The Role of the Language of Mathematics in Students' Understanding of Number Concepts in Eldoret Municipality, Kenya

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Abstract

This study set to examine the proficiency of students in using mathematical terminology and the related concepts. The need to carry out the study arose from the concern by the Kenya National Examinations Council (KNEC) and the general public over the perennial poor results in mathematics. Therefore, the objective of the study was to investigate the extent to which meanings of some mathematical terms are understood and/or confused by students for whom English is a second language in Eldoret Municipality, Kenya. The basis for the study is the constructivist theory by J. Bruner and the cognitive flexibility theory of R. Spiro, P. Heltovitch and R. Coulson which advocates for teaching learners to construct their meanings of mathematical terms. The descriptive survey utilized written tests as the main data collection instrument. The target population was standard eight pupils within Eldoret Municipality. Public schools were ranked according to performance in last year's KCPE results. Systematic random sampling technique was used to sample out 9 of the 34 public schools. Simple random sampling was then used to select a study sample of 270 pupils. Data analysis involved the use of both descriptive statistics such as the frequencies and the means and inferential statistics. The Analysis Of Variance (ANOVA) was used to test the hypotheses. The findings of the study showed that students have difficulties in using mathematical terms and the related concepts. Suggestions of possible ways of teaching these terms so as to generate more meaning to the learners were also made. The study could assist mathematics teachers, curriculum planners, and textbook authors to deal with the challenges that learners face in understanding mathematical language as a contributory factor to performance in the subject.

Keywords: Role, Mathematical Language, Students, Understanding, Number Concepts, Eldoret Municipality, Kenya

1. Introduction

The teaching and learning of mathematics, like any other subject, requires that both the teacher and learner communicate effectively. In Halliday's (1988) view, learning language involves 'learning how to mean' and hence the language of mathematics involves learning how to make and share mathematical meanings using language appropriate to the context, which is more than recognizing and responding to words in isolation. This in turn demands the use of appropriate language (words and symbols) whose level of difficulty is suitable to the cognitive abilities of the learners concerned. Communicating mathematical ideas so that the message is adequately understood is difficult enough when the teacher and learner have a common first language, but the problem is acute when their preferred languages differ. A number of studies have clearly indicated that a student's command of English plays a role in his/her performance in mathematics. Souviney (1983) has tested students in grades 2, 4 and 6 with various language and mathematics instruments on eight measures of cognitive development. His results showed that English reading and Piagetian measures of conservation highly correlate with mathematical achievements.

The primary function of language in mathematics instruction is to enable both the teacher and the learner to communicate mathematical knowledge with precision. In order to realize the objectives of mathematics instruction, teachers and textbook authors need to use a language whose structure, meaning, technical vocabulary and symbolism can be understood by learners of a particular class level. The communication of meaning frequently involves interpretation on the part of the receiver and this should warn us that messages could be given incorrect interpretations. Donaldson (1978) suggests that:

When a child interprets what we say to him, his interpretations are influenced by at least 3 things ... his knowledge of the language, his assessment of what we intend (as indicated by our non-linguistic behaviour) and the manner in which he would represent the physical situation to himself.

Some of the words and symbols used to communicate mathematical ideas can sometimes be misinterpreted by learners in their attempt to imitate their teachers. Pimm (as cited in Muhandiki 1992) has reported that apart from determining the patterns of communication in the classroom, the teacher also serves as a role model of a 'native speaker' of mathematics. Hence the learners' search for the meaning of whatever they hear can sometimes lead to wrong conclusions. An instance of the learners' tendency to change (though not deliberately) the meaning of mathematical words into what they think the teacher intended to say has been reported by Orton (1987) as follows:

A kindergarten teacher drew a triangle, a square and a rectangle on the blackboard and explained each to her pupils. One little girl went home drew the symbols and told her parents: 'this is a triangle, this is a square and this is crashed angle'.

This observation shows that the little girl's interpretation of 'rectangle' as 'crashed angle' exemplifies a situation whereby the child has a correct symbolic representation of a concept whose technical term she cannot produce due to linguistic problems. The performance in mathematics has been relatively poor despite the national efforts made in developing a curriculum that is appropriate to the needs of Kenya as a country. Towards this end, in 1998 the Government through the Ministry of Education Science and Technology (MoEST) and the government of Japan initiated a technical co-operation project known as SMASSE in Kenya. The whole idea is premised on the realization that the quality of classroom activities is critical for effective teaching and learning of mathematics.

