Specialised Mathematical English as A Resource of Learning Secondary School Mathematics: A Case Study in L2 Classrooms

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***Abstract*. Perhaps more than any other subject, teaching and learning mathematics depends on language. Mathematics is about relationships: relation between numbers, categories, geometric forms, variables and so on. In general, these relationships are abstract in nature and can only be realized and articulated through language. Even mathematical symbols must be interpreted linguistically. Thus, while mathematics is often seen as language free, in many ways learning mathematics fundamentally depends on language. For students still developing their proficiency in the language instruction, the challenge is considerable. Indeed research has shown that while many second speakers of English (L2) students are quickly able to develop a basic level of conversational English it takes several years do develop more specialised mathematical English. This paper reports findings of a study whose part of the objectives investigated how students construe specialised mathematical meanings from everyday words to express conceptual understanding of mathematics. The study employed multiple-case study design in three categories of schools, that is, Sub-County School (SCS), County School (CS) and Extra-County School (ECS). Data were collected by questionnaires, classroom observations and interviews. Findings indicate that students had challenges in interpreting mathematical meanings of ordinary vocabulary used in mathematics curriculum-they stated ordinary meanings of words instead of mathematical meanings. The paper recommends integration of mathematical language as a strand in the curriculum of mathematics in secondary schools in L2 context to assist learners attain conceptual understanding of mathematics.**

***Key Words*: Specialised mathematical English, Ordinary English, mathematics concepts, L2 learners**

I. INTRODUCTION

Mathematics is communicated by styles of a language that is used specifically by a community of people learning and talking about mathematics. The use of language specific to a particular discipline or community of people is referred to as a register. Prediger & Zindel (2017) give four characteristics of registers: "the types of communication situations, their fields of language use, the discourse styles, and modes of discourse" (p. 4160). Hence we have mathematics register, legal register, medical register, accounting register, just to mention but a few. Teachers and students, for instance, use the school academic language, also known as Language of Teaching and Learning (LoTL), for teaching and learning purpose hence it is referred to as school academic language register. Thus, the school academic language register plays an important role as the medium of instruction in school which aids communication with intent to learn. Academic register is unique in the sense that only socially privileged families provide opportunities for their children to learn it whereas all children can acquire basic communication skills in the everyday language in their families. Since the school academic register functions as a medium of instruction, it is a requirement for learning for all students hence it is a core subject taught at basic education curriculum level in schools.

Mathematical language conveys meanings that constitute mathematics concepts. A concept is an idea; the name of a concept is a sound, or mark on a paper, associated with it (Skemp, 1987). For instance, 'addition' is a concept which can be depicted in the expression 6+3=9 and related to 9-3 = 6. The numerals 6, 3and 9 and basic symbols +, - and = are meaningless in themselves. These symbols can only be understood within a certain numeration system and a discourse community. Therefore the meaning of the word 'addition' that bears the idea behind the expression 6+3=9 is understood within a given community (Hill, 2015). However, mathematics is universal and hence symbols have common meanings of concepts across cultures though expressed in various media of instruction with various words. For instance the symbol for division is /, - and ÷ in different cultures. As such, mathematics language is a specialised language (Gough, 2017) that utilises English as a medium of instruction in many mathematical contexts.

Mathematical language has a technical way of communicating mathematics. Umeodinka and Nnubia (2016) identified the following components of mathematical language:

(i) A vocabulary made up of symbols or words (ordinary and technical words). Symbols like π, $\sum$ and $\geq$ are used in language;
(ii) Syntax. A grammar that has the rules of how these symbols and words may be put into use;
(iii) Semantics. Words with mathematics meanings that are different from their everyday meanings;
(iv) Lexical words;
(v) A discourse or narrative made up of strings of syntactic propositions;
(vi) A community of people who use and understand these terms and symbols. (p.12)

The use of technical language of mathematics poses challenges to students learning mathematics. Some of these challenges, discussed herein, are semantics, syntax and discourse difficulties of mathematics.

