Dual Language Fluency and Math Word Problem Performance of Selected Students

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ABSTRACT

The researcher would like to find out whether the usage of mixed language test in problem solving tests in every Mathematics subject can be useful when presented to a sample of student participants. With the use of an experimental between-subject design, in order to see whether the presentation of language affected the scores of the student participants, through purposive sampling, the researcher gathered 16 college student participant, who are fluent in English or Filipino has a good math problem solving skill, and a grade of 90 or above on Filipino, English, and Mathematics. The researcher used a self-made 20-item math problem solving tests in gathering data for both control condition or the pure language and the experimental condition or the mixed language. It was found out that fluent-English participants outperformed the fluent-Filipino participants on both control and experimental conditions and it was found out that there’s no significant difference between the scores of fluent-Filipino and fluent-English participants on the experimental condition.

Keywords: mathematics, problem-solving, between-subjects design, purposive sampling, fluent-Filipino, fluent-English, mixed language test.

Language can be affecting mathematical performance throughout the world due to difference in language being used. As stated by Schleppegrell (2010) every school subject is constructed in language, but the forms and patterns varies from discipline to discipline, like in mathematics there are abstract and written concepts. Even if every students are fluent by their native language or fluent with the use English language, they both get an equal learning opportunity, but the reality is in order to effectively teach mathematics among students who learn English as their second language basically needs hard work (Winsor, 2007).

The Philippines has a long history and experience with the bilingual educational system. However, English as the medium of instruction became a dominant language of instruction in the Philippine academic setting. This probably affected the performance of the students in every academic subject. English as a medium of instruction in Mathematics became mandatory with DECS Order No. 52 during the time of former President Corazon Aquino (Dawe, 2014). In the Philippines, there are different languages spoken throughout which is referred to as the dialects, however it causes double-jeopardy among those in the minorities especially when they attempt to translate the written problem into Filipino and translate it into their own dialect.

Word Problems in Mathematics

Word problems in mathematics are the most commonly used in any forms of mathematics subjects, that each students must interpret before they are able to compute for the answers (Langenes, 2011). Word problems often pose a challenge because they require that students read and comprehend the text of the problem, identify the question that needs to be answered and finally create and solve a numerical equation (Krick-Morales, 2006).

Solving Math Problems through English Language

As Filipinos we study the English language as our second language but, we may have difficulties in reading and understanding the content of the problem. Problem solving in Mathematics involves the process of combination of one’s knowledge of sentence structures, mathematical relations, basic numerical skills and mathematical strategies in order to solve a mathematics problem presented in sentence or paragraph structure (Griffin & Jitendra, 2009). Mathematical problem skills requires the ability to read, interpret, and transform the words into the mathematical form before doing strategies on how to compute for the unknown
Yeo (2009) found that some students have slow progress in solving the problem due to their inability to translate the problem into a mathematical form. Some students also have difficulties in solving the problem because they do not comprehend the problem as they found the problem confusing. With application to what (Yeo, 2009) found out, in the Philippine setting, especially those who live and study in provinces may find difficulty in translating word problems into mathematical form due to different dialects around the Philippines. In a both qualitative and quantitative study among Grade 5 students on translating mathematical word problems into equations (Dela Cruz & Lapinid, 2014) provided evidences about the study conducted by Yeo (2009).

**Experimental Studies**

An experiment conducted by Gerber, Engelbrecht, Harding, and Rogan (2005) among first year South African calculus students found that on the first group of participants tuition took place on the native language while on the second group the tuition was in English and even other languages, and their findings suggests that there were no significant difference of adjustment means between native and foreign language learners, however there were differences by means of achievement. Cushen and Wiley (2011) investigated the language experience on a matched set of insight or problems that provides a diagram or sets of pictures which leads to a shift in observation of the problem, and non-insight or problems that only contain the mathematical word problems. The study investigated the influence of language experience on problem solving performance on a matched set of insight and non-insight problems. It has been found out that bilinguals have shown advantages on creative problem solving tasks, early bilinguals had an advantage in terms of cognitive flexibility, and advantages of bilinguals were seen on both sets of insight and non-insight math problems, while Bernardo and Calleja (2005) made an experiment on the effect of stating word problems in either Filipino or English. The participants were asked to answer by the use of either Filipino or English language. Based from the results of the study bilinguals tend to answer mathematically rather than realistic, successful in answering through the use of the first language and ironically failed to answer with the use of the second language. As a part of their study they also found no evidence that the language of the problem affected the tendency to ignore real-life considerations in modeling word problems in mathematics, in contrast with the study of Bernardo and Calleja (2005), Abedi, Leon, and Mirocha (2006) found out that bilinguals do not perform as well as non-bilinguals regardless of difficulty especially on areas where there is higher language load.

