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EFFECTIVE LINGUISTIC-MATHEMATIC TEACHING STRATEGY FOR INTERNATIONAL MATHEMATIC OLYMPIAD: ENGLISH FOR SPECIFIC PURPOSE PERSPECTIVE

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Abstract

Indonesian primary school students' achievement on the international level can be traced back through their participation in, one of them, International Mathematic Olympiad. Yet, the result was not satisfactory as Indonesia is always on the lower level which is left behind from the neighboring countries. The factors, as reported by Setiawan et al. (2015), are: the students possess low comprehension on every level of linguistic elements; and their lack of comprehension on item tests as a discourse is the major factor for students' failure to answer the questions. This paper tries to seek effective strategies for teaching English for Mathematics. Devoting on literature review, the expected strategies are proposed. The findings indicate that after designing blended curriculum and teaching trials, two strategies are nominated and may be applied: (1) providing glossaries for mathematic technical terms which are accompanied with phonetic transcription and (2) introducing mathematic technical terms by using two alternating procedures, namely: pre-working and while-working activities. The findings of this study may be as one of the alternative references to assist primary students to manage mathematic problems and to be the winner of the International Mathematic Olympiad.

Keywords: students' achievement, glossaries, mathematic technical terms, pre- & while-work

The success of mathematic Olympiad problems execution in English cannot be separated from two factors; they are student's ability to understand linguistic elements and mathematic problem comprehension thoroughly. Linguistic problem in this context is student comprehension of linguistic elements which contain of vocabulary, phrase, and sentence of English in mathematic Olympiad problem model. Mathematics competence test in English is given to know whether students have difficulty in understanding linguistic. Students are required to translate 10 questions. The result can be seen in *Table 1*. Generally, students have difficulties to understand English elements. From 10 questions, there are only two questions that are understood by the students more than 50%; they are the first problem and the second problem. There are two problems that are understood by 32% of students and 42% of students (the seventh problem and the sixth problem). Other left problems (six problems) can only be understood by less than 10% students.

Table 1: Recapitulation of Mathematics competence test result in English

Problem Number	1	2	3	4	5	6	7	8	9	10
Language	26	22	3	4	2	17	13	3	3	2
%	63.4	53.7	7.3	9.8	4.9	41.5	31.7	7.3	7.3	4.9
Material	22	14	1	2	0	3	1	3	0	1
%	53.7	34.1	2.4	4.9	0	7.3	2.4	7.3	0	2.4

N = 41

The data above can be explained that most of the students have difficulties in Mathematics problems linguistic in English comprehension. If referring to completion learning that PBM is said success if 75%-80% students can understand Mathematics problems in English, so it can be stated that PBM of English comprehension is unsuccessful. If linguistic comprehension is not mastered by the students, it can be predicted that student comprehension of Mathematics problem is also unsuccessful.

WORD UNDERSTANDING

Tracking student comprehension of English words, noted as the first problem. This problem is the most widely understood by the students.

Question 1

If a man covers km in 3 hours, what is the distance covered by him in 5 hours?

There are two keywords in this problem: *cover* and *distance*. Although those vocabularies are in common words group, there may be 63.4% students can understand the meaning. The students who understand the meaning *cover* translate with "menempuh", "mencapai" and translate *distance* with "jarak". While the students who cannot understand those words translate with phrase "mengikuti jalan" and there is students who does not translate it. Another evidence of student incomprehension to translate word meaning is the tenth problem as be displayed in the following data. This problem can only be understood by two students from 41 students (4.9%).

Question 10

Mr. White multiplies the first one hundred prime numbers. How many consecutive zero digits can be found at the end of the resulting number?

The word that cannot be understood by the students is *consecutive*. The students who understand this word translate with "berurutan", "berjejer", "berderet". All of the students who cannot understand this word do not translate and neglect in blank space. The same evidence also happens to the students when understand the fifth problem which has the word *consecutive*. This problem can only be understood by two students from 41 students. This phenomenon proves that

almost all students cannot understand Mathematic problems which have the word *consecutive*. Although this linguistic element is included in the word level, the students cannot understand the problems thoroughly because this word is the keyword of two problems (the fifth problem and the tenth problem).