Studies carried out on factors that affect mathematics achievement in Kenya at primary level (Kafu, 1976; Muriuki, 1991; Munguti, 1984; Omwono, 1990; Eshiwani, 1987) are silent on the role of language in mathematics instruction. Most of these studies have looked at factors such as: the Qualification of teachers; Time spent in lesson preparation; Teaching methods; Frequency of supervision; Students' and/or teachers' attitudes towards mathematics; Availability and use of media resources; Teaching experiences; Class-sizes, and In-service training. This paper explores the difficulties encountered by students in using mathematical concepts relating to numbers concepts.

Studies carried out with learners for whom English is a first language have shown that learners have difficulties in using mathematical terms. Pimm (as cited Muhandiki (1992) observes that:

It is common place to hear a teacher ... asking pupils if they have understood the meaning of a certain word, and possibly trying to test their understanding of it by requesting either a formal definition or a paraphrase of its meaning!

It is, however, important for teachers to realize that the process of learning definitions of mathematical terms can be complicated by the abstract nature and the consequent difficulty of the words used to refer to them. Since students can find it difficult to comprehend the meaning of some terms even after they have been defined, the teacher ought to discuss various meanings and interpretations of words and phrases so that each becomes aware of what the other means and understands by particular linguistic forms. Further, Dickson *et al*. (1984) have asserted that:

... many specialized terms have an essential and rightful place in mathematics and it is necessary that they are incorporated into the learning and teaching of the subject.

From the foregoing, it can be seen that language is critical to many of the processes of learning and instruction, and it confers many benefits in terms of enabling us to articulate, objectify and discuss the problems which the field of mathematics presents. Yet language brings its own rules and demands, which are not always in perfect correspondence with the rules and demands of mathematics; it presents ambiguities and inconsistencies which can mislead and confuse.

1.1 Statement of the Problem

For many people, the mention of mathematics is met with downcast eyes (Tankersley, p. 12, as cited in Too, 1996). The fear of mathematics is learnt somewhere around 4^{th} grade (ibid.). In Kenya, this problem starts in the upper classes at the primary level (standards 7 and 8) and becomes acute at the secondary level (forms 2 and 3) (Eshiwani, as cited in Too, 1996). This has resulted in dismal performance in the subject which has persisted over the years.

In fact, the performance in the subject at the KCSE level has been estimated on average to be below 20 percent. The problems developed by learners at the primary level are at times carried over to the secondary level as reported by the KNEC:

Some of the weaknesses in the KCSE exam should have been discovered in the lower classes and remedial action taken. The fact that these weaknesses have persisted for a long time requires drastic changes in the teaching of mathematics (KCSE Math's Report, 1990, p. 31).

This is exemplified by the following question which was performed poorly in the KCSE exam:

A train moving at an average speed of 72km/h takes 15 seconds to completely cross a bridge that is 80 m long.

a) Express 72km/h in metres per second.
b) Find the length of the train in metres.

The concept of distance, time and speed taught in upper primary and form 1 was being tested. However, many candidates were unable to do the conversion and relate the three variables to find the length of the train, prompting the council to add that:

The most glaring weakness is that of the learners' lack of knowledge in elementary techniques and their ignorance of simple algorithms and processes ... it is extremely worrying that inability to perform basic processes as multiplication and division is common feature in candidates work (KNEC Report, 2004, p. 45).

It is clear that issues on the role of language in mathematics instruction have not been dealt with, yet research done in other countries shows that learners have difficulties with the language of mathematics (Muhandiki, 1992). This suggests that if the teacher tries to force new ideas that cannot be related to those already learned and mastered, the new ideas can only be learned by rote and remembered in arbitrary and disconnected manner.

1.2 The Role of Language in Mathematics Instruction

The primary role of language is to enable both the teacher and learners to share mathematical knowledge with precision. A teacher needs to use the language which is suitable for the cognitive development of learners. According to Ishumi (1994), language is a powerful instrument in the formation of concepts, acquisition of particular perspective abilities, and the transfer or communication of such concepts. Klein (1998) argues that language serves three important functions: first, language allows people to communicate with each other; second, it facilitates the thinking process, and third, it allows people to recall information beyond the limits of memory. This assertion shows that language is not only important for communicating meaning but also because it facilitates thinking. The language used for thinking is most likely the first language, thus mathematics communicated in one language might need to be translated into another language to allow thinking and then translated back in order to converse with the teacher. Errors and misunderstanding might arise at any stage of this two-way inner translation process (Orton, 1987).

