Mathematics and Language: Impact on the Use of First Language in Students’ Mathematics Learning Process

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ABSTRAK

Paper in membahas tentang pelajar lokal di Surabaya, Indonesia, yang memilih untuk bersekolah di sekolah bertaraf Internasional dan menggunakan bahasa Inggris dalam belajar matematika. Sekolah bertaraf Internasional yang dimaksud dalam pembahasan ini adalah sekolah yang menggunakan bahasa Inggris sebagai bahasa pengantar dalam proses belajar mengajar. Penelitian tindakan kelas ini dilakukan khususnya untuk mengamati siswa kelas 8 di SPINS Interactional school Surabaya dari 2 kelas yang berbeda. Penelitian ini terbagi dalam 2 bagian, yang pertama adalah kegiatan mengajar dan yang kedua adalah kegiatan kelompok. Pengamatan yang lebih mendalam dilakukan terhadap 2 siswa dimana dua diantaranya memiliki kemampuan matematika yang kurang namun kemampuan bahasa Inggrisnya rata-rata dan satu lagi memiliki kemampuan matematika di atas rata-rata namun sangat kurang dalam kemampuan berbahasa Inggris. Kami melakukan penelitian tindakan kelas dan menggunakan pendekatan sosiolinguistik yang kami gambarkan dalam analisa tentang bagaimana bahasa memberikan andil dalam pemberian kesempatan dalam proses belajar mengajar. Data kami menunjukkan bahwa siswa yang menggunakan bahasa Ibu dalam proses belajar mengajar, menunjukkan hasil yang lebih baik dalam aktivitas kelas dan hasil tes. Sebaliknya, siswa yang menggunakan bahasa Inggris dalam proses belajar mengajar menunjukkan hasil yang tetap atau bahkan cenderung menurun. Kami juga menemukan bahwa sebenarnya siswa seringkali menggunakan bahasa Indonesia maupun bahasa Inggris secara bergantian baik dalam berkomunikasi dengan sesama teman maupun dengan guru selama proses belajar mengajar.

Kata Kunci: bahasa Ibu, proses belajar matematika

INTRODUCTION

Background

Nowadays, the number of local students whom eager to enrole in multicultural school is significant and growing. In the academic year 2014/2015, approximately 400 local students enrolled at SPINS Interactional School, range from kindergarten to grade 12. In this year only, for grade 8 students, 95% of them are labeled as English Learners or Bilingual students whom their first languages are not English. Most of the students at SPINS come from middle up class of local family and some of them are expatriate whom their family move to Indonesia due to their parents occupation. SPINS Interactional School is one of multicultural schools in Surabaya. Teaching staffs are dominated by local teacher and the rest are expatriat. The language used as a medium for academic purposes is English. Eventhough SPINS is stated as multicultural school or more well known as international school, but in fact most of the students are local students.

The common case that happen in the develop countries is that some imigrants come to those countries for living or other reason and their children attend the school which used the native language of the respective country. Different from the case in develop countries, in Surabaya, Indonesia, many middle-up class of local family choose multicultural school for their children as
their place to study. Their first language is Bahasa Indonesia but they choose the school with English as the medium language. From the interview with some of the parents, we found that their reason for choosing multicultural school is to prepare their child for study abroad, some because they see the quality of multicultural school is better than local school but some also because of the social status.

Since the language used in multicultural school is English, technically all local students whom their first language is Bahasa Indonesia, have to shift their language into English. Shifting language from Bahasa into English seems simple but actually not as simple as the word ‘shift’. It is happen because these students are local students whom study in their own home country whom their friends are mostly also local students and most of the teachers are also local people, but they have to study in different language namely English. In their social life as well, they hardly interact with expatriat. Most of their activities at home, lessons, public places, an so on are spent with local people.