PHRASE UNDERSTANDING

The phrase in this context is word group which refers to one meaning unit. Student comprehension of linguistic element in phrase level shows the same result with the word level comprehension. Moreover, the possibility conception in phrase level is greater as almost all of mathematics questions use phrase. It is proved in student translation result in *Question 3, 4, 6, 7, 8,* and *9*.

Question 3

Nasir draw 5 straight lines on a piece of paper. What is the maximum number of intersection points can Nasir make?

This problem has four phrases: *straight lines, a piece of paper, the maximum number,* and *intersection point*. These phrases are only understood by three students from 41 students or 7.3%. It shows the lack of student comprehension to phrases in English of Mathematics problems. The students who understand these phrases translate it consecutively, "garis lurus", "sepotong kertas", "jumlah maksimal/terbanyak", dan "titik potong". Some students only can translate *straight lines,* there are also students who can translate phrase *a piece of paper,* and there are also students who can translate *the maximum number* with "angka terbesar". Most of students do not understand phrase *intersection point,* so that they do not translate it. Another phrase example which cannot be understood by the students is found in *Question 9* as displayed in the following data.

Question 9

The sum of two numbers is 5. Suppose 3 is added to each number and then each of the resulting numbers is doubled. What is the sum of the final two numbers?

The phrases in this question can only be understood by three students from 41 students or 7.3%. it is exactly the same with student comprehension in third problem which has been explained above and also eighth problem. All of the students except three students who answer do not understand phrase *resulting number*. They leave the phrase which should be translated "angka-angka hasil". The same phrase is also found in fourth problem. Some students also cannot understand the meaning of *the final two numbers* which is should be translated "dua angka terakhir".

The explanation above signals that most of the students do not have strong comprehension of linguistic element in phrase level English. Whereas, most Mathematic problems in English is arranged using common phrases and standard phrases in English. This finding also gives a direction that Mathematic in English teaching activity cannot be separated from English teaching.

SENTENCE UNDERSTANDING

The student success of finishing Mathematic problems in English is also influenced by student comprehension of linguistic element in sentence level. Most students have less ability to translate passive sentences in English. There are 6 questions from 10 questions that use passive sentence; *Question 1, 4, 5, 8, 9* and *10*. It must be noted that passive sentence in *Question 5* is the same as *Question 10*; *can be found.*

Student comprehension of active sentence is detected better than passive sentence comprehension. It can be seen from *Question 2, 6,* and *7* which have active sentence structures and *Question 1, 5, 8,* and *9* which have passive sentence structures. The problems of active sentence structures above are understood by students consecutively 53.7%, 41.5%, and 31.7%.

Question 7

Umar and Yusuf walked to school from the same place at the same time. Umar walked at 90 m/min and Yusuf walked at 60 m/min. Umar realized that he left his pencil case at home when he reached the school.He walked immediately in the direction of his house and met Yusuf 180 m from school. How far was school from where they stayed? (m/min = meter/minute)

Passive sentence structures are understood by students consecutively 9.8%, 4.9%, 7.3%, 7.3%, and 4.9%. This finding signals that students should be given skill of passive sentence structures completely to help them in understanding mathematics questions in English.

There are two interesting thing about student comprehension in sentence level; first, there is one problem which is passive structure can be understood well by students, first problem, second, there is one problem which is active structure cannot be understood well by students, third problem. What is the explanation? The first problem shows passive sentence ....*what is the distance covered by him*... The word *covered* is the repetition from active form in previous clause. The possibility thing is students have understood this word so students have known the meaning when it is formed in passive structure. The third problem has active sentence form but it is not understood by students, the possibility thing that can be stated is student misconception of linguistic element in phrase level.

From all explanation above, it can be concluded that; (1) Most students do not have linguistic comprehension enough to finish Mathematic problems in English. Linguistic

comprehension is comprehension of linguistic elements in word level, phrase level, and sentence level. (2) Systematic teaching strategy is needed to give skill students understanding linguistic elements.

