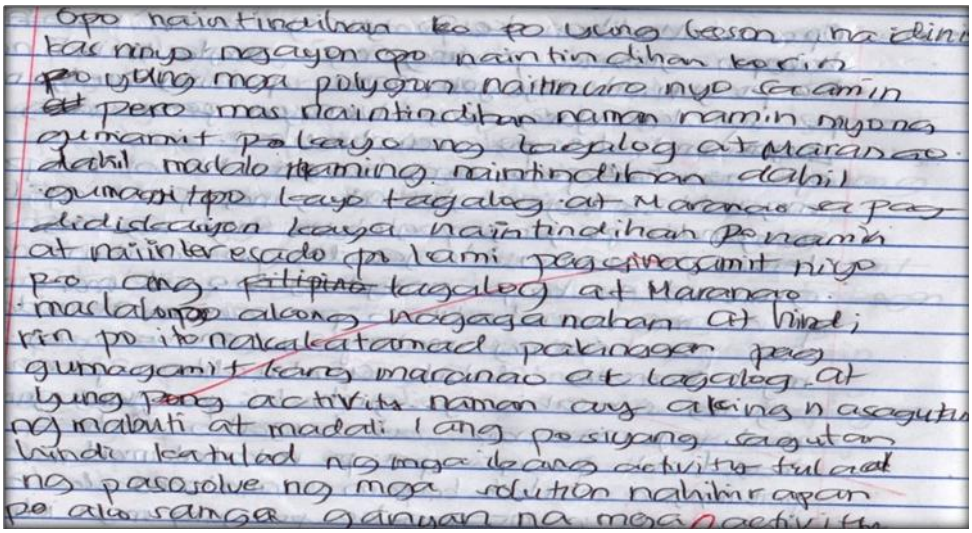


Figure 3: Sample of Student's Journal Entry (E3, 02/07/2017)

Apparently, other students from the experimental group revealed in their one-on-one interviews and journal (Figure 3), it says that they had better understanding on lesson using bilingual and become more interested in learning mathematics. They also perceived that learning mathematics was not boring using bilingual as medium of instruction. These are clear evidences that through bilingual medium of instruction helped a lot in the development of conceptual understanding, problem solving performance and mathematics interest of the students. Their expression of being interested (Table 8) may also have contributed in the increase of the number of students who have developed level of conceptual understanding (Table 2) and increase on their mean scores on problem solving performance (Table 5). It also shows that the students remarkable difference on their performance. This increase could be explained through their active and attentive participation using bilingual medium of instruction in teaching mathematics. They were interested using bilingual medium of instruction in teaching mathematics because they can express their thoughts and will not be afraid of making mistakes on the language they used. It will also bring the home and school closer together and open up communication between families and teacher that will help learner gain self-confident.

The findings of this study on students' conceptual understanding, problem solving performance, and mathematics interest is paralleled on their perception in the use of bilingual medium of instruction that bilingual medium of instruction helped the students performed better than the using English only in teaching mathematics as expounded on a local studies (Williams et.al., 2014) and international studies (Yang, 2015; Wolfaardt, 2005; Myers and Milne, 2008; Arthur et. al., 2014; Heinze et.al., 2005) that investigated the effects of bilingual medium of instruction.

Conclusions

Generally, this study concludes that bilingual medium of instruction was found to give positive effect on students' conceptual understanding, problem solving performance and interest in mathematics than using English only. Through bilingual medium of instruction it enables students to engage into more meaningful learning and performed well. Therefore, it is strongly recommended that Bilingual mathematics teachers should be encouraged to contribute their unique expertise to bilingual programs that would enhance the learning opportunities of language minority students. Moreover, teacher must have adequate knowledge in mathematics content and are able to create classroom environment that students can express their understanding or what they do not understanding using the language they prefer.

References

Aman, J. (2006). *An assessment of mathematical communication competency of fourth year science and non-Science high school students*. (Unpublished Masters' Thesis). University of the Philippines, Diliman, Quezon City.

Arthur, Y. D., Oduro, F. T., & Boadi, R. K. (2014). Statistical Analysis of Ghanaian Students Attitude and Interest Towards Learning Mathematics. *International Journal of Education and Research*, 2(6), 661–670.

Baute, Z. (2013). *Mother tongue-base instruction in English and mathematics: influence on pupils learning in selected elementary schools in Marawi City and Iligan City (2012-2013).* (Unpublished Doctoral Dissertation). Mindanao State University, Marawi, Philippines. .

Bernardo, B. (2000). Language and modeling word problems in mathematics among bilinguals. *Journal Psychology,* 139 (5), 413-25.