Focusing on mathematics subject, we found that SPINS student performance in mathematics was far below many local school in Surabaya. Joining several mathematics competition in Surabaya and mostly resulting average-below, we are questioning ourselves on the teaching and learning process that we have so far. Seeing the fact that many Indonesian Students who experienced as the champions in international competition are from local school only, we come into consideration whether the language medium we use becomes a barrier for students to learn mathematics. In addition, TIMMS result 2011 showed the fact that the East Asia countries such as Korea, Singapore, Chinese Taipe, Hongkong SAR and Japan still lead the mathematics performances from total 63 countries around the world. If we paid attention to the language base, those 5 East Asia countries, except Singapore, used their first language as the medium language in their education system. It was also supported by previous researches that first language is giving significant impact to the students learning process. Anushya Sathiaseelan, 2013, discuss about Mother tongue as the medium of instruction[1], somehow she did not make specific research in mathematics only but in general. Judit Moschovics, 2007 also wrote about immigrant students in US who use two languages when learning mathematics[2]. Similar to Judit, Nuria Planas, 2009 also discuss about bilingual students in Catalonia who came from South American countries who use their first language in learning mathematics[3].

Different from the previous research that brought up the case of immigrant students who came to another countries and they had to study with second language, students at SPINS are mostly Indonesian citizens alone who study in multicultural school with English as the medium language. This rise up the question about the impact of first language in the learning process when the students have to study in the second language medium without even going out from their own country.

1.2. Research question
The research question was formulated to achieve the research aim as follow:
“How will the use of first language give impact for students in learning mathematics”?

1.3. Aim of the research
In line with the background of this research and research question, the first aim of this research is to support students’ learning process. The second aim is to point out the valuable suggestions regarding the use of language in teaching and learning mathematics especially at multicultural school.

1. 4. Significance of the research
In line with the purpose of this study, the significance of this research is to give an insight to mathematics teacher and school on how to develop teaching and learning process that support students in learning mathematics.
METHODOLOGY

There are some elements will be discussed in this chapter regarding the methodology used in this research. We will describe about classroom action research methodology and the content within it such as the preparation and design of this research, the teaching experiment and the analysis. We will also talk about how we collect our data and how to work on it, also about validity of this research.

Classroom action research

The concept of Action Research was introduced by Kurt Lewin, 1944, though in the previous year John Dewey, 1910, had delivered his ideas on scientific methods to solve daily problems. In Indonesia alone, the government made a regulation that one of the competence required for a teacher is the ability to conduct a research to improve teachers’ professionalism. Type of the research proposed by the government was Class Action Research.

Class Action Research itself was defined as a method of finding out what works best in your own classroom so that you can improve students learning [6]. We will come to the detail of each of the steps in this classroom action research as describe below.

2.1.1 Identify a problem
Teachers/educators who conduct their class actually are the best parties who can define the condition of the class in the particular subject that they teach. Teacher might start it with the general view on any problems in the class, but teacher can even be more focus on particular case/problem and make it subject to be researched.

2.1.2 Review literature
Researcher will gather two types of information namely background literature and data. Literature review from previous researches which also discussed about language and mathematics are very important. Researcher gets all the literature review from secondary resources such as internet, magazine and journals. For data related to language and mathematics are gathered from UN-Unesco archives, TIMSS review report in mathematics and the data from SPINS Interactional School itself.

Plan a research Strategy

The Classroom Action research will be divided into several sessions. The preliminary activity was a survey to all 8th and 5th graders on what language they use in their daily basis. It is to figure out the language basis of the students who will become the subject of the research. The first research experiment will be class session. It will run from about a week and end with class test. Every end of the class session a treatment will be given to two students from two different classes who have low attainment in mathematics. One of them will get the support from the teacher with full English as the medium language and the other one will get the support from the teacher with Full Bahasa Indonesia. The second research experiment will be group work activities which related to the chapter thought during the class session. Both of the class will have a different treatment. One of the classes will work in full English as the medium but the other class will get a freedom to use any language they feel comfortable to use as the medium. This group work activities will also end up with class test.