Berry (1985) compared the progress in mathematics by a group of University students in Botswana and a similar group of Chinese University students in Canada. The former group claimed they had to do all their thinking in English because their own language does not facilitate mathematical proofs. Hence, they did not find this easy. The Chinese students, on the other hand, claimed that they carried out their proofs in Chinese and then translated back to English, and they were able to do it successfully. Thus, the conclusion that more severe problems would probably be attributed to students trying to learn mathematics through the medium of an unfamiliar language which is very different from their own.

Gagne (1970) classifies concepts into 'defined concepts' and 'concrete concepts'. According to him, a teacher is required to know what the learner needs in order to learn new concepts. A child is ready for a new concept when all the sub- concepts that are prerequisites to the concept are mastered. He suggests that children learn an ordered additive sequence of capabilities, and each new capability being more complex than the prerequisite capability on which it is built.

Dienes (1960) believes that mathematical concepts are properly understood only if they are presented through a variety of concrete, physical representations. He classifies these concepts as pure mathematical concepts, notational concepts and applied concepts. His systems of teaching emphasized mathematical laboratories where he commended the use of MAB to provide suitable early learning environment enabling the construction of place-value concept. He postulated 6 stages through which the teaching of mathematical concepts must progress. These are: free play, playing games, searching for communalities, representation, symbolism, and formalization.

Ausubel (1960) expressed the same view that concept development proceeds best when the most general, most inclusive elements of a concept are introduced first then the concept is progressively differentiated in terms of detail and specificity. Choat (1974) stresses the close interdependence of language and conceptual development by stating that:

Even if the learner interacts with the physical aspects of the learning situation i.e. objects, the verbal element is necessary both as a means of communication and as an instrument of individual representation '" in the acquisition of mathematical knowledge, a new conception, a child will not understand the word: without the word he cannot as easily assimilate and accommodate the concept (p. 11).

This reflects the views of psychologist Vygotsky (1962), that thought and language are interdependent. Further Piaget in his later work accepted that there might be a parallel development in the linguistic and cognitive strategies for making sense of the world.

The acquisition of language and concepts is a dynamic process. The child's understanding and use of language varies with the involvement of the child in the situation in which it is used, and the relevance it holds for him. Thus, it is essential that the child and teacher discuss various meanings and interpretations of words and phrases so each becomes aware of what the other means and understands by particular linguistic forms. Pimm (as cited in Muhandiki, 1992) observes that:

It is commonplace to hear a teacher ... asking pupils if they have understood the meaning of a particular word, and possibly trying to test their understanding of it by requesting either a formal definition or a paraphrase of its meaning! (p. 69).

However, it is important for teachers to realize that the process of learning definitions of mathematical terms can be complicated by the abstract nature of some, and the consequent difficulty of the words used to refer to them. Since students can find it difficult to comprehend the meaning of some terms even after they have been defined, the teacher ought to provide suitable learning experiences through which students can generate their own definitions. Blandford is reported (in Harvey *et al*., 1982) to have deplored the practice of giving students ready - made definitions by noting that:

To do this is ... to throw away deliberately one of the most valuable agents of intellectual discipline. The evolving of a workable definition by the child's own activity stimulated by appropriate questions is both interesting and highly motivational (p. 85).

Further Dickson *et al*. (1984) have asserted that:

... Many specialized terms have an essential and rightful place in mathematics and it is necessary that they are incorporated into the learning and teaching of the subject (p. 332).

1.3 Mathematical Concepts Associated with Number Properties

The concepts associated with number properties whose understanding by students were investigated in the study were: 'square of a number', 'square root', 'even', odd', 'prime numbers', 'divisor', 'factor', 'multiple'. Otterburn (1975); Nicholson (1977) and Muhandiki (1992) have reported students' difficulties with the concepts of 'multiple', 'factor', 'prime number' and' square root'. Students' responses to the test items revealed several confusions, hence lack of understanding of the use of each term, and the distinction between them. With respect to the word 'multiple', Otterburn and Nicholson (1976) report that the test item was poorly attempted; not so much in the number of blanks but in the very large number of confused responses:

... those who did not muddle it thought it was a misprint or synonym for 'multiply' and others thought it meant 'factor'. Of the 103 muddled responses, 85 muddled with' factor' (p. 19).