Crisostomo, S. (2000). *Filipino still rate low in mathematics and science*. Philippine star. Philippines: Philippine Star Printing Company, Inc.

Cuervo, M. (1991). *Bilingual instruction in college mathematics: effects on performance of Hispanic students on CLAST mathematics competencies examinations*. (Unpublished Doctoral Dissertation). University of Miami.

Cummins, J. (1989). *Empowering minority students*. Sacramento, CA: California Association for Bilingual Education.

Cummins, J. (2000). Biliteracy, empowerment, and transformative pedagogy. In J. V. Tinajero and R. A. DeVillar, (Eds.), *The Power of Two Languages 2000: Effective Dual- language use across the curriculum* (pages 9-19). New York: McGraw-Hill School Division.

Dixon, L. (2015). *The Bilingual education policy in Singapore: implications for second language acquisition*. (Unpublished Masters Dissertation). Harvard University Graduate School of Education, Cambridge, MA.

Espada, J. P. (2012). The Native language in teaching kindergarten mathematics. *Journal of International Education Research,* 8 (4), 359-366.

Fernandez, A. (2003*). The effects of dual language instruction on the pre-reading skills of kindergarten students*. (Unpublished Doctoral Dissertation). University of Houston, Houston, Texas.

Fraenkel, J., & Wallen, N. (2011). *How to design and evaluate research in education* (6th Ed.). New York, NY: McGraw-Hill Companies, Inc.

Heinze A, Reiss K, Augsburg F R (2005). *Mathematics achievement and interest in mathematics from a different perspective.* ZDM, Vol. 37(3): 212-220.
Launio, R. (2015). Instructional medium and its effects on students' mathematics achievement. *International Journal of Multidisciplinary and Current Research*, 3(1), 462-465.
Myers, D., & Milne, A. (2008). Effects of home language and primary language: A model and results for secondary analysis. In R. D. Cocking & J. P. Maestre (Eds.), *Linguistic and cultural influences on learning mathematics*. Hillsdale, NJ: Lawrence Erlbaum.
National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics.* Reston, VA: Author. NBE Resolution No. 73-7, s. 1973.
Nillas, L. (2002). Does language make a difference: a TIMSS-R analysis. *The Mathematics Education*, 6 (2), 95-112
Pascasio, M. (1997). *The Filipino bilingual: studies on the Philippine bilingual and bilingual education.* Quezon City: Ateneo de Manila University Press.
Satuito, T. V. G. (1998). *The effects of bilingualism versus trilingualism on english literacy achievement in a Philippine high school.* (Unpublished Doctoral Dissertation). Stanford University, Stanford, United States.
Senapati, P., Patnaik, N., & Dash, M.. (2012). Role of medium of instruction on the development of cognitive processes. *Journal of Education and Practice,* 3 (2), 58-66.
Valladolid, L. A. (1991). *The effects of bilingual education of students' academic achievement as they progress through a bilingual program.* (Doctoral Dissertation). United States International University.
Williams, A., et. al. (2014). *Teaching Math and Science in the Mother Tongue; Challenges, Strategies, and Perceived Effects.* International Conference in Science and Mathematics Education, NISMED, Philippines.
Wolfaardt, D. (2005). *Namibia: A Case for a Gradual Transitional Bilingual Language Programme.* Proceedings of the 4th International Symposium on Bilingualism, 2357- 2366, Somerville, MA: Cascadilla Press.
Yang, E. (2015). *Cognitive effects of bilingualism: executive functions and language practice.* (Unpublished Doctoral Dissertation). The University at Buffalo, State University of New York.

Appendix 1

Conceptual Understanding Test (cut)

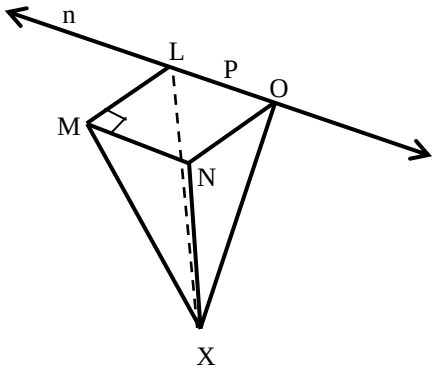
Name:_____ Date: _____Rating:_____
School:_____ Sex:_____ Grade Level: _____

DIRECTIONS.Select the letter that corresponds to the correct answer and write the letter of your choice on the space provided before each number.

Note: Unless otherwise stated, all the following should be assumed.

5. Illustrative figures are not necessarily drawn to scale.
6. Geometric figures lie in a plane.
7. The word line indicates straight line.
8. The word average indicates arithmetic mean.

For numbers 1 and 2. Refer to the three dimensional figure shown below. In this drawing the points M, L, O, and N are coplanar and $\angle LMN$ *is a right angle*.



