THE INFLUENCE OF MATHEMATICAL TERMINOLOGY ON STUDENTS' ACHIEVEMENT AT THE HIGH SCHOOL LEVEL

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Abstract

The main purpose of this study is to investigate the influence of mathematical terminology on students' achievement at the high school level. Descriptive research study was used for this research. Twelve high schools were randomly selected from four selected townships of four districts from Yangon Region. The target population was (600) Grade Ten students. As instruments, a mathematical terminology test and a mathematics achievement test were used. The mathematical terminology test was used to investigate Grade Ten students' understanding of mathematical terminology concerned with mathematical terms, mathematical symbols, and mathematical structures. It included (15) items for each dimension. The mathematics achievement test was used to explore Grade Ten students' mathematics achievement. It involved three sections: (11) multiple choice items, (3) short questions and (6) long questions. For obtaining reliability, the pilot test was administered. The internal consistency of the instruments were (.780) and (.805) by using Cronbach's Alpha. In order to know the correlation between students' understanding of mathematical terminology and their mathematics achievement, Pearson product-moment correlation was used. The correlation coefficient between students' understanding of mathematical terminology and their mathematics achievement was (.682). This result shows that students' understanding of mathematical terminology is positively related with their mathematics achievement. It means that if students' understanding of mathematical terminology is low, their mathematics achievement will be low. On the other hand, if students' understanding of mathematical terminology is high, their mathematics achievement will be high. To sum up, mathematical terminology influence on students' mathematics achievement at the high school level.

Keywords: mathematics, terminology, mathematical terminology, mathematical term, mathematical symbol, mathematical structure.

Introduction

Education is as a basic human need, integral part of the quality of life, a support for moral and social values, and an instrument for economic productivity. Human beings create their society by using education as a tool. Education can only enhance the status of an era, a country, a nation, and a life. It is more noticeable in 21st century because a person needs to be educated to handle with the demands of the century including science and technology. It is hard to imagine today without using some form of technology. The origin of this interesting technology comes from mathematics. Mathematics is the necessity of technology and science. So it can be said that mathematics is at the heart of many successful careers and successful lives for societal development, particularly in the extraordinary and accelerating change circumstances. Human cannot live far away from mathematics. Since mathematics is finding the solution or solving problems, it trains a student to be successful in 21st century that demands critical thinking and problem solving.

Mathematics is a language itself. It has its own terminology. Mbugua (2012) stated that mathematical terminology is a system of communication with its own set of symbols,

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convections or special words. Mathematics concepts are present by mathematical structures. The language of mathematics consists not only of words and texts but also of symbols and diagrams; explicit instruction can help build the connections between the elements of mathematical language (Walle, 2001, cited in Lee, 2006). Bloom (1956, cited in Owens, 2008) asserted that the most type of knowledge in any particular field is its terminology. The understanding of terminology is the foundation of the whole mathematical knowledge and process.

If education is said as a hero, mathematics will be his gun and then the mathematical terminology might be the bullet. The hero counts on his gun and the gun can be nothing without having any bullets. Mathematical terminology is influent upon the power of mathematics. It plays a vital role in teaching and learning of mathematics and even the whole process of education. So, it is necessary to study the influence of mathematical terminology on students ' achievements at the high school level.

Purposes

The main purpose of the study is to study the influence of mathematical terminology on students' achievements at high school level. The specific objectives are as follows:

1. To investigate Grade Ten students' understanding of mathematical terminology including terms, symbols, and structures
2. To explore Grade Ten students' mathematics achievement
3. To find the relationship between students' understanding of mathematical terminology and their mathematics achievement
4. To give suggestions for improving the understanding of terminologies in students' learning mathematics.

Research Questions

Q1: To what extent do Grade Ten students understand mathematical terminology?

Q2: To what extent can mathematics be achieved by Grade Ten students?

Q3: Is there any relationship between students' understanding of mathematical terminology and their mathematics achievement?

Scope of the Study

The following points indicate the scope of the study.

1. This study was geographically restricted to Yangon Region.
2. Participants in this study were Grade Ten students from selected schools within 2018-2019 academic year.
3. This study was limited to mathematical terminology concerned with terms, symbols, and structures including in Grade Ten mathematics textbook.

