PROBLEMS OF THAI STUDENTS IN COMPREHENDING ENGLISH MATHEMATICS
ปัญหาของนักเรียนไทยในการเข้าใจคณิตศาสตร์ ที่เป็นภาษาอังกฤษ

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Abstract

The study aimed to investigate whether Matthayomsuksa 1 (M1) students in the English Program at a large state-run high school in Northeastern Thailand had problems in studying mathematics in English and what kind of problem they had. The instruments employed in this study were two mathematics tests. One was an English test requiring the students to translate mathematic vocabulary, write algebraic expressions, and solve word problems whereas the other was a Thai test assessing only word problem solution ability. The data were analyzed, using percentages, means and t-test.

The results of the study revealed that the students seemed to have problems in learning English mathematics due to vocabulary, phrases and sentences specific to mathematics. Among

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these, the most problematic appeared to be word problem solving, and the least problematic was vocabulary recognition. The result of the Thai test seemed to affirm that the problems arose from the students' low English proficiency.

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาว่านักเรียนระดับชั้นมัธยมศึกษาปีที่ 1 ในโครงการการจัดการเรียนการสอนโดยใช้ภาษาอังกฤษเป็นสื่อ ในโรงเรียนระดับมัธยมศึกษาขนาดใหญ่ของรัฐบาล ทางภาคตะวันออกเฉียงเหนือของประเทศไทย มีปัญหาในการเรียนวิชาคณิตศาสตร์เป็นภาษาอังกฤษหรือไม่ และมีปัญหาอะไร เครื่องมือที่ใช้ในการศึกษาคือแบบทดสอบคณิตศาสตร์จำนวน 2 ชุด แบบทดสอบชุดแรกเป็นภาษาอังกฤษ ประกอบด้วย การแปลคำศัพท์ การเขียนนิพจน์ทางคณิตศาสตร์ และการแก้โจทย์ปัญหา ส่วนแบบทดสอบชุดที่สองเป็นภาษาไทยและทดสอบเฉพาะโจทย์ปัญหาเท่านั้น ในการวิเคราะห์และนำเสนอข้อมูล ใช้ค่าร้อยละ ค่าเฉลี่ยและ t-test

ผลการศึกษาพบว่า นักเรียนมีปัญหาในการเรียนคณิตศาสตร์เป็นภาษาอังกฤษเนื่องจากคำศัพท์ วลี และประโยคภาษาอังกฤษมีความเฉพาะเจาะจงทางคณิตศาสตร์ โดยนักเรียนมีปัญหาในการแก้โจทย์ปัญหามากที่สุดและการแปลคำศัพท์น้อยที่สุด ผลจากแบบทดสอบภาษาไทยยืนยันว่าปัญหาในการเรียนคณิตศาสตร์เป็นภาษาอังกฤษมาจากความสามารถทางด้านภาษาอังกฤษที่อยู่ในระดับต่ำของนักเรียน

คำสำคัญ:คณิตศาสตร์ที่เป็นภาษาอังกฤษ

1.   Introduction

Without objections, English is a language used to communicate internationally. In the education area, English is considered one of the core subjects in school curricula in many countries. In addition, English becomes the language of instruction for many subjects, namely, science and mathematics, even in the countries where English is not the first language. For example, the Malaysian government has changed the language of instruction from Malay to English in science and mathematics in order to keep up with globalization (Mohamed, 2008; Nordin, 2005).

In the Thai educational system, English plays an important role from the elementary level to the tertiary level as a compulsory subject.   Realizing the importance of English, the Ministry of Education (2001) approved of the English Program in which the English language is a medium of instruction for mathematics, science, social studies and arts for eighteen hours a week. In such a program, the students are required to understand the above-mentioned subjects by using their English competence including knowledge of vocabulary items and technical terms as well as linguistic structures. The requirements, however, cause difficulties in learning processes for English as a foreign language (EFL) learners as it usually takes them a number of years to have enough English proficiency to understand academic contexts (Cummins, 1980). In other words, using the English language in the classroom coupled with English authentic texts normally hinders the students' comprehension of subject contents, especially science and mathematics (Dahlan et al., 2006; Nordin, 2005).

To be specific, English mathematics is difficult for non-native English learners, mainly due to unfamiliar words and sentence structures which are unique to English mathematics. The

learners have to interpret mathematic phrases to make a logical discourse, and the way of presenting numerals such as fractions, ratios, and powers in English mathematics has been found to confuse the learners who are not good at English (Barwell, 2008; Cuevas, 1984; Jarret, 1999). When they study English mathematics, they tend to encounter double difficulties (Garegae, 2008): one from reading the authentic English texts and the other from communicating the mathematical ideas (Brown, 2005). According to Moschkovich (2005), the students tend to have lower mathematics performance when dealing with mathematics in English than studying mathematics in their first language.