_____1. Which of the following intersecting lines have common endpoint N?

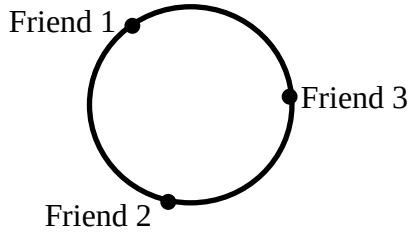
A. $\overleftrightarrow{NM}$ *and* $\overleftrightarrow{ML}$ B. $\overleftrightarrow{NX}$ *and* $\overleftrightarrow{PL}$ C. $\overleftrightarrow{LM}$ *and* $\overleftrightarrow{OP}$ D. $\overleftrightarrow{NM}$ *and* $\overleftrightarrow{NO}$

_____2. Which of the following lines is parallel to $\overleftrightarrow{LM}$?

A. $\overleftrightarrow{LO}$ B. $\overleftrightarrow{NO}$ C. $\overleftrightarrow{LX}$ D. $\overleftrightarrow{OX}$

_____3. Three friends are standing in a circle. How many different line segments can be drawn that connect two friends as shown in the figure below?

A. 1
B. 2
C. 3
D. 4



Appendix 2:

Problem Solving Performance Test (pspt)

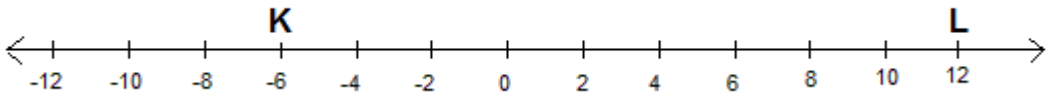
Name:_____ Date: _____Rating:_____
School:_____ Sex:_____ Grade Level: _____

DIRECTIONS: Answer each of the following problems. Show solutions clearly and eligibly in a separate sheet of paper.

Note: Unless otherwise stated, all the following should be assumed.

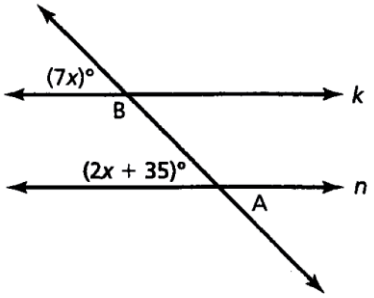
1. Illustrative figures are not necessarily drawn to scale.
2. Geometric figures lie in a plane.
3. The word line indicates straight line.
4. The word average indicates arithmetic mean.

1. The points K, L, and M are collinear, point K has a coordinate -6 and point L has coordinate 12 as shown in the number line below. If point L is between point K and point M and $|KM| = 25$. What is the coordinate of point M?



2. Find the measures of two complementary angles such that the larger angle is twice that of the smaller angle.

3. In the figure below, lines k and n are parallel. Line t is a transversal. What is the value of x? What is the measure, in degrees of $\angle A$ and $\angle B$?



Appendix 3

Mathematics Interest Survey (MIS)

This is a survey questionnaire of how much you are interested in Mathematics. As you read the statements, you will know whether you agree or disagree.There is no "right" or "wrong" answer. This is **NOT** a test. So, please answer each statement honestly. You are only asked to rate and give your opinion for each statement by encircling SD (Strongly Disagree), D (Disagree), A (Agree) or SA (Strongly Agree). An example is shown below.

Example:

	Statement	Strongly Disagree		Strongly Agree	Agree
1	Mathematics is fun.	SD	D	(A)	SA

	Statements	Strongly Disagree	Disagree		Strongly Agree
1	Mathematics is enjoyable to me.	SD	D	A	SA
2	Compared to other subjects, mathematics is exciting to me.	SD	D	A	SA
3	I look forward going to mathematics class this grading period.	SD	D	A	SA
4	My other classes are more interesting than mathematics class.	SD	D	A	SA
5	I enjoyed solving mathematical problems.	SD	D	A	SA
6	I easily understand new mathematics concepts.	SD	D	A	SA
7	My teacher usesother language(s)in teaching mathematics to reinforce my understanding of mathematical concepts.	SD	D	A	SA

8	Compared to other subjects, I feel relaxed studying mathematics.	SD	D	A	SA
9	I am interested and willing to use mathematics in real life situations.	SD	D	A	SA
10	Our mathematics class is dull.	SD	D	A	SA
11	I like to develop my mathematical skills and study mathematics more.	SD	D	A	SA
12	Mathematics is very interesting, and I usually enjoy.	SD	D	A	SA
13	The things we learn in mathematics class are not applicable in real life.	SD	D	A	SA