These issues raise the question of whether or not the teaching of the corresponding terms is done through definitions, examples (relevant and non-examples) or a combination of both. It would be appropriate for the teacher to plan suitable learning activities for learners so that they can generate their own 'workable' definitions of such terms instead of being given strict definitions, which is likely to lead to confusion. This also occurs when a term is defined differently by different authors. Orton (1987) has made a similar observation noting that:

We all know what a triangle is, but do we know what a natural number is? ... to many professional mathematicians the natural numbers are: 0, 1, 2, 3, --- The definition of prime numbers at one time included the number '1' and may still do for some people, but nowadays most definitions ... exclude the number '1'.

The study, therefore, sought to determine the extent to which pupils understand the terms associated with the number properties.

1.4 Limitations of the Study

The study confined itself to the investigations of students' understanding of some mathematical terminology and related concepts. It was conducted in public primary schools within Eldoret Municipality. The population of the study was standard eight pupils from the selected primary schools. The findings however apply to all schools in Kenya since the methods and content of mathematics teaching/learning are the same.

2. Materials and Methods

This study was carried out in public primary schools of Eldoret Municipality, Kenya. Eldoret is a town in Western Kenya and the administrative centre of Uasin Gishu District of Rift Valley. Lying south of the Cherangani Hills, the local elevation varies from about 2100m above sea level to more than 2700m in the nearby areas.
A descriptive survey design was adopted in the study. The study was confined to standard eight pupils from public primary schools. Eldoret Municipality has a total of 51 primary schools with examinable classes, out of which 17 are private schools and 34 public schools and a sample of 9 schools was selected from the 34 public schools using systematic sampling technique. This constituted 26.5% of the school population. These schools were serialized 1-34 in order of performance in previous year's exams, giving a sampling interval, K= 4 (34/9 = 3.7, which was approximated to 4). The first school was drawn randomly (random start), then every 4th school was subsequently selected to obtain the required sample. Simple random sampling was then used to select a study sample of 270 pupils from an approximate of 2750 pupils. This represented 10% of the pupils' population.

The written tests were used because they provide insights into the difficulties pupils face when using mathematical concepts and terminology. They were considered appropriate since they are the most commonly used learning assessment methods and exposed pupils' difficulties in this topic. The written tests were on basic concepts of area and perimeter, number properties, fractions and arithmetic operations. In order to ascertain pupils' difficulties in using mathematical terminology and the related concepts, parallel tests were given on the same concept and results analyzed using descriptive and inferential statistics. This involved the use of percentages and means as descriptive statistics and Analysis of Variance (ANOVA) was used to test the hypothesis. Pupils' responses were scored to determine the number of those who got wrong and correct responses to the test items and those who did not attempt the questions. Frequencies and percentages of certain specific difficulties detected during scoring was coded from pupils work and analyzed. Two-way ANOVA with fixed levels at 5% level of confidence was used to test the hypothesis.

3. Results and Discussion

3.1 Concept of Even Numbers

The good performance (66.3% success) in the responses to the concept of even numbers suggested that the meaning of even number is well understood by most students. However, the students who gave 8 (2.2%) and 6 (3.0%) may not have considered the clause 'bigger than 10'. Furthermore, the students who gave 11, 9, 5 and 13 as an example of an even number bigger than 10 might have confused 'even' with 'odd' or 'prime' numbers. The good performance may be attributed to the fact that division by 2 is learned much earlier than the other divisibility tests which make it more meaningful and easier to apply than the others.

The students' performance on the parallel test further showed that although 59.6% of them correctly interpreted the words ‘number double some whole number’ in the context of even numbers, some gave wrong responses such as 5, 11, 13, 15, 17 which shows confusion with 'odd' and/or 'prime' numbers. The latter observation suggests an example of a technical term (even), which seems to be more meaningful to students than the corresponding ordinary English words.