**Using English as a Medium of Instruction in Mathematics**

Coggins, Kraven, Coates, and Carroll (2007) in their book entitled English Language Learners in the Mathematics Classroom pointed out that mixing of languages can be used as a strategy for the discussion between students, however Dominguez (2005) pointed out that problem solving can provide a reason for students to strive to communicate in a second language. Maldonado, Empson, and Dominguez (2011) made a point that use of linguistic differences improves the discussion atmosphere, they also pointed out that it can be used as a resource rather than as an impediment. Winsor (2007) also pointed out that a student learn a new language and mathematics effectively when they write to communicate what they have learned, they learn in groups, and the learning is set in context. As Winsor (2007) pointed out that hard work is needed to effectively teach mathematics among students who learn English as their second language Schlepeggrel (2010) stated that it is a challenge to help students to move between everyday informal ways of construing knowledge and the technical academic ways necessary for advanced learning.

**Qualitative Studies**

Vizconde (2006) described the attitude of mathematics and science student teachers towards the English language and it was found out that the student teachers have difficulties
adhering the bilingual education policy, however the participants argued that English is necessary but Filipino can be used as a support language, contrary to the study of Yanagihara (2007) in Cebu City found out that scholastic achievement rates for mathematics, science and English taught in English are low indicating a problem with the medium of instruction. Camahalan (2006) conducted a study about self-regulated learning among Filipino students based on Mathematics achievement, Mathematics self-regulated learning, and Mathematics school grade between young and old as for the groups in the experiment and it was found out that when students are given opportunities to self-regulate and explicitly taught of self-regulated learning strategies, academic achievement is more likely to be positively affected. The study confirmed that students as active agents of their behaviors can be trained to be responsible learners and thus acquire the goal of life-long education.

Synthesis

The studies presented in the literature review portion of the study have stated that the use of language interferes with the problem-solving skills of each student, especially when English, which is learned as a second language, like the majority of nationalities. Different studies have found contrasting results especially among bilinguals in which there were differences in terms of achievement as to what Gerber, et. al (2005) found out as opposed to Abedi, et. al (2005) wherein there’s no difference on the way the bilinguals performed regardless of difficulty. Dela Cruz and Lapinid (2014) studied about the impact of language with regards to translating a word problem into a mathematical equation. However in the context of this study, to determine the effect of language in presenting a math problem as opposed to stating it as used by Bernardo and Calleja (2005) will be used for baseline purposes in the control condition of the study.

The researcher would like to seek answers to the questions: What is the overall level of proficiency among the fluent-Filipino participants after taking the pure-English problem solving test? What is the overall level of proficiency among the fluent-English participants after taking the pure-Filipino problem solving test? What is the overall level of proficiency among the fluent-Filipino participants after taking the mixed language test? What is the overall level of proficiency among the fluent-English participants after taking the mixed language test? Is there a significant difference between the level of proficiency among fluent-Filipino and fluent-English participants after taking the mixed language test?

Method

Research Design

The research design applied in this study was an experimental between-subjects design, wherein there are different groups of participants used in the experiment and those participants of the study took part in each of the condition of the experiment (Myers & Hansen, 2012). The research design was used in order to see how does the mixture of language affects the scores of the participants in a math problem solving test.

Sampling and Participants

Through the use of purposive sampling, the researcher chose 32 college students of San Beda College Alabang, 16 who are fluent in Filipino and 16 who are fluent in English, and taking the course MA101(College Algebra), the participants must have a good mathematical problem solving skills, and have a grade of 90 or higher in English, Filipino, and Mathematics.

Instruments

The researcher made use of 2 sets of questionnaire. The first set was for the control condition wherein there are sets of problem-solving tests written in pure Filipino and pure English, while the second set were used for the experimental condition wherein the test problems were in the mixed language format.

In terms of scoring as set by the researcher, if a participant answered a certain item with a
correct solution and came up with the correct answer, it was equivalent into 4 points. When there is a correct manner of writing the solution, but the answer was wrong, it was equivalent into 2 points. And lastly, if neither the solution nor the answer is correct or very far away from the correct answer, it will be equivalent into 0. The total number of points that the participants can get is 80, and each scores have its corresponding verbal interpretations, with a score of 0 to 16 is considered as poor, however 17 to 32 is below average, 33 to 48 is average, 49 to 64 is above average, and 65 to 80 is excellent.