Most of the EFL students in the English Program normally studied mathematics in Thai at the elementary level. These non-native speakers of English hardly use English in their daily lives. That is why they encounter difficulties in learning English mathematics in their first year in the English program. This study, therefore, aims to investigate the following research questions in order to come up with effective solutions to the problems:

1. DoMatthayomsuksa1 (M1) students in the English program at a large state-run high school in Northeastern Thailand have problems in studying mathematics in English?

2. What kinds of problem do the students have in studying English mathematics?

2.　The language of English mathematics

According to the mathematics curriculum issued by the Ministry of Education (2008), the students are required to follow the Learning Contents and Standards – a set of guidelines for the students' achievement in the core subjects - in order to have

abilities to think and communicate mathematically, which means they should be able to integrate mathematical skills such as reasoning, measuring, planning etc. into the "real world" circumstances (Ballantyne et al., 2008). To evaluate the students' achievement in learning mathematics, most challenging mathematics tests often comprise word problems which the students are required to solve systematically and logically. To successfully do so, the students also need the knowledge of mathematic vocabulary as well as phrases or algebraic expressions. The characteristics of vocabulary, phrases and sentences used in English mathematics are described below:

2.1. English mathematic vocabulary

Garegae (2008) stated that despite being native English speakers who are accustomed to using English in the real situation, the learners would still find mathematic vocabulary difficult. That is because the English mathematics language consists of terms whose meanings are different from those used in ordinary English. In this regard, EFL learners who have not mastered English generally struggle with such words (Ballantyne et al., 2008; Clarkson, 2006; Kazima, 2006). According to Garegae (2008), mathematical terms are divided into two categories as follows:

(1) Technical terms specific to mathematics

This group of words is connected with mathematics only. That is, it has meaning only in mathematics. Some examples are given below:

Polynomial refers to one term or the sum/difference of two or more terms. For example, $4x2 - 3y + 7$ is a polynomial.

Coefficient refers to the numerical factor in any term of a polynomial. For example, in the expression $2x + 3y - 16$, the coefficient of x is 2 and the coefficient of y is 3.

(2) Terms with common meanings in ordinary English but different meanings in mathematics

This group of vocabulary items has more than one meaning. These words are used both in ordinary English and mathematic English. However, when they are used in mathematics, their meanings have little or no relationship with their common ones (Mckenna and Robinson, 2006). An example is 'odd' which means 'different from what is normal or expected' in ordinary English, but 'a number that cannot be divided exactly by two, for example 1, 3, and 5' in mathematics.

2.2 English mathematic phrases

A mathematic phrase, or an algebraic expression, is a composition of numbers, variables, and operation symbols (eg. 2x + 1) which can be translated from word phrases. Algebraic expressions are formed by word phrases which are not complex but dense because the variables have to be interpreted restrictedly (Capraro et al., 2010). However, word phrases that contain the terms with more or less the same concept may not generate the same algebraic expressions. For example, the terms decreased by, deduct, depreciate, less than , minus, subtract and take away all signal subtraction in mathematics operation, but they do not always generate the same algebraic expressions of subtraction as demonstrated below:

Word phrases	Algebraic expressions
1. 5 minus b	5 - b
2.5 less than b	b - 5

2.3　English mathematic sentences

In English mathematics, the sentences are often presented in simple and declarative structures without ambiguities, hidden agendas or cultural assumptions (Dahlan et al., 2006). In addition, the sentences are often in active rather than passive. Paradoxically, these clear sentences are actually problematic for the beginners of English mathematics (Jamisson, 2000). That is, however simple the sentences in English mathematics are, the learners still require good English ability to understand their concepts (Barwell et al., 2007; Jamisson, 2000). Some examples of English mathematic sentences are

1. Stephanie is six years old. She is one year older than one-sixth the age of her　mother. How old is Stephanie's mother?

2. A chicken dinner costs $2.50 more than a spaghetti dinner. If the cost of both is $18.40, how much does each meal cost?

3.Methodology

3.1 Subjects

The subjects in the study were all 33Matthayomsuksa1 students in the English Program at a large state-run high shool in Northeastern Thailand in the academic year 2010. All of them were familiar with the teaching method which uses Thai as a medium of instruction. Their average English language proficiency was considered lower than the standard level, based on the result of English for Speakers of Other Language (ESOL) Examination provided by the University of Cambridge. That is, only 6% passed the test. Taking three English mathematic classes per week in the English Program, they were found to struggle with the learning as they had to make sense of English texts used in this particular context.