Definition of Key Terms

Mathematics: Mathematics is the study of numbers, quantities, shapes, and space using mathematical processes, rules, and symbols (Barker, 1964).

Terminology: A structured set of concepts and their designations (graphical symbols, terms, phraseological units, etc.) in a specific subject field (University of Surrey, 2018).

Mathematical terminology: Mathematical terminology is a system of communication with its own set of terms, symbols and or structures (Mbugua, 2012).

Mathematical term: Mathematical term refers to a word that labels mathematical concepts e.g. quotient, chord, power, area among others (Wanjiru, 2015).

Mathematical symbol: Mathematical symbol is a concise way of giving lengthy instructions related to numbers and logic **(** Cobb, 2009).

Mathematical structure: A mathematical structure is a set or sometimes several sets with various associated mathematical objects such as subsets, operations and relations, all of which must satisfy various requirements. The collection of associated mathematical objects is called the mathematical structure (Wells, 2017).

Review of Related Literature

Mathematics as a Language

Mathematics is the essential tool to empower people with the knowledge, competencies and attitudes which are precursors for the dynamic world. Learning mathematics is like learning a new language. All languages have their own terminology, and mathematics is no exception. Unlike common English, which students hear, see, and use daily in reading, watching television, and conversing, the language of mathematics is limited largely to school (Thompson & Rubenstein 2000, cited Lee, 2006). It is the study of abstract system built of abstracts. It is a systematized, organized and exact branch of science. Mathematics is the language of physical science. It has its own terminology - terms, symbols, structures. Mathematics ideas can be understood by making connections between terms, symbols, structures and real - life situations (Lee, 2006). Terminology is a pivotal component of mathematics success (Seethaler, Fuchs, Star, & Bryant, 2011, cited in Wanjiru, 2015), and a student's general knowledge of mathematical terminology can predict mathematical performance (Walt, 2009, cited in Wanjiru, 2015).

Mathematical Terminology

Phyllis and Whitin (2000, cited in Lee, 2006) reminded that mathematics is language too. Since each language has its own terminology, mathematics has its unique mathematical terminology. Undoubtedly, the many difficulties that students face when learning the terminology of mathematics are complex and can negatively impact their language development. Students have to learn and use the terminology of mathematics to understand the many difficulties that it presents students. Mathematical terminology is a system of communication with its own set of terms, symbols and or structures (Mbugua, 2012).

Mathematical Terms

Mathematics learning can generally be divided into three periods. In the first period, mathematics can be taught without knowing the mathematical terms. It just needs to read and write the numbers, for example: 1, 2, 3, …. In the second period, mathematics learning depends on the term of mathematics. In this period, there are two kinds of mathematics. The initial one needs to understand the mathematical language and another one does not. After this period, most of mathematics learning depends on the terms of mathematics. Definition

of mathematical terms may be regarded as the most importance of mathematics learning. Mathematical terms refers to words that label mathematical concepts :quotient, chord, power, are a among others(Wanjiru, 2015).

According to the research of Rubenstein and Thompson (2002, cited in Owens, 2008), there are at least (11) categories of difficulties associated with meaning of mathematical terms. The categories are defined in the following manner: (a) meanings are context dependent, for example: foot as in (12) inches vs. the foot of the bed, (b) mathematical meanings are more precise, for example: product as the solution to a multiplication problem vs. the product of a company, (c) terms specific to mathematical contexts, for example: polygon, parallelogram, imaginary number, (d) multiple meanings, for example: side of a triangle vs. side of a cube, (e) discipline-specific technical meanings, for example: cone as in the shape vs. cone as in what one eats, (f) homonyms with everyday words, for example: pi vs. pie, (g) related but different words, for example: circumference vs. perimeter, (h) specific challenges with translated words, for example: mesa vs.table, (i) irregularities in spelling, for example: obelus vs. obeli, (j) concepts may be verbalized in more than one way, for example: (15) minutes past vs. quarter after, and (k) students and teachers adopt informal terms instead of mathematical terms , for example diamond vs. rhombus. These categories of difficulties associated with meaning of mathematical terms are leading to misunderstanding in learning mathematics. In other words, mastery in mathematical term may lead success in learning mathematics.