THE PROBLEMS OF MATHEMATICS

Mathematic comprehension problem in this context is student comprehension of Mathematics questions in English thoroughly. Student comprehension indicator is determined by student answer correctness in doing the problems. Knowing the matter, it is noted in *Table 1*. It is clearly seen in label "Material" fourth row and fifth row that student comprehension of Mathematic problems is very low. From 10 question, there is only one problem (*Question 1*) which can be understood more than half students or about 53.7%. The other questions; *Question 2* can be understood by 34.1% students; *Question 3* and *6* can only be understood by three students; *Question 3, 7,* and *10* are only understood by 1 students (2.4%), and no one (0%) understand *Question 5* and *9*. What are the factors which influence the lack student comprehension of mathematics questions in English? At least, there are three factors: linguistics element comprehension, technical term comprehension, and transformation: verbal linguistics to mathematics operational language.

1) Linguistics Element Comprehension Factor

It is true that mathematics comprehension problem is influenced by linguistics element comprehension? The answer is true and certainty. The evidence has been explained in detail above which is seen from word level, phrase level, and sentence level. It is proved when students is failed to understand linguistic element each level, so student comprehension of mathematics questions thoroughly will not succeed.

Another interesting finding in this part is there is the other factor except the language which influences student success in doing mathematics question. The answer is comparing the label between "Language" and "Material" in *Table 1*. The previous paragraph has been convinced that student comprehension of problems is influenced by student comprehension of linguistics element. That statement can be stated that student linguistic comprehension is as good as problem student comprehension. This does not happen in this research. Studied exactly, student ability in understanding linguistic element is higher than problems comprehension. So, the expectation is problems student comprehension result is also the same with student comprehension result of linguistic element. The fact is not the same. Problem student comprehension is lower than student comprehension of linguistic element. This phenomenon is

happened to all given problems (10 questions). Moreover, although student can understand linguistic element but they are failed to understand whole problems. For examples are *Question 5 and 9*. There are two students who are success to understand linguistic element in fifth problem but they are failed to understand whole mathematic problems. The same phenomenon is found in ninth problem: there are 3 students who understand linguistic element but they are failed to understand whole problems. From these evidences, it can be concluded that student comprehension of linguistic element do not guarantee student success to understand whole problems.

The other strong factor which is possible to be student comprehension success determinants of mathematic problems are (1) student comprehension of mathematic operational or technical term of mathematics, and (2) verbal linguistics transformation to mathematic operational language.

2) Technical Term Comprehension Factor

Almost each mathematic problems are found technical term. This term is understood absolutely to get right answer. Note example problem in second problem.

Question 2

Find the sum of all multiples of 5 from 5 to 200.

This problem has technical term; *sum* means "jumlah" and *multiple* means "kelipatan". If these two terms are failed to be understood, it can be convinced that the obtained result is not correct. From this problem, there are some interpretations of student comprehension.

(1) Student only writes row of number multiplies from 5 to 200.

(2) Student only writes sum of all multiplies of 5.

(3) Student writes row of number multiplies from 5 to 200 then add all of it.

From *Table 1*, it can be seen that there are only 14 students from 41 students or 34.1% who can understand this technical terms. Another example problem which has technical term is found in *Question 9*.

Question 9

The sum of two numbers is 5. Suppose 3 is added to each number and then each of the resulting numbers is doubled. What is the sum of the final two numbers?

As seen from red bold, this problem has many mathematic operational technical terms: adding, result, and grade. Table 1 shows that no one (0%) can finish this problem. This finding recommends that absolute requirement to get correct result is student comprehension of technical terms. The same finding is also found in fifth problem. This problem is not answered by students

because this problem has mathematic technical terms which are they keyword, such as *whole number* means "bilangan cacah".

3) Transformation Factor: Verbal Linguistics to Mathematics Operational Language

The third determinant factor of student success to finish mathematic problem in English is expertise student changing verbal linguistics to mathematic operational language. From 10 given questions in Olympiad model, they use verbal linguistics and six of them are included as story problems; *Question 1, 3, 6, 7, 8,* and *10*. None of them is found using direct mathematic operational language problems, such as: (10 + 3) – 4 = ..., etc. Fifth following problem is the example of mathematic problem which uses verbal linguistics.

Question 5

How many positive whole number less than 2005 can be found, if the number is equal to the sum of two consecutive whole numbers and also equal to the sum of three consecutive whole numbers?

None of them is mathematic operational symbol which makes student comprehension and foresight student change verbal to mathematic operational language determining student success in finishing the problem. If *Question 5* is changed as following data, there is no student that can solve this problem.