In addition less than half (41.1%) produced the expected term 'even', 55.2% gave confused responses, and 3.7% gave no response. This is a sharp contrast with the high success rates reported in the preceding results above. This, therefore, suggested further that there appear to be no suitable colloquial words that can be used to give a concise definition of the concept of 'even number'. Thus, a response like 'prime' and 'odd' instead of 'even' imply the students (19.7%) inability to distinguish between the two concepts.

From the foregoing, we can conclude that to most students, success in the production of the term ‘even’ implied success in the interpretation of the corresponding colloquial expression which in turn implied success in the use of the same term.

3.2 Concept of Odd Numbers

Unlike even numbers, the concept of the odd numbers appeared not to be well understood by most students (50.7%). This suggested that the students confused both the terms 'odd' and the words 'bigger than 10'. This was evidenced by the responses such as 130, 12, 14, 20 and 18 which show that the affected students could not differentiate between even numbers and odd numbers. Responses such as 8, 7 and 5 (9.6%) implied that students, did not take into consideration the terms 'bigger than 10'. However, the absence of and/or unfamiliarity with the concept of an odd number was also shown by the fact that 5.9% of the students gave no response.

Similarly, like the colloquial expression for ‘odd’ numbers, the words 'number not double any whole number' appeared not to be well understood as the term 'odd'. This was shown by the fact that less than half 43.3% of the students correctly interpreted the term ‘odd’ did not only incorrectly interpret its colloquial expression but also the condition bigger than 10. This observation was reflected in responses like 100, 22, 12, 5 and 9.

The students' inability to produce the term ‘odd’ was reflected by their poor performance (40.4% success) on the relevant item on the test. The response 'even' suggested that the students (17.0%) probably overlooked the condition 'not double' and paid attention to the word ‘double’. The response 'uneven' suggested the students' interpretation of the given example in terms of a number that is not even but in the absence of the technical term odd produced the ordinary English antonym for 'even', which is not meaningful in the mathematical sense. Similarly, the response 'prime' implied that the students (13.3%) were probably guided by the fact all primes bigger than 10 are not double any whole number thereby implying that odd numbers like 15 and 21 were not considered. The other meaningless responses suggested that the given example of an odd number was interpreted in the ordinary English meaning. The students' performance on this item implied that to most students, success in the production of the term ‘odd’ meant success in the interpretation of its colloquial expression which in turn led to success in the use of the same term.

3.3 Concept of Prime Numbers

The students’ performance on the items of prime numbers showed that whereas at least 50% of them correctly interpreted the terms 'even' and 'odd', only 32.2% did the same for 'prime'. The various wrong responses showed that 43% of the responses were given as 'odd' numbers. This implied the students' inability to distinguish between odd and prime numbers probably because the latter (except 2) are a subset of the former. Furthermore, the response '9' suggested that the affected students not only confused prime with odd number but also overlooked the condition 'bigger than 10'. The responses 7 and 5 also implied the same.

The students' performance further indicated that 58.2% of them correctly interpreted the colloquial expression for prime number. However, the condition only in the phrase 'divide exactly by itself and 1 only' appears to have been ignored or misunderstood by the rest of the students. Thus, the observation (11.8%) of students who gave responses that were non-prime odd numbers suggested that the affected students were unaware that those particular responses had other factors. The response '5' and '7' indicated that the condition 'greater than 10' was ignored.

The students’ poor performance on the parallel test showed that whereas 21.1% of them produced the term ‘prime’ from the given example, the response ‘odd’ (by 30% of the students) is additional evidence to the earlier observation that the distinction between the two terms may not be grasped by many students. Similarly, responses such as 'unlucky' and 'good' indicated the students’ (4.4%) interpretation of the given example in the colloquial sense. The students' performance on this item therefore suggested that to most students, success in the production of the term prime implied success in its use, which in turn implied success in the interpretation of its colloquial expression.

3.4 Concept of Factor of a Number

The students’ good performance (75.9% success) on the item testing their understanding of the concept of factor of a number indicated their correct interpretation of factor as a number ‘whose product with another number is given number’. However, absence of 1 and 21 among all the responses meant that no student realized that 1 is a factor of every number also every number is its own factor.

The wrong response 42 may be attributed to the fact that since factor is often encountered in the content of multiplication, the students (4.1%) might have interpreted factor of 21 as the product of 21 and another number, say 2.