Procedures

The researcher constructed a test that will be used for the study. A pilot study was conducted among college students in a school around Muntinlupa City, in order to determine the item-difficulty index of both self-made tests used for gathering the data.

The research instruments underwent revision, after the pilot study was held and determined the item-difficulty index. If the participants are fluent in Filipino, fluent in English, and able to solve problem-solving questions, then those students are the participants of the research study.

The participants were contacted and an informed consent was given to the participants, which represented the agreement in joining the research study. The mixed-language test or the experimental condition was first conducted. After the participants were able to finish the mixed-language test, the participants gave a 15 minute break to them.

In order to assess the impact of the experimental condition, a pure language type of test or the control condition was conducted by taking a problem-solving test in opposition to the language the participants are fluent at, fluent-Filipino participants took the pure English type of test and the fluent-English took the pure Filipino type of test, in order to give more insights on how language could be affecting the performance of the students in solving math problem-solving questions.

After the participants, took the pure language type of test the researcher gave them a moment of silence to relax a little, while the participants were relaxing, the researcher gave them their rewards. The participants were debriefed after the experiment has been conducted.

Data Analysis

In order to answer the research questions, to provide data the research study used the arithmetic mean in order to find the average score of each participants fluent in Filipino on the pure English type of test as their control condition, as well as of those participants fluent in English on the pure Filipino type of test to answer research questions 1 to 4. And another statistical method in using to answer the research questions is the T-test for independent groups in order to determine whether there is a significant difference between the fluent-Filipino and fluent-English participants after they took the mixed language type of test.
Results and Discussion

Research Question 1. What is the overall level of proficiency among the fluent-Filipino participants after taking the pure-English problem solving test?

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<thead>
<tr>
<th>Level of Proficiency</th>
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<th>PF</th>
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<tbody>
<tr>
<td>Excellent</td>
<td></td>
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<tr>
<td>Above Average</td>
<td>1</td>
<td>6.25</td>
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<tr>
<td>Average</td>
<td>7</td>
<td>43.75</td>
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<tr>
<td>Below Average</td>
<td>7</td>
<td>43.75</td>
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<tr>
<td>Poor</td>
<td>1</td>
<td>6.25</td>
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| Total                | N=16| X= 33.25 |

Table 1. The Level of Proficiency Among Fluent-Filipino Participants in the Pure-English Problem Solving Test

In the control condition of those participants fluent in Filipino, comes up with (M=33.25) wherein fluent-Filipino participants that took the pure English type of test gets an average score within the “average” mark of the set verbal interpretation. It has been noticed that most fluent-Filipino participants were able to reach the average and below average mark of the pure English type of test, individually. In relation with the study by Bautista, Mulligan, and Mitchelmore (2007) among 75 students they found out that when Filipino students are given problems presented in Filipino the performance of the students improves, however it does not guarantee the accuracy of the solution. As the students who are fluent in Filipino were given a test presented in pure English type, the performance of the students were affected negatively (Causapin, 2012) which is seen as reason on why the students who are pure in Filipino mostly reached a mark within the range of “below average”. As discussed by Langeness (2011) language is a burden among English language learners. With relation to Alidou et. al (2006) premature use of English, which is particularly common in the Philippine setting can lead into low achievement in mathematics, literacy, and science, and probably one of the reasons on why the overall average of the students only reached the “below average” mark.

Research Question 2. What is the overall level of proficiency among the fluent-English participants after taking the pure-Filipino problem solving test?

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<tr>
<td>Excellent</td>
<td>1</td>
<td>6.25</td>
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<tr>
<td>Above Average</td>
<td>3</td>
<td>18.75</td>
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<tr>
<td>Average</td>
<td>4</td>
<td>25</td>
</tr>
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<td>Below Average</td>
<td>6</td>
<td>37.5</td>
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<tr>
<td>Poor</td>
<td>2</td>
<td>12.5</td>
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| Total                | N=16| X=35.625 |


Table 2. The Level of Proficiency Among Fluent-English Participants in the pure-Filipino Problem Solving Test

With (M=35.625) the fluent-English participants that took the Filipino type of test reached the “average” mark of the given verbal interpretation, the fluent-English participants seem to have an advantage in solving the pure Filipino type of test, because of their knowledge on how to translate some words into the English language, however on the other side the scores of the fluent-English participants got their scores affected in the pure Filipino type of test, which shows that proficiency in conversational English is not the only prerequisite to master Mathematics and it is also important to be familiar with scientific English (Gerber, et. al 2005).

Questions 1 and 2 could be related to the study by Bernardo (2005) wherein it was found out that linguistically, there was no effect in the mathematical abstract components of the problem-solving questions, but comprehension and understanding might have affected on the way each participants answered the test as the scores of the participants were found as highly scattered from one another.