The triangulation of data will provide the validity. To triangulate, we will collect the data from students’ score, observation of students’ behavior and teacher’s evaluations. If all data point to the same conclusions then we can have some assurance of validity.
Data collection

For collecting the data of the research, researcher will use a survey, interview, students’ work and also field note.

Interview

There will be several interviews after every class session and after the completion of the whole chapter. Every end of class session researcher will conduct an interview with certain students who were chosen to be the focus on the analysis. After the completion of the whole chapter, researcher will also conduct another interview to do further observation and gain more detail information about students’ achievement after the completion of the chapter.

Students’ work

Students’ work were designed as one of the instruments in the teaching and learning process to assess how far students’ understanding toward a certain lesson given. The students’ work will include class test before and after the group-work, and group work activities it selves.

Field note

Field note is one of the important data collections. There is a certain regulation in the school that any types of recording activities are restricted. Because of that regulation then Field note become very important in spite of the data that we gather from students’ work or interview.

Data analysis

After all data are gathered then the researcher will do a descriptive analysis. The goal of this descriptive analysis is to picturing the condition of the classroom to the respect of bilingual students. The analysis will be described systematically and accurately about the fact and characteristics or particular classrooms.

Analysis on class session

The research was conducted in 8th grades of SPINS Interactional School Surabaya. It was conducted in 2 sections of 8th grades. Initially, we planned to have deeper insight to two students from different sections, Jocelyn and Michelle, somehow along the research process we found that Gracielle also represents another type of students which is different from Jocelyn and Michelle. Both Jocelyn and Michelle are having low performance in mathematics but quite average in English, at the contrary Gracielle was the opposite of them. She has a poor performance in English but she has quite good performance in mathematics. This research was conducted during 2nd semester of 2014/2015 academic year. Students learn a chapter about Mensuration of Pyramids, cones and spheres. As design in semester plan, the chapter took two weeks to accomplish. The first session of the research will be a normal class as it was. But in every end of the class session teacher will give additional explanation to Michelle and Jocelyn. Both of them will sit in different place and time. For Michelle, teacher will assist her in full English as the medium language. For Jocelyn, teacher will assist her in full Bahasa Indonesia as the medium language.

Teacher started the chapter with introduction of pyramids shapes. With some pyramids models, teachers showed to the class some different types of pyramids such as triangular pyramid, square pyramid and rectangular pyramid. For other shapes such as pentagonal pyramid or hexagonal pyramid, teacher only made a drawing on the board. Coming into the detail of the pyramids,
teacher continued the session to explore the net of the pyramids. For instance, by drawing the net of the right square pyramid, teacher explain that constructing a right square pyramids is combining a square shape with 4 triangles.

![Figure 1. The net of a square pyramid](image)

Square will be the base of the pyramids and the 4 triangles are folded up, these are known as lateral faces. From the diagram above, it is shown that the total surface area of a pyramid is the sum of the base area and area of the lateral faces. After explaining the basic idea of the net of pyramids and its relation to the total surface area of the pyramids, teacher gave some examples on finding the total surface area of the pyramids. Class was ended by giving some homework on finding the surface area of the pyramids.

On the second day, teacher first reviewed about the surface area of a pyramid then continued to the discussion on the volume of the pyramids. Without giving any detail explanation, teacher directly came to the formula for volume of pyramid then continued to some examples on finding the volume of the pyramids.

On the third day, teacher discussed another shape namely cone. Teacher explored students’ idea about cone. Many of them came up with ice cream, or birthday cap and many more. Teacher then explain on how to construct the net of the cone, as below.

![Figure 2. The net of a cone](image)

From the diagram above it was shown the idea on how the curved surface of a cone has an area of $\pi rl$ so that the total surface area of a cone is $\pi r^2 + \pi rl$. In fact, it took quite some time for the teacher to explain about the area of the curved surface of the cone. It is difficult for students to associate the diagram of curved surface on the left with almost rectangle-look on the right side.

After working on some exercise of finding surface area of the cone, then continue to the volume of the cone. Since the cone is actually also the pyramid with circular base, then the formula for the volume of the cone will be similar with the pyramids. The different is only in the base which always circular.