Mathematical Symbols

The terminology of mathematics consists not only of words or terms but also of symbols and diagrams; explicit instruction can help build the connections between these elements of mathematical terminology (Walle, 2001, cited in Owens, 2008). Symbols are a communication tool. Mathematical symbols can put the lengthy statements, accurately and in exact form, in a brief description. For example if someone wish to say that the sum of the squares of two sides of a right triangle is equal to the square of the hypotenuse, then it can be written in symbolic form as $c^2 = a^2 + b^2$. For the ancient Greeks, a symbol was a "token, sign, mark" or anything that would be comparable to the real thing whose place it took. In mathematics a symbol is a sign that stands for a quantity, an operation, or a relation. Symbols are used to eliminate the need to write long, plain language instructions to describe calculations and other processes. The literature on the symbols of mathematics, such as constants and variables is enormous. Symbols in mathematics are generally used in two forms. The first is the process of what can be called alphabetization in mathematical discourse. The second is the process of meaning that accrues to symbols through the processes of `pattern recognition' and the privileging of formal similarity in symbolic, graphic forms.

Mathematical Structures

Mathematics can be described as the art of creating and exploring mathematical structures. A structure in the everyday sense might think of buildings, houses, and bridges. It may also be said as a more abstract object involving some form of complex organization. The plot of a movie, a musical composition, and government bureaucracies all are structures in some sense. All of these are instances in which small sub – structures are organized in ways to create larger, more complicated patterns. A building is nothing but the complicated organization of smaller sub – structures such as bricks, cement, wood, and iron. Mathematics

is no different as the construction of a building. A mathematical structure is nothing but a (more or less) complicated organization of smaller, more fundamental mathematical substructures. Numbers are one kind of structure, and they can be used to build bigger structures like vectors, matrices and calculus. A structure consists of a set together with one or more binary operations, which are required to satisfy certain axioms. The binary operation in this definition may be any operation at all, such as addition, multiplication, or composition of functions.

The mathematical structures of a lesson differ from one lesson to the next. Studying mathematics is like building a castle in one's head. When building a castle, it needs first to learn to build a brick, and once that is mastered, then it can be used to build a wall. Stronger bricks allow for higher walls and bigger towers. The beauty of a mathematical structure comes from its ability to have larger structures built from it. Certain mathematical concepts allow for faster building than others. Mathematical structure means the identification of general properties which are instantiated in particular situations as relationships between elements. These elements can be mathematical objects like numbers and triangles, sets with functions between them, relations on sets, even relations between relations in an ongoing hierarchy.

Research Method

Research Design and Sample Size

The research design for this study is a descriptive survey research design which seeks to determine whether, and to what extent, a relationship exists between mathematical terminology such as mathematical terms, mathematical symbols, and mathematical structures and students' achievement at the high school level. In this study, data were collected through a quantitative method. All participants were Grade Ten students from Yangon Region. The sample schools were selected by using stratified random sampling method. Three high schools were selected from a township in each district. Therefore, twelve high schools were included and (600) Grade Ten students participated in this study.

Instruments

A mathematical terminology test for students' understanding of mathematical terminology and a mathematics achievement test were used as the instruments. The mathematical terminology test consisted of (15) mathematical terms, (15) mathematical symbols, and (15) mathematical structures. To investigate Grade Ten students' achievement, a mathematics achievement test was constructed. The instruments were based on the content area of Grade Ten mathematics textbooks prescribed by the Department of Basic Education Curriculum, Syllabus and Textbook Committee.

Research Findings

Based on the scores in mathematical terminology test, understanding of mathematical terminology was divided into three levels: low, moderate, and high.

Table 1 Level of Students' Understanding of Mathematical Terminology

Level	Score (x)	Number of Students	Percentage (%)
Low	$x \leq 19.27$	108	18
Moderate	$19.27 < x < 35.23$	396	66
High	$x \geq 35.23$	96	16
Total		**600**	**100**

Table 1 showed that students whose scores were below and inclusive (19.27) were included in low level of understanding mathematical terminology, students whose scores were between (19.27) and (35.23) were in moderate level, and students whose scores were above and inclusive (35.23) were included in high level. Then, 18% of students (108) were low in understanding of mathematical terminology, 66% of students (396) were moderate in understanding of mathematical terminology, and 16% of students (96) were high in understanding of mathematical terminology.