Firstly, semantics difficulties arise out of four situations. Firstly, semantics constitute of words with precise meaning in mathematics context but have diverse meaning meanings in non-mathematical situations. Such words include simplify, power, similar, side, right, compound, singular, base, characteristic, complementary, supplementary, determinant and evaluate. Everyday words are imbued with mathematics meanings. The word 'constant' who's everyday meaning is an event that happens all the time or repeatedly (Hornby, 2015) has a totally different meaning in mathematics.

Research has proved that even native speakers of English who are assumed to be proficient in English also face hurdles in distinguishing mathematical meanings of the words from their everyday meanings (Heller & Morek, 2015). Consider the word 'singular'. In lay talk, the word denotes just one person or one thing. Singular also means exceptionally good or great; remarkable (McIntosh, 2013). Now contrast the ordinary meaning of singular with its mathematical meaning. In mathematics, singular (as used in singular matrix) means a *square* matrix having a zero *determinant.* A determinant is the difference between "the *product* of the *elements* of the minor diagonal from the product of the elements of the main diagonal…." (Ministry of Education, 2004; p.183). Again the explanation uses other terms such as square, determinant, product and elements of which the learner should be familiar with. Some of the words that have diverse meanings in lay-talk but which assume precise meaning in mathematical language are presented in Table 1. Essentially talking mathematically requires a grasp of the language of mathematics which is a challenge to learners.

Semantics also comprise of words or phrases that convey very complex meanings for instance mantissa and integral which are technical in the sense that their meanings can only be understood in mathematics. Some technical terms are created out of the language of teaching and learning. For example 'quadrilateral' and 'parallelogram' are made up of Latin and Greek elements but used in English medium (Wathen, Trinick & Guerrier, 2021).

Table 1. Examples of Polysemous Words Used in Secondary Mathematics Syllabus

Word	Meaning in Everyday Life	Meaning in Math
Singular	One thing, remarkable, great	A matrix without inverse (as in singular matrix)
Similar	Looking alike in appearance	Exactly the same shape
Origin	The beginning, as in origin of man	Point of intersection between x and y axis (0,0)
Characteristic	Feature	Whole number part of logarithm
Mean	(adj.) stingy, (v) to intend	Average
Root	the underground part of a plant	The quantity raised to the power 1/r
Table	Furniture	An arrangement of numbers, symbols or words to exhibit facts or relations
Point	Idea, statement	Dot(.) delineating whole number and decimals
Area	a space or surface	The quantitative measure of a plane or curved surface
Expression	a look indicating a feeling	A symbol representing a value

(MoEST, 2002; Semeon & Mutekwe, 2021)

Semantics has several words with the same meaning such as add, sum, plus, combine, put together, increase by; subtract, decreased by, take away, minus, less, difference; multiply, times, product; divide, into, quotient among others which have to be used correctly to demonstrate conceptual understanding.

Secondly, Syntax difficulties poses challenges relating to rules of grammar. Challenges of understanding a concept arise when a concept is made up of the relationship between two words. Examples of relationships are given as follows:

- A father is 4 times as old as his son.
- Anindo earns £ 6 more than Juma.
- A boat is 1.5 km nearer to point A than a ship (the distance between the boat and the ship is not 1.5 km).
- Lack of direct correspondence between symbols and words. For example, the number x is 6 less than the number y is not written as x = 6 – y but instead written as x = y – 6.

Lastly, but not least, we have discourse difficulties in mathematical language. Discourse is defined as a verbal interchange of ideas especially conversation. It is a formal, orderly and usually extended expression of thought on a subject (McIntosh, 2013). While every act of communication can count as an example of discourse, some scholars have broken discourse down into four primary types: argument, narration, description, and exposition. The mapping from some text into a representation in the listener's mind is referred to as "interpretation". In doing mathematical tasks, a student is supposed to read a text and interpret it mathematically in order to solve a given problem. Discourse difficulties may arise out of logical connectors (if…then, if and only if, because, that is, for example, such that, but, consequently, either…or), references of variables (Variables are the number of things not things themselves) among other factors.

Freeman (2018) classifies Mathematical language into two groups: Language of words and semiosis. He further puts the language of words into three categories namely: technical words such as parabola, polygon, hypotenuse, ordinary words for instance even, difference, points, power; and styles of meaning and ways of presenting arguments in Mathematics.