Finding the volume of the cone, students found it easier than finding the surface area of the cone itself. Students apparently confuse with the use of height of the cone and the slant height of the curved surface of the cone.
The last shape in the chapter was sphere. For explaining the idea of surface area of the sphere and its volume, there should be some experiment to be conducted. Somehow, due to the time limit then teacher come with explanation on volume of sphere with drawing

![Illustration of volume and surface area of a sphere](image)

Figure 3. Illustration of volume and surface area of a sphere

After completing all parts of the chapter, teacher conduct class test to test students’ understanding on the chapter. During the test session most of the students found difficulties to accomplish their work on time. On the due time, many students were still working on their paper. The most difficult questions for most of the students were about surface area of pyramids and imagining the change of the shape, for example:

\[
CBAD \text{ is a pyramid. } AB = AC = AD = 9 \text{ cm, and } \angle BAC = \angle BAD = \angle CAD = 90^\circ
\]

Calculate:

a. The volume of the pyramid.

b. The total surface area of the pyramid.

![Triangular pyramid](image)

Figure 4. Triangular pyramid

Students did not find any difficulties working on part (a), but finding total surface area on part (b), most of the students struggled to find the area of \(\triangle BCD\). They confused how to get the height of \(\triangle BCD\). Eventhough most of the class found difficulties but we still found some students who were able to solve the question. They notice that \(\triangle BCD\) is isosceles \(\triangle\) so that they can use the length of BD and CD to get the height.

**Analysis on group work**

Class experiment on group work activities was designed not only to see the overall performance of the class and the impact of the treatment toward their progress in learning mathematics but also to give room for students to develop their idea in constructing the net and the model of 3-dimension shapes as well as calculating the surface area and volume of the shapes. In this group work activities, each class was divided into 6 to 7 different groups with 3 to 4 group members respectively. All groups got equivalent task to construct the net of either pyramid or cone.
then join the net to form the model of pyramids or cones. Nevertheless, none of the group in the same class will get exactly the same type of shapes. They will work on different types of pyramids and cones.

In this group work, Jocelyn worked in the group that constructed a rectangular pyramid while Michelle worked with the group that constructed a hexagonal pyramid and Gracielle worked in the group that constructed triangular pyramid. It was not arranged that three of them got different types of shapes. It was a coincidence because the lottery was used to decide the group and the shapes that they have to construct.

Gracielle worked in a group that all of them are Indonesian students who use Bahasa Indonesia as their medium language at home and socialize. During the group work activity they used full Bahasa Indonesia among their group members. Gracielle’s group use stereo form as the main material to make a model of triangular pyramid. They discuss a lot on deciding the size of the shapes, whether the shapes will be right triangular pyramid or right angle triangle base pyramid, and so on. In fact, Gracielle quite struggled to understand the term slant height and the height of pyramid, her partner Samantha helped her to explain fully in Bahasa Indonesia, until finally she understood it well.

In another group, Jocelyn worked with her two other friends that both of them are boys. They also use Bahasa Indonesia in most of the discussion they made during the group work activities, even though sometimes they also used English. During the group work, we found that Jocelyn was quite passive along the activity. She worked quite less and hardly speaking with both of her partners. On the interview session, we found that she did not feel comfortable to work with boys. She prefers to work with girls or those who close to her. This group constructed rectangular pyramids with paper as the material used.
Michelle, worked in the group that quite random. She worked with another one girl and two boys. This group has quite fun members, they enjoyed working together and they used English language along their group work activities. During group work activities, Michelle was quite active.

She wrote the information on the chart paper such as volume and surface area of their hexagonal pyramid.

Figure.7. The net and 3-dimensional model of hexagonal pyramid

Re-test on this chapter was conducted after the completion of the group work. It was expected by working in small group and constructing the net of pyramids or cone, students can have better understanding on this chapter and the result of the test could be better. Many of the students find it easier to work after having group work activities, somehow certain students still find it difficult to work on the test paper.