Based on the results of the mathematics achievement test, students' achievement of mathematics was divided into three levels: low, moderate, and high.

Table 2 Level of Students' Achievement in Mathematics

Level	Score (x)	Number of Students	Percentage (%)
Low	$x \leq 8.59$	93	15.5
Moderate	$8.59 < x < 31.95$	399	66.5
High	$x \geq 31.95$	108	18
Total		**600**	**100**

Table 2 showed that students whose scores were below and inclusive (8.59) were included in low level of achievement in mathematics, students whose scores were between (8.59) and (31.95) were in moderate level, and students whose scores were above and inclusive (31.95) were included in high level. Then, 15.5% of students (93 students) were low in mathematics achievement, 66.5% of students (399 students) were moderate in mathematics achievement, and 18% of students (108 students) were high in mathematics achievement.

For the relationship between students' understanding of mathematical terminology and their mathematics achievement, the results are summarized in Figure 1.

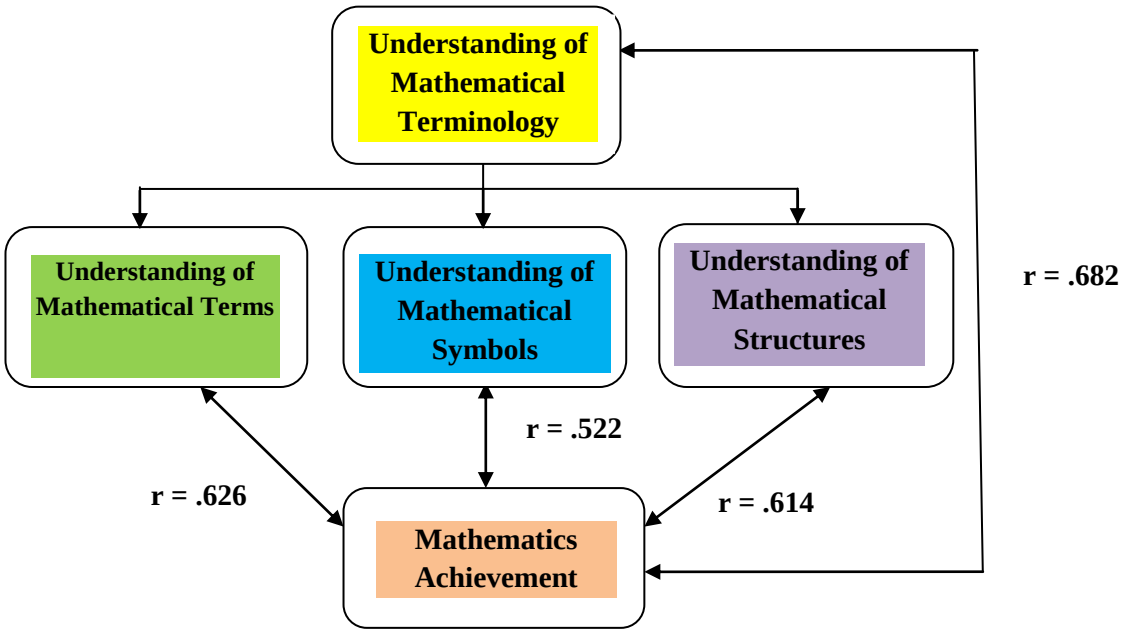

Figure 1 Correlation between Students' Understanding of Mathematical Terminology and their Mathematics Achievement

According to Figure 1, students' understanding of mathematical terms is positively correlated with their mathematics achievement (*r* = .626, *p*<.01). Students' understanding of mathematical symbols is positively correlated with mathematics achievement (*r* = .522, *p*<.01). Students' understanding of mathematical structures is positively correlated with mathematics achievement (*r* = .614, *p*<.01). Students' understanding of mathematical terminology is positively correlated with mathematics achievement (*r* = .682, *p*<.01).

Conclusion

Discussion

In the information age, science and technology make a huge revolution to the earth. The earth is like a village with a rapid transfer of information from pole to pole. Mathematics is a tool of information age. Mathematics is the origin of science and technology.