Research Question 3. What is the overall level of proficiency among the fluent-Filipino participants in the mixed language test?

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<tr>
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<td>18.75</td>
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<tr>
<td>Below Average</td>
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<tr>
<td>Poor</td>
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<tr>
<td>Total</td>
<td>N=16</td>
<td>X=36.75</td>
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Table 3. The Level of Proficiency Among Fluent-Filipino Participants in the Mixed Language Problem Solving Test

In the mixed-language test among fluent-Filipino participants, there’s 1 who got an excellent level of proficiency, however there’s 3 students each who got good and average, and 9 on the below average.

With an outcome of (M=36.75) there was a seen little improvements on the scores of the fluent-Filipino participants overall on the mixed language type of test. Coggins (2007) in her book pointed out to allow mix language use as an instructional medium in Mathematics during the discussion of students, however because of the seen improvements in the score of the fluent-Filipino participants it can be generalized that mixing languages could be necessary not just in the classroom as a medium of instruction but also as a test format in problem-solving test in mathematics.
Research Question 4. What is the mean score of the fluent-English participants in the mixed language test?

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<tbody>
<tr>
<td>Excellent</td>
<td>2</td>
<td>12.5</td>
</tr>
<tr>
<td>Above Average</td>
<td>3</td>
<td>18.75</td>
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<tr>
<td>Average</td>
<td>10</td>
<td>62.5</td>
</tr>
<tr>
<td>Below Average</td>
<td>1</td>
<td>6.25</td>
</tr>
<tr>
<td>Poor</td>
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<td></td>
</tr>
<tr>
<td>Total</td>
<td>N=16</td>
<td>X=46.25</td>
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</tbody>
</table>

Table 4. Level of Proficiency Among Fluent-English Participants on the Mixed Language Problem Solving Test

After the fluent-English participants took the mixed-language type of test, there were 2 who got an excellent level of proficiency, however there were 3 who got good, 10 with average, and 1 on the below average level.

Resulting with (M=46.25) with an “average” mark, the fluent-English participants once again outperformed the fluent-Filipino participants, and similar with the fluent-Filipino participants fluent-English participants also have improvements, however compared with the fluent-Filipino participants, fluent-English participants have bigger improvements as they became bilinguals in a very early as they learn English in a very early age, and as Coggins (2007) suggested the use of mix language discussions in any mathematics class, and as stated by Dominguez (2005) that problem solving can provide a reason for students to strive to communicate in a second language, among fluent-English students, mix language test can also help boost the competency.

Research Question 5. Is there a significant difference between the level of proficiency among the fluent-Filipino and fluent-English participants in the mixed language test?

With an outcome of t(30)=1.724 as opposed to t(30)=2.042 the researchers therefore conclude that there is no significant difference between the performance of the fluent-Filipino and fluent-English participants in the mixed language type of test, and as pointed out by Abedi, et. al (2005) found out that bilinguals do not perform as well as non-bilinguals regardless of difficulty especially on areas where there is higher language load.

The representation of language did affect the scores of the students which can be seen on the large differences of the participants between the different sets of test. In support with the findings, Bernardo (2005) stated that first-learned language affect mathematical performance, if the student is fluent in English therefore there is a tendency wherein he/she will outperform than those whose first-learned language is Filipino, which can be seen from the entire results in terms of the mean score between each participant. This can give the logic that a student may not perform well in mathematics not necessarily because of weak mathematical ability, but due to understanding the language being involved (Njagi, 2015)

Conclusion and Recommendation

The researcher therefore concludes that language plays a factor in mathematical problem solving tests, when a student takes a test that opposes the language he/she is fluent at, most of the students will fail to reach the average mark of the test, however through a mixed-language test it
can help improve the student’s math problem solving tests, and lastly there is no significant difference between the performance of the fluent-Filipino participants and the fluent-English participants on the mixed language type of test.

As a form of intervention, if anyone desires to improve his/her problem-solving skills, language plays a big factor as presented in the study, and in order to be better in whatever language used in a problem-solving test, it is still necessary for everyone to know the basics of the English and Filipino language and read books so that vocabulary can increase in order to understand every single word in the written problem. For the practicing Mathematics instructors, try to be clear in expressing in dual language, especially in mathematical terminologies that each students can’t understand. As for further studies an attempt to analyze how fluency and mathematical performance can be correlated with one another and also through a factorial study in order to determine what kind of interaction is present between fluency and mathematical performance.

References:
identity-enhancing participation in mathematical discussion. Journal for Research in Mathematics Education, 41