From this point of view, learning Mathematics involves relating meaning to symbols, words and oral sounds (Orton & Frobisher, 2016). Orton and Frobisher added lexical words to the categories of mathematical language. Lexical words have a similar meaning in mathematical language as in everyday language, for example 'altogether', 'replacement' and 'remainder.' Knowledge of lexical words facilitates understanding of situations in which concepts are relayed hence can be classified as auxiliary language to mathematical language. The understanding of words used in Mathematics is closely related to conceptual understanding (Lee & Patnode, 2013) and is enhanced by semiosis.

Semiosis is the use of signs in mathematics where a sign is a signifier or a sign vehicle to a meaning or concept (Gibbs & Orton, 2004). For instance we have a general form of a triangle as a signifier of a three sided plane figure which could take specific attributes of an equilateral, right-angled, isosceles or scalene. Mathematics concepts were developed and refined from physical objects Greeks craftsmen produced such as cylinders and pyramids which today make use of symbols. Semiotic language plays a pivotal role in learning school mathematics.

Theories of learning aver that children develop concepts, even mathematical concepts, from material things to abstract ideas (Vygotsky, 1987). Material things must not necessarily be tangible but can be diagrams which help learners to visualise a representation of the tangible thing and hence help to interpret equations and construct knowledge.

Symbols complement verbal language and mathematical vocabulary when learning mathematics (Otuma, 2022; Rashida, 2021). For instance when a teacher mentions *Binomial expansion* [sic], however much s/he labour to explain in lexical language, the concept will remain a mirage to many learners until a symbol(s) is/are used, that is

$$(x+a)^n = \sum_{k=0}^{n} \binom{n}{k} x^k a^{n-k}$$

which learners can manipulate to get various values for x and a.

Blachowicz (2020) note that students need graphical representations to support semiosis and vocabulary development. An understanding of these words would lead to correct graphical representation and have positive implication for solving mathematical tasks. For example, the item in the student's written task required learners to appreciate the meaning of diameter to correctly interpret what was required.

Mathematical language is acquiring a prominent role in the learning and teaching of mathematics (Huang & Normandia, 2007; Suweken, Waluyo & Okassandiari, 2017; Umeodinka & Nnubia, 2016). Suweken, Waluyo and Okassandiari (2017) posit that the subject matter of mathematics is conveyed in a technical language which has to be understood and used appropriately to attain understanding of concepts. Mathematics is expressed in a technical way through a natural language (Robertson & Graven, 2019; Phakeng, 2018) and its vocabulary often overlaps with ordinary language of teaching and learning (English) thus posing confusion and the development of flawed understanding of concepts (Raiker, 2002).

Available studies in the use of language in mathematics classrooms have commented the need for more research in the specialised use of language in expressing mathematics concepts (Nyandoro, 2019; Otuma, 2014; Otuma, 2022; Umeodinka & Nnubia, 2016). However, this seeming consensus about the importance of specialised use of language in expressing mathematical concepts has not necessarily led to adequate research in the use of specialised mathematical language by learners in classrooms. Although among the existing studies there have been some analysis of the use of technical (specialised) vocabulary and conceptual understanding of mathematics (Gurefa, 2018; Mberia & Mwangi, 2018; Venesa, 2019) using quasi-experimental design, there has been relatively little analysis of mathematical language usage in natural settings of classrooms, especially those produced from a socio-cultural perspective. The current research was an attempt to fill the gap by analysing usage of specialised mathematical language in L2 mathematics classrooms.