Mathematic Olympiad problem of problem story model can be seen in sixth problem. Student is asked to think complex series of mathematics logics. "Reduction" operational is not stated clearly using the common word, such as: "subtracted" or "minus". The used word is *eat* in the sentence *He eats....* If student does not understand linguistic element and is unable to associate the word *eat* which means "reduction", it can be convinced that this problem cannot be done correctly. This question can only be done by 3 students from 41 students.

Question 6

Aisyah has some candies. Every day, he eats one half remaining candies from the previous day, plus one more candy. After five days all candies were gone. How many candies does Aisyah have originally?

Question 6 can be changed to mathematic language as this following table.

Fifth days (sum of the first candy)	Fourth days	Third days	Second days	First days

Another story problem needs high grade logic is *Question 8*. This question resembles *Question 6* in different scenario. *Question 8* uses mathematic operational of "reduction" and "adding", while eighth problem tests student ability to understand the concept of "fraction" and "multiplication" by using the word *two third* and *how many times*.

Question 8

A ball is dropped from a height of 81 feet. On each bounce it raises two-third the height of the previous height. How many times will it bounce before it rises to a height less than ten feet?

If the structure question is transformed or changed into mathematic language, there will be rows sum of 5 bounces before the last bounce reaches less than 10 feet. But, this problem can be done by 3 students from 41 students.

The height of falling ball	First bounce	Second bounce	Third bounce	Fourth bounce	Fifth bounce
81	2/3 x 81 = 54	2/3 x 54 = 36	2/3 x 36= 24	2/3 x 24 = 16	2/3 x 16 = 10.7

From explanation above, it can be concluded that the findings are (1) The success finishing of mathematic problem in English cannot be separated with student comprehension of linguistic elements thoroughly in word level, phrase level, and sentence level. Almost all of mathematic Olympiad problem are related to verbal linguistics. (2) Operational concept learning or mathematic technical languages are needed to be strengthened in order that student can solve mathematic problem well. (3) Transformation practice of mathematic problems from verbal linguistics to mathematic symbol language that is needed to get attention and rational portion. (4) It is needed to find mathematic learning strategy in English which is effective relative to help student in both understanding mathematic problem in English and finishing it well. Although this finding has been explained in detail and concluded above, the stated language from the student is very brief to represent the limits of understanding the problem and finishing the problem well. All of the students said in brief way, "Bahasa Inggrisnya sulit".

DISCUSSION: LEARNING STRATEGY OF LINGUISTICS PROBLEMS IN PRIMARY SCHOOL MATHEMATICS OLYMPIAD

Some people assume that learn mathematic does not need many language comprehension. So, many parents and teachers suggest the kids or students learn mathematic if their language ability (English) is lack. They seek an excuse that mathematic does not use many languages. The fact is not as simple as assumption. Mathematic has closed relationship with language especially the ability of

logical reasoning which is integrated with context or problem story. If one keyword is not understood, it can be predicted that the result is less or wrong.

Data *Table 1* shows that KPM participants have trouble in finishing the problems. It happens because most of the participants do not know the meaning of keyword /"technical term" in mathematic. Most of the students do not know the linguistic element *remaining, intersection point, two-third a height*, and etc. the fact is there are many translation problems from English to Bahasa Indonesia is incomplete: there is no synonym in Bahasa Indonesia, it does not choose Indonesian word and many students cannot translate it. How is the strategy which can be taken to solve the linguistic problem? This is the possible solving.

1) Providing Glosaries

The first offered strategy to solve '*mathematic technical terms*' is providing *glossary* in the teaching material. Glossary is list of words with definition completed with another explanation in a certain field. This strategy is aimed to help the students master mathematics technical terms fast and properly in the matter of interpretation. Naturally, language/term in mathematics is *non redundant* and *unambiguous* (Brunner, 1976 from Cuevas, 1984: 136). Moreover, Halliday (1975) as referred by Cuevas (1984: 136) conveyed for elements in the language of mathematics.

(1) Original mathematics terms, such as: *set, point, field, column, sum, even* (number), *random*

Example:

- In particular month sometimes ago, three dates of even numbers fell on Thursdays. On which day of the week did the fifteenth day of that month fall?
- Find the sum of all multiples of 5 from 5 to 200!

(2) Locus terms, such as: *square on the hypotenuse* and *least common multiple*

Example:

- Nasir draws straight lines on a piece of paper. What is the maximum number of intersection points that Nasir can make?

