

**LANGUAGE OF MATHEMATICS: ITS PLACE INSIDE THE MATHEMATICAL
CLASSROOMS**

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Abstract

Mathematical language is an essential component in mathematics classrooms. The present study aims to find out the problems faced by secondary school teachers in regard to teaching language of mathematics. The results show that teachers do face problems in teaching mathematics. Teachers are being interviewed to find out the reasons and areas of the problems faced by them. Implications for further study are drawn for the curricular development and for teacher education programmes.

The role of language in mathematics depends on one's view of its nature. When mathematics is referred to as a language, it is talked about as a means of communicating or conveying ideas. Mathematics is viewed as symbolic in nature and thus not hindering its comprehension by second or third language speakers. Others argue that language does play a role in interpreting mathematical concepts, and only after learners have discussed and shared ideas with each other through language do they truly understand (Daniels & Anghileri, 1995).

According to Gates (2001), language in mathematics is an essential component to make it more "real" to learners, and this can be done through the context in which mathematics is taught. Students, through language, can think and talk mathematics and in this way the relevance and application of mathematics to real-life situations can be facilitated. Another important way that language is important in mathematics is through the use of word problems. "Without access to the appropriate aspects of the language of mathematics, pupils may be restricted to their use of strategies for thinking and for problem solving". (Daniel & Anghileri, 1995).

Language is an extremely important tool in mathematics, especially with Curriculum 2005 and Outcomes Based Education (OBE). According to Jaworski, (1994) language should be used as a tool in guiding the students' responses. In books one may find the use of symbols but when one

needs to share ideas and discuss or solve problems in groups, and then the need arises for language. According to Durkin and Shire (1991) "By expressing ideas in principled operations and numbers, surely the mathematician transcends the vagaries and pitfalls of everyday discourse." This becomes important when forming links with the real world. He says learners start and continue mathematics education in a language, as mathematics "advances".

Related Literature: Irujo Suzanne (2007) in her article found the difficulties through the research support when mathematics is being taught to English language learners. She came up with the following difficulties: 1. Vocabulary/semantics difficulties: Words with math meanings that are different from their everyday meanings (e.g., *set, point, field, column, sum, random, table, altogether, round, equals*) 2. Words or phrases that are "conceptually dense," in that they convey very complex meanings (e.g., *exponent, coefficient*) or combine two or more concepts to form a new concept (e.g., *common denominator, least common multiple*) 3. Multiple terms for the same thing (*add, sum, plus, combine, put together, increased by; subtract, decreased by, take away, minus, less, difference; multiply, times, product; divide, into, quotient*)

2. Vocabulary/syntax difficulties (understanding a concept is harder when the concept is made up of the relationship between two words):

1. All numbers *greater/less* than X
2. Mary earns *5 times as much as* John
3. Joseph is *as old as* Mary
4. Mary is 6 years *older* than John
5. *Twenty* (used as noun) is five times X
6. When 10 *is added* (passive) to X
7. *Two numbers, the sum of which* is 1
8. *Two numbers, whose product is 1, are reciprocals of each other*
9. *By what percent is 16 increased to make 24?*
10. *Divided by* versus *divided into*
11. Lack of one-to-one correspondence between symbols and words:
 1. *8 divided by 2* is not $8 \div 2$
 2. *The number a is 5 less than the number b* is not: $a = 5 - b$ (it's $a = b - 5$)

3. Discourse difficulties:

12. Logical connectors (*if... then, if and only if, because, that is, for example, such that, but, consequently, either... or*)

1. These may signal similarity, contradiction, cause/effect, reason/result, chronological sequence, or logical sequence

13. References of variables (variables are the *number* of things, *not* the things themselves)

1. *There are 5 times as many students as teachers in the math department* (the correct equation is $5t = s$, not $5s = t$)

2. *Three times a number is 2 more than 2 times the number* (*number* refers to the same number both times)

3. *If the first number is 2 times the other, find the number* (what do *first number, the other, and the number* refer to?)

14. Cultural difficulties (notation of division problems; use of periods and commas; units of measurement; use of fractions; application of rules versus analysis and problem-solving)

Another area of language difficulties that has received a good deal of research attention is word problems. Here are some of the difficulties it creates:

1. The language used in the problem is often more complex than it needs to be order to do the math.

2. The language lacks redundancy, so there are no repetitions or expansions, both of which help learners construct and corroborate meaning.