As knowledge of mathematics is essential for any vocation, mathematical terminology is vital in the process of understanding mathematical knowledge. Mathematical terminology is divided into three portions: mathematical terms, mathematical symbols, and mathematical structures in the study. Like anyone who wants to be top must trace the first step, students must learn first terms, symbols, and structures concerned with the topics of mathematics learning such as algebra, geometry and trigonometry to be proficient in mathematics.

Table 1 showed that the result responses the research question (Q1): To what extent do Grade Ten students understand mathematical terminology? By the response, 18% of students (108) were low in understanding of mathematical terminology, 66% of students (396) were moderate in understanding of mathematical terminology, and 16% of students (96) were high in understanding of mathematical terminology. It can be said that most students are in moderate level of understanding the mathematical terminology.

Table 2 replied the research question (Q2): To what extent can mathematics achievement test be performed by Grade Ten students? From the response, 15.5% of students (93) were low in mathematics achievement, 66.5% of students (399) were moderate in mathematics achievement, and 18% of students (108) were high in mathematics achievement. It can be said that most students are in moderate level of achievement in mathematics.

Based on the obtained data, the correlation between students' understanding of mathematical terminology and their mathematics achievement was found that $r = .682$, $p < .01$. It is strongly correlated as the size of the correlation coefficient is between 0.65 and 1 (Mills & Gay, 2016). Therefore, students' understanding of mathematical terminology is strongly correlated with their achievement in mathematics. This result showed that the direction of the correlation was positive and it pointed out that students' understanding of mathematical terminology is high, and then their mathematics achievement will be high. But if students' understanding of mathematical terminology is low, their mathematics achievement will be low. So, this finding answered to the research question (Q3): Is there any relationship between students' mathematics achievement and their understanding of mathematical terminology? This result supports the finding of Mbugua (2012): the understanding in mathematical terminology is also poor as achievement in the subject. The result also supports that knowledge of terminology influences achievement in mathematics (Sepeng & Madzoreras, 2014).

To sum up, mathematical terminology plays a critical role in mathematics achievement in High School level of mathematics education. To be high in understanding of mathematical terminology, some suggestions are presented as follows.

Suggestions

Mathematics is a compulsory component for human life. Mathematical knowledge is helpful in character and personality development. Mathematical instruction in basic education is the most fundamental process to be sound in mathematical knowledge . Mathematics instruction that encourages appropriate teacher and student communication provides contexts for learning the terminology of mathematics (NCTM, 1990). Pimm (1981, cited in Sepang & Madzorera, 2014) also expressed that mathematical terminology poses numerous challenges to learners' comprehension in solving related tasks, especially those involving word problems. Mathematical terminology used in mathematics problems appears to be an academic obstacle to learner' success in problem solving.

Therefore, students should be taught mathematical terminology concerned with mathematical terms, mathematical symbols, and mathematical structures in detail before problem solving. Developing and then using a systematic plan for teaching terminology will maximize and facilitate improved students' performance in mathematics. It is important that teachers to apply general language instructional techniques to mathematical language on a regular basis.

According to Moore and Readence (1984), the graphic organizer may be one of general language instructional techniques. A graphic organizer represents concepts and their relationships visually. It helps students to understand a concept and recognize similarities and differences between that concept and other concepts. So, teachers should teach with graphic organizer, representing the concept word, its definition, characteristics word, the

examples and non-examples of concept word. As an example, in teaching the word "rectangle", the teacher should explain its concept with its definition as well as examples of rectangle such as blackboard, textbooks, and non-examples of rectangle such as chalk, ball.

To maximize students' learning of terminology in achieving positive academic outcomes across content areas, teachers should begin terminology instruction by providing students with an informal description, explanation, or example of the new terminology either directly or through indirect means. This will help students begin the process of connecting the new meaning to their prior knowledge. It is important to provide students with opportunities to restate the teacher-provided descriptions, explanation, or examples in their own words. This opportunity reinforces the connections to their prior knowledge. Teachers should also help to strengthen the linkage to prior knowledge, students are asked to construct a picture, symbol, or graphic representation of the term or phrase, and provide students with periodic opportunities to reengage in a variety of activities to help them further develop and enrich their knowledge. Students often only develop surface-level understanding of the material, and educators should give opportunities for further engagement students will gain the desired deep understanding necessary for mathematical reasoning and communication.