(3) General terms: *feedback,output, cover*

Example:

- If a man covers 10 1/5 km in 3 hours, what is the distance covered by him in 5 hours?

(4) Terms taken from Greek and Latin, such as: *parabola, denominator, coefficient,* and *asymptotic.*

Example:

- When the same whole number is added to both numerator and denominator of 2/5, the value of the new fraction is 2/3. What number was added to both the numerator and denominator?

From exploration above, it is obvious that the success in solving mathematics questios influenced by the students understanding towards technical mathematics terms. In order to make the students accustom to gain concepts of those terms, providing bilingual glossaries in teaching material is a need. This is supported by Abedi et al. (2004) that list of words or *glossary* proved can help the students to understand mathematics questions. Besides, glossaries providence can be used by the students to solve the questions independently outside the class. It means that glossary is a tool helps students to do *self-learning* without limited time and place. The glossaries providence can be seen in the models as follows based on need.

Model 1

denominator/dɪˈnɒm.ɪ.neɪ.tər / : penyebut

even number/ˈiː.v ən ˈnʌm.bər / : bilangan genap

intersection point /ˌɪn.təˈsek.ʃ ɔ n pɔɪnt/ : titik potong; titik singgung

numerator /ˈnjuː.mə.reɪ.tər / : pembilang

odd number/ɒd ˈnʌm.bɔ r / : bilangan ganjil

Model 1 contains of three parts: mathematics technical terms, *phonetic transcription*, and the definition in bahasa Indonesia. This glossary does not only provide the terms' definition in bahasa Indonesia, but also how to read them properly. This model is good to be given to students due to improving their pronunciation when reading or presenting questions and even doing them. Therefore, the students have to be given knowledge of phonetics and training of how to read them.

A simple glossary model can be seen in *Model 2*. Different to *Model 1*, this glossary does not include phonetic transcription to be introduced. The students should know the terms in English and the meaning in bahasa Indonesia.

Model 2

Addition	:	Penjumlahan
algebraic forms	:	bentuk aljabar
Angles	:	Sudut
Area	:	Luas
associative principle	:	sifat asosiatif
Circumference	:	Keliling
commutative principle	:	sifat komutatif
complement of a set	:	komplemen suatu himpunan
Decimals	:	Decimal
Degrees	:	Derajat

universal set	:	himpunan semesta
Variable	:	Variabel
Venn diagrams	:	diagram Venn
whole number	:	bilangan cacah

There are three choices of providence if the teaching material created as a book: in the end of the book, in each chapter, and in each exercise section. Moderate choice is providing glossary in each chapter. If it is put in the end of the book, it will need a longer time to find the term that is looked for as it is too far to search and the terms are too many as it contains the whole terms exist in the book. If it is put in each exercise section, it will not be efficient as there is repeated terms probability.

2) Introducing Technical Terms

Based on class observation, technical terms and keywords are not introduced to the students. After doing ceremonial activity; praying, checking students' presence, etc, the teacher directly shares the question sheets and asks the students to do them individually or in group. With such limited time, the next activity is discussing the questions and asking one of the students to write the answer in the board. Both teacher and students work through the answer written in the board.

This learning strategy has weaknesses: *(1) noisy class, (2) incorrect question understanding, (3) students' disappointment.* The indication of noisy class is shown by the students while obtaining the questions. They uncomfortably do the questions in front of them. They look around, whisper, and ask each other the terms or keywords they find in the questions. The class will be in a mess because of such unobvious voices done by almost all of the students. Students keep asking each other and a group of students will talk to another group.

LK1 : Hey, what does this mean? I do not know.

LK5 : What number?

LK1 : Number 5.

LK 5 : I do not know either. I'll read it first.

From the students' unawareness of terms exist in the questions; it is undeniable that they do the questions based on their own understanding and interpretation. It is just like the students stare, enjoy, and try to define a meaning of such abstract images but it is failed as they do not have any abstract aesthetics. With the skill of guessing that is unknown to the fact, it can be predicted that the result of students' works may be incorrect. The impact is, after one of the student write the answer in the board, the answer will be incorrect. The teacher then elaborates the method to solve it. Even a small unnoticed thing could be a fatal to the students. For example is the way to write decimals. In