3.2 Instruments

Two tests were given to the subjects to examine the problems they were facing in studying mathematics in English. The following are the characteristics of the two tests.

3.2.1   English test

The test comprises three parts: translating 20 mathematic vocabulary, writing 10 algebraic expressions and solving 10 word problems as elaborated below.

(1) Translating mathematic vocabulary

According to the study on mathematic vocabulary conducted by Garegae (2008), two kinds of mathematic vocabulary caused problems for L2 learners: words with more than one meaning (used differently in ordinary English and mathematics English) and words with meanings only in mathematics. Ten words of each kind were selected from Garegae's study. The selection was based on whether the words had been introduced to the students and included in their lessons. The first group includes addition, different, factor, multiples, parallel, perimeter, product, remainder, substitute and sum, and the second group consists of equilateral triangle, highest common factor, perpendicular line, prime number, regular pentagon, right angle, significant figure, simple interest, square number and standard form.

(2) Writing algebraic expressions

This part aimed to evaluate the students' abilities to decipher mathematical phrases into mathematics concepts, which are needed for solving problems or equations. It comprised ten word phrases that had been taught in the classroom, for instance, x dozen, twice a number, and 5 less than a number.

(3) Solving word problems

In this part, ten word problems were given to the students in order to evaluate their understanding of English mathematic sentence structures and their ability to translate those descriptions into equations before the problems were to be solved. It is generally accepted that the ability to solve word problems correctly shows the students' success in learning mathematics. An example of word problems in the test is "A chicken dinner costs $2.50 more than a spaghetti dinner. If the cost of both is $18.40, how much does each meal cost?"

3.2.2 Thai test

To ensure that the problem that might occur really arose from the students' lack of English competence, not their poor mathematic ability, the ten word problems on the English test were translated into Thai for the students to solve. The result of the test in Thai was compared with that of the English test to see whether there was any significant difference. If the students could do the Thai mathematics test significantly better than the English one, it meant that their difficulties really resulted from poor English knowledge.

3.3 Procedures

The students had been informed about the test one week before the English mathematics test was to be taken. The time allowed for the completion of the test was two hours. The Thai test was given to the students three days after the first.

4. Results

The data drawn from the scores of the English test as seen in Table 1 show that the part that the subjects could do the best is the vocabulary (32.58%) (from the average of both types, 20 items),

followed by algebraic expressions (23.64%) and word problems (15.15%). Considering each part of the test, it can be seen that the means of the technical terms and algebraic expressions are equal. This implies that translating technical terms seemed to be as difficult as writing algebraic expressions. However, the mean of both types of the vocabulary is statistically greater than that of the algebraic expressions, which means the students could translate vocabulary better than writing algebraic expressions. Overall, no part reaches 50 %; therefore, it can be concluded that the students had difficulties studying English mathematics.

Table 1 Results of the English mathematics test

	Translating vocabulary (20)		Writing algebraic expressions (10)	Solving word problems (10)
	1. Terms with common meanings in ordinary English but different meanings in mathematics (10)	2. Technical terms specific to mathematics (10)		
Mean	4.15 (41.52%)	2.36 (23.64%)	2.3636 (23.64%)	1.5151 (15.15%)
	3.26 (32.58%)			

(P-value of the three pairs ≤ 0.20)

Concerning the two types of vocabulary, the results as illustrated in Table 2 indicate that the mean score of the terms with

common meanings in ordinary English but different meanings in mathematics is 4.15, which means each student recognized and understood four words on average.   Meanwhile, they could remember averagely two technical terms. The statistical difference between both groups is significant at P = 0.00. This means the students did not know technical terms as well as terms with common meanings in ordinary English but different meanings in mathematics.

Table 2 Comparison between two types of vocabulary

Vocabulary	Mean	S. D.
1. Terms with common meanings in ordinary English but different meanings in mathematics	4.15	2.25
2. Technical terms specific to mathematics	2.36	2.10

P = 0.00

        To be certain that the problems above were caused by the students' poor English ability, the results of the tests on English and Thai word problems were compared and presented in Table 3.

Table 3 Results of the tests on English and Thai word problems

	English Word problems (10)	Thai Word problems (10)	Score difference
Total (330)	50	119	69
Mean	1.52 (15. 15 %)	3.61 (36.1 %)	2.09 (20.9%)

P=0.000

According to the data above, on average each student could solve one or two English word problems correctly as the mean score was only 1.5151 or 15.15 %. On the other hand, they could solve three or four word problems in the Thai version as the mean of the Thai test was 3.6061 or 36.06%, which is about 21% different from the English one. As the students had statistically different ability in solving the English and the Thai word problems, it can be concluded that the problems really arose from English ability, not mathematical skills.