Gracielle particularly, found that the group work was really helped her to understand the chapter a lot better. She could ask, express her opinion and even argued in Bahasa Indonesia among her friends and even with the teacher. She indeed finds herself in less confidence once she has to speak in English but it will be the opposite in Bahasa Indonesia, she will become quite talk active. She got full mark on her test after the group work. It was a huge leap compare to her test before the group work which only reach 4.75 out of 10.

Jocelyn on the other side found that group work did not really help her. She said that the after class session with the teacher was really help her. The teacher explained to her exactly as the explanation in class but with full Bahasa Indonesia as the medium language. She got 7 on her second test. It was 3 marks higher than her first test, 4. When we asked her, why she could get higher marks in her 2nd test, whereas on her 1st test Teacher also help her in Bahasa. She argued that she has more time to study, besides, during the group work most of their friends are using Bahasa Indonesia so more or less she also get some new insight from hearing those conversation.

Michelle somehow got different result than Jocelyn or Gracielle. She get 2.5 on her first test and even got lower on her second test, 1.75. Her class was the class that has to use English during the group work activities and she was the student who got a help from the teacher after every class session with English as the medium language. Michelle has a good performance in English, somehow she tends to get confuse on some terms in mathematics. For instance, she often mixed up between cone and sphere. She confused between circular base of the cone and the shape of sphere that apparently looks like a circle. When talking about surface area, she often confused how to differentiate between slant height and the height of the pyramid as well as in constructing the net of the pyramids.
CONCLUSION

Answer to the research question

This chapter will consist of the conclusion that was drawn from the whole teaching and learning activities to answer the research question. As described in analysis, we found that the use of first language give positive impact on students learning process. From the result of the test 1 and test 2 we noted that the class that have a chance to use any language (first language) that they feel comfortable resulting higher marks than another class that have to use full English. 76.2% of students of class with first language as a medium got higher marks on their second test compare to their first test. 60% of students of another class also improved on their second test compare to their first test. Even though both classes experienced improvement but the first class have higher percentage increase (2.6%) than the second class (1.9%).

Gracielle is one of the students who showed a significant progress in her learning process when we give her a chance to use her first language as the medium. During the interview she explained that learning Mathematics in Bahasa Indonesia is a lot more easier than using English. She can understand the explanation better when it is delivered in Bahasa Indonesia. She herself can speak, ask and explain better in Bahasa Indonesia. She also got better result on her second test compare to her first test after she got a chance to do group work and communicate with Bahasa Indonesia. In addition we have to put a note that Gracielle has a quite good performance in Mathematics subject, she just has barrier in English as the medium language.

Jocelyn is also another student who shows a good progress after we gave her an opportunity to use Bahasa Indonesia as the medium language. Jocelyn did not experience a great leap as Gracielle, but her progress was quite significant during the treatment. First positive attitude that we can clearly see was her involvement during session in Bahasa. She post questions, answered the questions given and work very enthusiastically. Somehow she did not show an interest during group work. As explained in analysis, her main reason was because her team’s member was all boys and she was the only girl. In Jocelyn case, there was another factor than just language base that give impact on her learning process. It might be a culture or other factor.

Michelle is the student who experience degradation on her marks and performance. Michelle was a poor performer in Mathematics and even though she can communicate with English but for Mathematics she finds many confusing terms or explanation. She got 1.75 on her second test. It was 0.75 lower than her first test, 2.5. Michelle stated during the interview session that she did not like mathematics; she said that mathematics was hard. We found that in spite of the use of full English in her class that become one of barriers for her, she herself did not show much interest to the subject itself. She was actually quite active during group work activities; somehow she was more into the work of designing and writing the information on the paper rather than working with the calculation of volume or surface area.
REFERENCES


Judit Moschkovich. *Mathematics, the Common Core, and Language: Recommendations for Mathematics Instruction for Els Aligned with the Common Core*. University of California, Santa Cruz.