The students' performance further suggested that the words 'multiplied exactly' are more meaningful (91.1 % success) than the term factor (75.9% success). However, as was also noted above, no student gave 1 and 21 as an example of a number, which can be 'multiplied exactly' to give 21 thus suggesting the possibility of some students assuming the presence of non-existent restrictions.

The students' dismal performance moreover showed that only 4.8% produced the term 'factor' from the given example. The fact that the students who were successful could not produce the term factor indicated that the latter is less meaningful than its colloquial expression. Further, the high response of the terms 'multiple' (24.4%), 'product' (11.1%), and 'multiply' (4.4%) may be attributed to the s multiplication connotation that it may have conveyed to the students. Similarly, the response 'square' implied the students' (11.9%) interpretation of the words multiplied exactly as multiplied by itself suggesting the linguistic difficulty of the former.

The students' performance on this item therefore indicated that to most students, success in the production of the term factor implied success in its use which in turn meant success in the interpretation of the corresponding colloquial expression.

3.5 Concept of Divisor of a Number

The students' performance on the item dealing with the concept of the divisor of a number showed that most of them (80.0%) correctly interpreted the term 'divisor'. In particular, the responses 'l' and '15' suggested that the affected students' knowledge of the fact the 'l' and any number are divisors of the latter. However, the responses '30' (5.9%), '125' (2.7%) and '225' (2.2%) indicated students' possible interpretation of 'divisor' as 'multiple'.

The students' performance further showed that, unlike 'factor' the colloquial equivalent of 'divisor' was less meaningful to students (69.6% success) than the term itself (80.0% success). Thus, responses such as '30' (11.1 %), '225' (7.4%) and '45' (4.1%) suggested that the students interpreted the words 'divides exactly' into as 'divided exactly by' hence writing its multiple. Further, 3.0% returned blank responses.

The students' performance also showed that 44.1% of them produced the term 'divisor' to the given example. However, the wrong response of 'multiple' may be attributed to the students' (19.3%) possible interpretation of the words 'divides exactly into' as 'it divided exactly by'.

The performance on the parallel item generally indicated that, to most students, success in the production of the term 'divisor' (or its alternative) implied success in the interpretation of its colloquial expression which in turn implied success in the use of the same term.

3.6 Concept of Multiple of a Number

The students performance on this item showed that 59.6% of them gave correct examples of 'multiples of 4 bigger than 10'. However, although '8' and '4' are multiples of 4, its production suggested the students' (7.l %) misinterpretation of the words 'bigger than 10'. Furthermore, the absence of and/or unfamiliarity with the concept of 'multiple' may have led to responses like' 5', '6', '11', '14' and '3'.

The students' performance further showed that the colloquial expression of the term 'multiple' appeared to be more meaningful (77.0% success) than the term itself (59.6% success). Some rough working on the test scripts (e.g. 'times 4', 'number x 4') suggest that the word 'times' in the test item may have contributed to the correct interpretation of the words' several times 4'. However, the wrong responses of '3' (7.4%), '14' (5.9%), '19' (3.7%) indicated the students' possible literal interpretation of the words 'several times 4' as 'bigger than 4'.

The students' inability to produce the term 'multiple' from the given example was reflected in their performance (19.6% success). However, a noticeable characteristic in the wrong responses with highest frequencies was their association with the concept of 'multiplication'. Thus, as was mentioned in the preceding paragraph, if the word 'times' guided students in the production of their responses, then, in the absence of what was probably a more abstract term 'multiple' the wrong responses 'multiply', 'multiple', multiplication', 'times' and 'product' were given.

The performance on this item generally suggested that, to most students, success in the production of term 'multiple' implies success in its use which in turn implies success in the interpretation of the corresponding colloquial expression.

3.7 Concept of Square of a Number

The performance on this item showed that less than half of the students (47.0%) correctly interpreted the concept of 'square' of a number.

However, the response of '2' given as the 'square' of '4' suggested that the students' (39.3%) confusion of the latter as 'square root' of '4'. Similarly, the response of '8' suggested the students' (10.0%) interpretation of 'square of 4' possibly as 'multiple of 4' or 'double 4'

The students' performance further showed a remarkable improvement (78.2% success). This meant that the colloquial expression of the square of a number is more meaningful than the concept itself. However, the responses of '4', '8', '12', '20' and '24' suggested that the students (21.9%) interpreted the words 'multiply by itself' as 'multiple of'.