II. THEORETICAL FRAMEWORK

A perspective which greatly influenced the understanding of the study was Vygotskian Socio-Cultural Theory (SCT) which emphasises the importance of using a language in social situations, as a necessary herald to individual learning (Vygotsky, 1987). Vygosky's perspective on the role of language in learning can be explained in two ways: First, language accommodates a medium of learning. This means that learning can basically take place in a social context and social interaction is the essence of learning. Second, language is an instrument that assists a learner to think. A learner conceives and perceives a mental picture through a familiar language before it is verbalised or expressed in signs. In the case of learning mathematics, native speakers of a language of teaching and learning are assumed to have advantage over their peers, L2 and L3 because they already have the register of the language and hence can visualise a variety of mental pictures easily. SCT posits that when a learner is familiar with the academic language s/he can learn individually through interaction with peers and even by reading text books. It becomes apparent that language of mathematics (which comprises of both technical and non-technical words) is pivotal as a channel of mediation on both social level and individual level. Vygostsky strongly claims that concepts cannot be acquired in conscious form without language and a child cannot have a conscious understanding of concepts before they are explained in a related context using language (Vygotsky, 1978). SCT has been applied by Huang and Normandia (2007) in a study to examine linguistic features of students' written discourse in secondary school mathematics in Central New Jersey in United States of America. Similarly, Semeon and Mutekwe (2021) applied SCT to explore Perceptions about the use of language in classrooms in South Africa. The Vygotskian socio-cultural approach to classroom promotes effectiveness in teaching and learning and it is for this reason that this study will adopt the socio-cultural perspective as the theoretical framework.

III. METHODOLOGY

The empirical enquiry employed a multiple-case study which is advantageous in situations where a researcher wants to study a phenomenon in its natural setting. Similarly, in the larger study from which this paper is extracted, the researcher examined in detail the use of mathematical language during teacher-student interaction in classrooms, hence case study design was appropriate. Case study explored the holistic nature of a phenomenon (Gustafsson, 2017), Specialised Mathematical English (SME) in the study, and offered a perspective that informed exploration of the use of mathematical language in classrooms for conceptual understanding (Hamel, 1993). Form three Mathematics classes were the cases in this study. A class is a bounded system, bounded by place (located in a school) and time (period over which a topic/lesson of study was done) hence multiple case studies were appropriate strategy for this study. Multiple-case study allowed more in-depth understanding of the cases as a unit through comparison of similarities and differences of the individual cases. Furthermore, Case study provided more comprehensive exploration of research questions and theory development (Heale & James, 2015)

The context of this study was mathematics classes taught in public secondary schools in Bungoma South sub-county, Bungoma County, Kenya, in East Africa. The population of this study comprised of form three mathematics students whose age ranged between 16 and 20 years in public secondary schools and their mathematics teachers. Form three students were assumed to have been in the school system long enough (11 years) since primary and hence could use the language of instruction (English) appropriately. Proficiency in the language of instruction was necessary in this study to guard against the danger of associating difficulty in understanding and using mathematical language to problems of understanding and using the language of instruction.

Of significant importance was the technicalities of accessing form four class for research study when they were months away to the final secondary school examination. Usually the form four class was guarded from outside interference to minimise any chance of exam malpractice that could be planned and sneaked into the class.

The secondary schools for the study were obtained by purposeful sampling as it was not practicable and economically feasible to randomly select schools from a population of 10,413 secondary schools in Kenya. Maximum variation sampling came in handy to obtain schools with greatest differences, that is, Extra County School (ECS), County School (CS) and Sub-county school (SCS) according to categories of secondary schools in Kenya (MoE, 2020). Cluster sampling was used to obtain samples of form three classes and their respective teachers as it applies to groups of individuals or items that are naturally grouped into clusters. Classes in secondary schools in Kenya are naturally grouped into form 1, form 2, form 3 and form 4 where, depending on the population of the class, a class could be sub-divided into streams, say, Yellow, Orange, Green, Blue and Purple. Sample of students for interview was obtained by systemic sampling which captured data of phenomena from varied sources. Table 2 gives sample size.

Table 2. Sample Size

Participants	Category	Population	Sample
Public secondary schools	Extra county	3	2
	County Sub-county	11 48	2 10
	Total	**62**	**14**
Form three students	Extra county	1103	220
	County Sub-county	2120 3478	424 695
	Total	**6701**	**1339**

The research study collected both qualitative and quantitative data using Questionnaires, semi-structured interview schedules and classroom observation from form three students and their mathematics teachers. Questionnaire comprised one section detailing words that take different meanings in lay-talk and mathematics. The Participants were asked to (1) state a mathematical meaning and (2) give a visual representation or a symbol for the vocabulary. The researcher conducted open, participant and semi-structured observation of lessons to analyse how students use the technical language of mathematics to convey mathematics concepts. The purpose of classroom observations was to lead to a contextual description of each classroom learning experiences including aspects of classroom talk and use of language during learning of mathematics. The study also conducted teacher and student interviews. The aim of teacher interviews was to source data to help in understanding issues relevant to the stated aims of the study, but specific to the teaching circumstances of each teacher. The essential focus of teacher interview was to investigate whether the teachers were conscious of their approaches to use of language during teaching of mathematics.