3. Word problems are either set in artificial contexts or lack context, which can create confusion.

4. If students don't fully understand the language that is used to describe the situation in a word problem, they will have difficulty connecting the mathematical operations to the situation.

5. Illustrations accompanying word problems often don't aid in the comprehension of the problem.

Ron (1999) developed the concept of "mathematized language," which can help explain why many ELLs progress well with the language of mathematics at first but then hit a plateau. This theory begins with everyday language, which is acquired naturally through social interaction. Mathematized language is similar to everyday language, but makes the mathematical concepts that are present in the everyday language explicit. Mathematized language can be used to help

build up mathematical language. Ron provides an example of how a child uses everyday language to talk about wanting to buy a doll but not having enough money. Through natural acquisition with some instruction, the child learns to state this in mathematized language, by saying how much money she has and how much the doll costs and asking how much more money she needs. This mathematized language makes the transition to the language of mathematics easier. The language of mathematics then allows the child to verbalize the fact that she has to add some unknown amount to the money she has (\$15) so it equals the price of the doll (\$22), and finally move to symbolic language: $15 + x = 22$. At each step in this process, the language of math must be more consciously taught and learned; if this does not happen, children will have difficulty reaching the stage of symbolic language.

Lena Licón Khisty (1991) observed a mathematical classroom why to better understand the language factors that hinder or promote the learning of mathematics by students whose first language is not the dominant language of instruction. The focus of the study was on discourse characteristics of the teacher since the premise is that it is the teacher who is the primary model of what is to be learned, enculturation of the subject matter, and engineer of effective learning environments.

The study was concerned with a very unique population of students. The study is based specifically on the observations conducted in two middle grade classrooms. The classrooms are in schools that have a significant population of Hispanic LEP and NEP students and are in the same district. Results of the study were: 1. the first is little mathematics was actually spoken. Although the classroom environment could be characterized as verbally active, the actual mathematics instruction could be characterized as almost silent. Little attention is given by teachers the mathematics register. Very few mathematical words or phrases were actually spoken regardless of whether fractions were taught in one classroom and decimals in the other. 2. Secondly, when it was spoken, it was not always correct, appropriate, or unambiguous, and it was not related to the development of meanings. The teaching of mathematics in these two classrooms can be characterized as being procedural with little or no development of concepts. Mathematics was spoken in a manner that required that students rely on their weakest ability in a second language, listening, and that put them at an additional disadvantage. Little Spanish was being used.

Frank tapson (1990) in his article places an extreme importance to language of mathematics .he viewed that it has helped maintaining the reputation of having so much precision that no other subject have. He draws attention to some of the words that can give rise to various difficulties for various reasons. He addresses the teachers need to be are and sensitive to the way we need and use language to convey meaning. Some of the examples arise while using the language of the mathematics are: 1. Different words are being used to what appears to be similar things. 2. two or more words are needed to differentiate between things which are different in themselves but which are a part of the same general topic/ 4. one mathematical word have different uses, 5. there are pair of words are difficult to distinguish because they refer to related concepts or objects which are connected in some way and confusion arises over which word applies to which thing. E.g. capacity and volume, deduction and induction. 6. Language in mathematics becomes unnecessarily complicated when compared with ordinary everyday language.

Kgomotso Gertrude Garegae (1989) explored students' competence in the vocabulary used in the junior secondary curriculum. Since mathematics instruction utilizes both ordinary and specialized mathematical language, we argue that second language learners, unlike their first language counterparts, face double jeopardy in a mathematics class. Eighty (80) students were asked to define, describe and/or give a pictorial representation of each word in the given list. The paper concludes that although mathematical and ordinary language have a high correlation of 0.70, students' better performance in the mathematics register suggests that language problems faced by L1 students may not necessarily be of the same nature as those faced by L2 learners. A convenient sampling strategy (Maxwell, 1996), was employed to select participants, Form 2 students, from two schools around the city of Gaborone. Classes chosen were to consist of students with a wide range of abilities to give a typical junior secondary school classroom in Botswana public schools. Words were taken from Year One and Year Two portions of junior secondary school mathematics syllabus. Twenty words with more than one meaning (used differently in OE and ME) were listed in Section A, and students were asked to (1) make a statement in ordinary English, (2) make a statement in mathematics English, and (3) to give a pictorial example(s) of each word, a symbol or a picture representation as shown below. The second section of the questionnaire (Section B) consisted of 20 composite words which have meaning only in mathematics. Students were asked to (1) describe each expression, and (2) to give a symbol and/or a diagram representing the expression. The questionnaire was given to 80

students (2 classes) and 91% were returned. After collection, the filled questionnaires were corrected to find the extent to which students knew the vocabulary used in the mathematics class. The results are summarized in the tables and bar chart below.