Moreover, students should be involved in small-group and or peer-to-peer discussions on specific terminology further develop a deeper understanding. Teachers should reduce misconceptions that may have formed in students when some mathematical terms have double meanings such as the word "square" that means double multiplication and a rectangle with all sides are equal. Moreover, some mathematical symbols do not like their abbreviation such as the symbol of slope is " m" while the symbol of mean is "μ". At that time, students used to be ambiguous between the term and symbol and then it leaded to choose uncertain structures for a problem. So teachers should give the clear instruction between mathematical terminologies to lessen students' hazy memories concerned with them.

Furthermore, medium of instruction starts with English, second language, from Grade Ten of Basic Education in Myanmar. Students face several difficulties in learning subjects due to changing the medium of instruction. According to Gueudet (2016), any change or transition process can be either continuous or discontinuous, with identified ruptures or gaps. This change could become apparent as an epistemological obstacle, as a cognitive discontinuity or as a didactical gap. A transition would be identified as a necessity for entering into a different type of discourse (in terms of the language, symbols, tools and representations involved). So, mathematics teachers should help students to transmit this transition period well. If students do not understand what the meanings of mathematical terminology, they will not be interested to solve problem. If they cannot solve the problem, they will have mathematics phobia. To sum up, the mathematics teachers should teach students the mathematical terminology before problem solving in mathematics, and schools should also support additional textbooks, workbooks, and real objects if it can be such as coins, dice, and charts to facilitate in understanding of mathematical terminology. Hence, high understanding of mathematical terminology may lead to high achievement in mathematics.

In addition, this study dealt with the influence of mathematical terminology concerned with mathematical terms, mathematical symbols, and mathematical structures, on students' achievement at the high school level. Since mathematics is a compulsory subject for all levels of

basic education, further studies should be conducted for other levels such as primary level and middle level concerned with notations, representations, sign and so on. Sound foundation of mathematical terminology from primary level would mold perfect performance in mathematics towards middle level and high level of mathematics education.

Conclusion

Mathematics is an integral part of daily life. A day begins with mathematics and ends with mathematics. Everything on the world can be expressed as mathematics such as the earth is round like a circle, a day has 24 hours, and a rectangular playground has an area of 50 square-meters. Mathematics is concerned with physics, chemistry, biology, history, geography, and so on. If English is an international language, Mathematics will be a universal language. Each language has its own terminology: terms, symbols, structures, notations, representations and so on. Mathematics has its own terminology. Mathematical terminology was defined a system of language with mathematical terms, mathematical symbols, and mathematical structures in the study.

Many educators admitted that understanding of mathematical terminology is essential in the whole process of mathematics teaching and learning. It communicates the concepts of mathematics and problem solving. It leads factual understanding to the conceptual understanding of mathematics. So, it is necessary to understand the importance of mathematical terminology in mathematics.

According to the above results, generalization can be drawn that if students' understanding of mathematical terminology is high, achievement in mathematics will be high. It can also be summarized that if students' understanding of mathematical terminology is low, their mathematics achievement will be low. So, the role of mathematical terminology is critical in mathematics achievement. Therefore, mathematics teachers should focus on students' understanding of mathematical terminology in mathematics education. The study will help mathematics teachers to understand the importance of mathematical terminology in teaching mathematics. Moreover, this study will offer a teaching aid for mathematics teachers in teaching mathematics. It will also support in constructing curriculum of mathematics for high school level.

Acknowledgements

We would like to offer respectful thanks to Dr. Aye Aye Myint, Retired Rector, Yangon University of Education, Dr. Pyone Pyone Aung, Pro-Rector, Yangon University of Education and Dr. Kay Thwe Hlaing, Pro-Rector, Yangon University of Education who give us permission to fulfill our dream of doing this thesis. We wish to express our deepest gratitude to our teacher, Dr Soe Than, Professor and head of Department, Methodology Department, Yangon University of Education for his intellectual resources.

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