The students' performance further showed that, with the exception of 34.4% of them who produced the expected term 'square', the rest either gave confused or gave no responses. For instance, the responses 'multiply' and 'product' suggest that in the absence of the required technical term, the students (14.4%) were probably influenced by the word 'multiply' in the test item. Similarly, although the response 'multiple' makes the given statement mathematically correct, its production suggested that the students (12.6%) did not understand the two parts of the item. The response 'square root' suggests the students' (21.5%) inability to distinguish between the colloquial expression for 'square' and 'square root' of a number.
The general performance on this item indicated that to most students, success in the production of the term 'square' implied success in its use, which in turn implies success in the interpretation of its colloquial expression.

3.8 Concept of 'Square Root' of a Number

More than half of the students (66.7%) correctly interpreted the term 'square root' while the rest gave either confused or no responses to the item. For instance, the response '81' given as 'square root of 9', suggested the students' (19.3%) interpretation of the latter as the 'square of 9'.

The fact that a similar confusion between 'square' and 'square root' was noted earlier, suggested further that the distinction between the two concepts is unclear to some students. Similarly, whereas the responses of '18' suggested students' (5.9%) interpretation of 'square of 9' as 'double 9', the responses of '$4^{1}/_{2}$' (4.4%) further suggested that 'square root of 9' was interpreted as 'half 9'.

The students' improved performance on further probing suggested that colloquial expression for the term 'square root' is more meaningful than the term itself. However, the wrong responses of '81', '18' and '9' indicated that the words number which can be multiplied by itself…'were probably interpreted as 'number obtained when 9 is multiplied by itself, '2' and '1' respectively.

The students' performance also revealed some confusion similar to those mentioned above. For instance, production of 'square' instead of 'square root' suggested the possibility that the students (25.9%) might have thought it was the needed answer since its replacement in the second part of the test item statement makes the latter true which implies the first part was ignored. Similarly, the response 'multiple' suggested that the students' (8.9%) either interpreted or read the statement: '3 is called the…..of 9' as '9 is called the……..of 3'.

The performance on this item in general revealed that to most students, success in the production of term' square root' implied success in its use which in turn implies success in the interpretation of its colloquial expression.

3.9 Concept of 'Cube' of a Number

With the exception of 12.2% of the students who correctly interpreted the term 'cube', the rest gave either confused or gave no response. For instance, the responses of '16' given as the 'cube of 4' suggested that the students' (35.9%) interpretation of the latter as the 'square of 4'. Similarly, the response of '12' resulted as the students (26.7%) multiplied 4 by 3 instead of multiplying 4 by itself thrice. Further, responses of '2' and '8' suggest the interpretation of' cube of '4' as the 'square root' and multiple of 4 by 13.3% and 10.0% of the students, respectively.

The students' performance further suggested that the colloquial expression for the term 'cube' is more meaningful than the term itself. However, the wrong responses of '12' and '16' suggest that the words 'number which can be multiplied by itself 3 times' were probably interpreted as 'multiplied by 3' and 'multiplied by itself, respectively.

The performance also showed that, with the exception of 8.5% of them who produced the expected term 'cube', the students either gave confused or not responses.

For instance, the responses 'multiple' makes the given statement mathematically correct; its production suggested that the students (30.0%) did not understand the connection between the two parts of the item. The responses 'square' and 'square root' indicated that the students (20.1 %) are unable to distinguish between the colloquial expressions for 'square', 'square root' and 'cube' of a number. The general performance thus revealed that to most students success in the production of the term 'cube' implied success in the interpretation of its colloquial expression which in turn implies success in the use of the same term.

3.10 Concept of 'Reciprocal' of Number

The students' performance on this item showed that only 16.7% were able to write correctly the reciprocal of 5. However, the wrong responses such as 25 indicated that some students' (36.3%) interpreted the ‘reciprocal’ as the 'square’ of 5. Similarly, responses of '10' and '2½' suggested that to the affected student, 'the reciprocal of a number' implied the number multiplied by '2' and ½, respectively.

The students' performance, though still below average, revealed that the colloquial expression for the term 'reciprocal' is more meaningful than the term itself. However, the wrong responses of '1', '5', '25' and '10' suggested that the words 'number when multiplied by 5 gives 1. .. ‘were probably interpreted as 'number obtained when 5 is multiplied by: '1', '5', and '2', respectively.