Findings showed that the performance of students on Section A of the questionnaire, the results were as follows: mathematics English and ordinary English had a strong correlation of 0.7023. Mathematics symbols have moderate correlation with both ordinary and mathematics register, with 0.4867 and 0.4895, respectively. From these results we cannot claim that being good in every day English guarantee that a student knows and understands mathematical language.

Robert E. Jamison (1989) in his paper focuses about the use of language as a tool for teaching mathematical concepts. He wanted to show how making the syntactical and rhetorical structure of mathematical language clear and explicit to students can increase their understanding of fundamental mathematical concepts. The use of language in mathematics differs from the language of ordinary speech in three important ways 1. It is nontemporal. There is no past, present, or future in mathematics. Everything just is. This presents difficulties in forming convincing examples. 2. Mathematical language is devoid of emotional content. 3. The third feature that distinguishes mathematical from ordinary language, One which causes enormous difficulties for students, is its precision. 4. Ordinary speech is full of ambiguities, innuendoes, hidden agendas, and unspoken cultural assumptions.

Sundar Sarukkai (2005) Mathematics is a unique discourse, as represented by its objects of discourse, discursive strategies and even in the way it 'uses' language. But there should be no doubt that the uniqueness of the discourse is not only due to a privileged symbolic system. Of course, mathematics uses symbols as part of its discourse and creates a rich narrative on these symbols and operators. The central role of the = sign is also an essential difference between this and other discourses. Because of the overwhelming presence of symbols, the specialty of mathematics has been mistakenly attributed to these 'non-linguistic' symbols. This has led to discourses attempting to mimic the mathematical one primarily by appropriating the suspicion of language and attempting to rewrite the discourse in symbolic notation. At the outset, it can be stated that mathematization does not have to do only with appropriating mathematical equations and techniques. It is the engagement with language manifested in its symbolic domain that suggests the uniqueness of the mathematical discourse. From this it follows that one can conceivably have mathematized discourses without it being visibly symbolic

Abraham Arcavi (2001) viewed that Students of mathematics have to juggle with at least three mathematical languages: rhetoric, symbolic and graphical. Each of these languages have distinct characteristics and can be used in different ways to support, or to alienate, sense-making. How can insights into the nature and characteristics of these languages enlighten mathematics education in all its branches – curriculum development, the practice of teaching, research on learning, teacher education.

Method: For the purpose of the study, subjects were selected from 15 public schools of North Delhi. The public schools were selected on convenience basis. Two teachers from each school were selected by the investigator for the study. A questionnaire was developed to find out the problems faced by the mathematics teachers in their teaching. . The teachers were given questionnaires related to problems faced by them in mathematics teaching with a short verbal briefing of the topic under study.

Results and Findings: The role of language in mathematics depends on one’s view of its nature. When mathematics is referred to as a language, it is talked about as a means of communicating or conveying ideas. Mathematics is viewed as symbolic in nature and thus not hindering its comprehension by second or third language speakers. Others argue that language does play a role in interpreting mathematical concepts, and only after learners have discussed and shared ideas with each other through language do they truly understand (Daniels & Anghileri, 1995:102).

Table : Problems faced by teachers in language of mathematics

Problems	Responses	
	Yes	No
Teaching mathematical terms which have nonmathematical Usage	13 (43)	17 (57)
Teaching concepts which have more than one meaning in subject itself	14 (47)	16 (53)
Explaining word problems	18 (60)	12 (40)

An overview of the above table shows that 53% of the teachers don’t face problems in teaching those mathematical terms which have non- mathematical usage, while 43% of the teachers feel

that these terms cause problems in their mathematics teaching. When asked about the examples where the problems were faced, the investigator listed the following areas:

1. Terms like 'example'
2. Terms used in mathematical reasoning.
3. Verbally when we say sum or difference as terms with young children, it causes difficulty in understanding for students.
4. In Euler equation there is difficulty in giving examples of definition or to explain them.