5. Discussion

Based on the results presented above, the students' average score of each part of the test is lower than 50%. Therefore, it can be said that the EFL learners found learning English mathematics difficult due to their limited language abilities, especially their insufficient knowledge of the English mathematic vocabulary, phrases and sentences.

Vocabulary is important for comprehension of any subjects; English mathematics is no exception. Similar to Clarkson (2006), Garegae (2008) and Kazima (2006) who stated that EFL students struggled with mathematic vocabulary, this study found that the

subjects also had problems with the vocabulary, especially the ones specific to mathematics or technical terms. This is because the technical terms are not usually used in daily life. When the students encounter their specific meanings, it is important that they recognize and understand their definitions in order to use them in class. On the other hand, the students have more opportunities to be exposed to the terms that have both meanings in ordinary and mathematics; therefore, the words look more familiar when being introduced in English mathematics class and more easily memorized (Gargare, 2008; Kasima, 2006).

In addition, it happened that the students found English phrases in mathematics difficult to understand. For example, they incorrectly interpreted the phrase x dozen as the squared of x (x2) instead of 12x, which is probably caused by two factors –the unknown word dozen and the meaning of the phrase x dozen that refers to multiplication. Another example is twice a number which was incorrectly decoded as the squared of a number (n 2, meaning n x n) instead of double a number (2n referring to n + n). This means the students could not distinguish the concept of multiplication from that of addition through the algebraic expressions. One more case is "5 less than a number," which must be translated as n-5, but most students decoded it as 5 – n. The cause of the problem is similar to what Ballantyne et al. (2008) mentioned that some algebraic expressions were produced differently from word phrase arrangement, thus causing confusion and misunderstanding.

When it comes to word problems which contain precise and informatively dense sentences, the students need to pay attention to the structures in order to relate the relevant information to the modeling solution (Capraro et al., 2010; Jarret, 1999). The results from the study revealed that the students failed

in forming complete mathematic equations. To elaborate on this, they could make a list of information presented in the word problems, but they were not able to apply the information into mathematic concepts to the modeling solution (+, -, x, ÷). As a result, they were unable to solve the problems.

In other words, the students lacked good reading skills to understand and form mathematical concepts through English sentences. That is why they gained the lowest average score in the word problem part. Word problem solving is, therefore, the most difficult part for the students in learning English mathematics. This corresponds to the fact claimed by Barwell (2003), Jarret (1999) and Verschaffel et al.(2000) that multi-skills such as reading, translating and decoding are crucial for English mathematics learning. On the contrary, the students gained the highest average score for the vocabulary part because they were required only to recognize single words or short word phrases without integration skills.

The results of this study imply that the language barriers had a significant effect on the students' abilities to make English mathematics comprehensible, as supported by Cuevas (1984) and Nordin (2005) that the students found mathematics more difficult when an English textbook was used in the classroom. The findings of the study support Moschkovich's claim (2005) that ESL students tended to have lower performance in English mathematics than mathematics studied in their first language.

On the contrary, when the students took the word problems on the Thai test, the average score increased significantly. The comparison between the English test and the Thai test indicates that the students could gain higher scores in solving word problems in their first language as they could write more correct equations. Even though some of them had a limited language skill when they

did the same item on the English test, they could draw a diagram to help write the equation. For example, a few of them could sketch the diagram below in an attempt to solve the word problem "A chicken dinner costs \$2.50 more than a spaghetti dinner. If the cost of both is \$18.40, how much does each meal cost?"
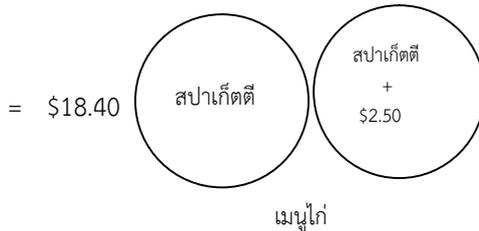
The equation represented by the picture was correctly formed. Consequently, it can be assumed that the Thai test allowed the students to understand clearer mathematic concepts than the English test, indicating that English is the major cause of their difficulties in mathematics learning.

6.1 Conclusion

Based on the results of this study, it can be concluded that the students in the English Program at the high school under study had problems in learning mathematics in English due to their limited English proficiency. They were poor in all the three aspects investigated: mathematic vocabulary, algebraic expressions and word problems. The instructors in charge of the same or similar course are, therefore, suggested to familiarize the students with technical terms, phrases and sentences used in English mathematics earliest in the course. Integrating mathematics in English class may also be a possible way to build up sufficient background knowledge to study English mathematics, making it less difficult for EFL learners.

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