The students' performance also showed that only 7.0% of them produced the required term reciprocal from the given example. The fact that 5.2% of the students returned blank responses and another 47.8% gave meaningless responses like 'fraction', 'half', 'divisor', 'odd', '25' suggested that the term 'reciprocal' may be too abstract hence missing from their mathematical registers. The same could be said of the responses 'multiple' and 'product', although their selection may be attributed to their descriptions in term of 'multiplication'.

The students' performance on this item in general indicated that to most students success in the production of the term 'reciprocal' implied success in its use and the latter in turn implies success in the use of the corresponding colloquial expression.

4. Conclusion

The analysis of the responses to the written test items presented above has shown that difficulties associated with the learning and use of mathematical terminology and the related concepts may be attributed to either student's inadequate grasp of the language of mathematics or the fact that some terms cannot be expressed explicitly in ordinary language. However, since the students' greatest difficulties relate to the production of the technical terms, it seems that the latter are either avoided during mathematics instruction or they are not linked to the ordinary English expressions.

Although the terms 'factor' and 'divisor' have the same meaning, the latter is not used in the primary math's books while the former is seen in terms of division than multiplication as the following examples illustrate:

15 can be divided exactly by 3; hence we say 3 is a factor of 15
3 is a factor of 30; when you divide 30 by 3, you get 10

It would be more appropriate if such examples were given with respect to the term 'divisor' so that the corresponding examples for 'factor' would be as follows:

3 can be 'multiplied exactly' to give 15; hence we say 3 is a factor of 15.
3 is a 'factor' of 15; when you 'multiply' 3 by 5, you get 15

Therefore, the non-use of the term 'divisor' in the booklets may also have contributed to the production of 'factor' (instead of divisor) by several students in the present study. The simultaneous use of the two terms can make students realize that they have the same meaning.

Furthermore, the concept of factor as described above is applied when performing divisibility tests, leading to the concept of 'prime' number. Thus, a 'prime' number is defined as a 'number, which has no other factors except itself and '1'. It is, however, evident that although students apparently learn how to perform divisibility tests, starting with that of the number 2, no mention is made of the terms 'even', 'odd' and 'multiple'. This task seems to be left for the classroom teacher to do. In spite of what appears to be a deliberate attempt to avoid or minimize the use of the technical terms in the books, the concepts of 'square' and 'square root' of a number are introduced directly by their definitions as illustrated below:

When we multiply a number by itself, we call it 'squaring the number'. So when we 'square 3', we get 3x3, which gives 9'

4x4 can be written as 42 [which is read '4 squared']

The square of 4 is 16; hence we say the' 4' is the' square root' of 16

It can be seen here that the colloquial meaning of the concept of 'square root' [number which can be multiplied by itself to give another number] is not given. This is likely to lead to difficulties in distinguishing between the technical terms 'square' and 'square root' as revealed in the students' responses in the study. The confusion between the two terms may therefore be attributed to the problem of linguistic interpretation.

5. Recommendations

From the study findings and the discussion held in this paper, it is critical that students be helped to acquire the vocabulary and correct phraseology of mathematics appropriate to their age and ability if they are to succeed in the subject. By administering suitable diagnostic tests, the teacher can get an idea about students' language difficulties and appropriate remedial measures taken. Given the several confusions observed in the students' responses, the authors suggest that there is need for students to be shown as many instances of a given term/concept as possible. Thus after students have understood the colloquial language for a given concept; they should be gradually introduced to other versions of that concept, culminating in the relevant technical term(s).

Students' understanding of a given concept can be developed further by considering non-examples of that concept. For instance, after students have learned the concept of 'even numbers', they should be shown examples of 'non-even numbers'. This technique is likely to enhance students' ability to distinguish between concepts, particularly those that are 'subsets' or 'inverses' of others. Similarly, it is important, particularly when teaching less able children, to repeatedly use a new term to which they have been introduced to enable them to become completely familiar with it.

Teachers also need to be aware that it is not easy to define some mathematical terms very precisely in ordinary English, and that such terms are best understood in their technical forms. However, an alternative approach to defining technical terms would involve the use of suitable relevant examples already known to students. In order for these suggestions to work, it will be necessary for students to be actively involved in the learning activities, with the teacher playing the role of a guide and a facilitator of learning.

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