With reference in teaching of concepts which have more than one meaning in the subject itself, 47% of the teachers do consider it as a problem that affects their mathematics teaching. On the other hand the problem is not been viewed as affecting their teaching by 53% of the teachers. Some of the teaches following examples of such concepts-

1. Inverse
2. Terms in geometry
3. Pyramid

Language of mathematics especially word problems are found difficulty by majority of teachers. This is evident from the above table where 60% teachers faced problems in teaching word problem to students while 40 % of teachers don't feel it as a problem. When asked about where the teachers felt the problems, following reasons were enlisted by the investigator-

1. Language is not student friendly
2. Concept learning is not ward based and terms with multiple usage cause problems in smaller classes.
3. Sometimes students don't understand what kind of question they should ask and what kind of answers they should give.
4. Problems related to variables
5. Students commit mistakes in writing many time as they are not bale to comprehend
6. Students get confused in unless than and greater than symbols.
7. When the students are not able to draw relation between unknown and given values especially linear equation, they face problem in establishing relation between them
8. Framing relations in linear equations in one two variables. Learners are unable to visualize due to which they lose understanding of the meaning conveyed by a particular word problem as in surface area and volume.

Apart from the above problems, other problems faced by teachers in mathematical language are:

1. The question of mensuration is difficult and calculating of different values at different times.
2. Problems related to L.C.M and G.CD, 2-d and 3-D.
3. Units in volumes, areas and circumference
4. In mathematics student know formula of mathematics but how should they implement them, they never know
5. Even after having lots of practice students are not able to solve problems independently
6. Although the difference in the usage of mathematical terms and their routine usage is clarified, there is tendency to fall back.
7. Students are generally confused between necessary and sufficient conditions. They take definition and properties as the same thing
8. A teacher commented “ we are able to explain the problems but when it comes to students to read and understand the problem, the answer in most cases comes out as ‘ mam we got confused’ how to make them understand word problems on their own is the problem being faced”

Conclusion: Teachers hold an importance place in a school. It is the efforts of teachers that can determine the direction of success of teaching learning situation. Thus, if we want to improve situation of mathematics education in the country, problems faced by teachers in teaching must be taken into consideration. This will help to organize better conditions and situations ensuring success in mathematics education

Teachers faced problems in mathematical language as it was found difficult to comprehend by the students. Teachers also faced in explaining word problems to students.

The present study will provide an insight to curriculum developers and textbook writers to make the curriculum interesting and related to students life. Teachers must take special attention regarding the use of mathematics language while dealing with the students.

References:

- Arcavi, A. (2009). The Languages of Mathematics. Paper presented at Episteme, 3rd International conference to review research on Science, Technology and Mathematics Education, India <http://cvs.gnowledge.org/episteme3/abstracts.php>
- Best, John W., Kahn, James V. (2006). Research in Education. New Delhi: Prentice Hall of India

- Buttsworth, R.N (2001, July). Problems and solutions in mathematical education - a spectrum extremity. Proceedings of ASET-HERDSA 2000 Conference, Toowoomba. <http://www.aset.org.au/confs/aset-herdsa2000/procs/buttsworth.html>
- Irujo, Suzanne (2007, March). Teaching Math to English Language Learners: Can Research Help?
- MHRD (1986). National Policy on Education-1986, Government of India.
- Mon Chiew Chin, Sam Chap Lim (2005, December). Using Lesson Study Process to Enhance Mathematics Teacher's Content Knowledge and Teaching Practices. Paper presented at the International Conference on Science and Mathematics Education (CoSMED), organized by RECSAM.
- N,CERT (2005). National Curriculum Framework for School Education. New Delhi: NCERT
- NCERT (2005). National Focus Group on Teaching of Mathematics. New Delhi: NCERT.
- Tapson, F (2000). The Language of Mathematics. International Journal for Mathematics Teaching and Learning. ISSN 1473 – 0111, 1-4
<http://www.cimt.plymouth.ac.uk/journal/ftlangm.pdf>