The study tested reliability of items using split-half method where correlation coefficient for the two halves was obtained. The reliability coefficient was greater than zero point seven (>0.7) hence the instruments were deemed reliable. In order to achieve the soundness of the research study, the researcher endeavored to select the sample correctly to suit the research purpose. The researcher selected a large sample within the constraints of economy and logistics, and apportioned enough time to exhaust data collection. Form three students selected as research participants were deemed to have been in school long enough and acquired proficiency in English which was a prerequisite of the study. The students were highly likely to interpret items in English and give quality data

Qualitative data from multiple cases was analysed within cases and across cases to establish similarities and differences of individual cases. Themes arose from the analyses and assertions about the cases as a whole emerged. Quantitative data was measured on interval scale since it was in form of percentages. Specialised vocabulary had three measurements, that is, correct mathematical application (usage), confused/misconception and blank. Analysis involved comparison of results between and among variables using Pearson's correlation co-efficient, r.

IV. RESULTS AND DISCUSSIONS

This study reports findings from students' questionnaire on everyday words together with student interview and classroom observations. Table 3, 4 and 6 presents findings from students' questionnaire in Sub-County School (SCS), County-School (CS) and Extra-County School (ECS) categories respectively. The code CORRECT means that a student has given the right definition or description; BLANK means a student did not have an idea of the term; and CONFUSED means that a student has given a wrong definition or description. For example, while a student attempts to define SIMILAR, they may give the meaning of SIMPLIFY.

Table 3. Students' Level of Proficiency in Every Day Words with Specialised Meanings (SCS)

S/N	List of Vocabulary	Mathematical meaning			visual illustration, diagram, symbol OR example		
		Correct	Confused	Blank	Correct	Confused	Blank
1	Table	1.8	59.8	38.4	1.5	45	53.5
2	Parallel	1.1	9.0	89.9	2	88	10
2	Root	18.0	40	42	4.5	40	5.5
3	Factor	5	60	35	6	34	40
4	Power	0.1	44.9	55	5	40	55
5	Base	2	64.5	33.5	10.5	49.5	40
6	Characteristic	0	55.7	44.3	0	30	80
7	Bar	0	75.8	24.2	0	40	60
8	Plane	0	25.6	74.4	0	0.6	99.4
9	Plot	0	10	90	1	69.3	29.7
10	Point	1	69	30	0	20	80
11	Product	2	18	80	0	58	42
13	Reflection	0	90	10	0.1	90.9	9
14	Congruence	0	5	95	0	10.3	89.7
15	Regular	0	13.7	86.3	0	82	18
16	Similar	0	3	97	0	5	95
17	Enlargement	0	69.8	30.2	0	9	91
18	Expansion	0	70	30	0	74.3	55.7
19	Expression	0	9.8	90.2	0	9.6	90.4
20	Solution	3	17.6	79.4	0	0.2	99.8
21	Mean	2.5	13.5	86	0.5	50.5	49
22	Area	2	25	73	0.7	40.3	59
23	Segment	1.1	1.9	97	0.1	17.9	82
24	Translation	0	14	86	0.5	9	90.5
25	Simplify	0	46.5	53.5	1.5	23.5	75

When mathematical meaning (correct) was correlated with visual illustration (correct), the result was a positive moderate correlation of 0.387 indicating a moderate influence of knowledge of specialised mathematical English on conceptual understanding of mathematical understanding. An interesting observation from Table 1 is that students in SCS scarcely interpret specialised meanings of Every Day Words as portrayed by numerous scores of zero in column two. Students hardly stated correct mathematical meaning of vocabulary such as characteristic, bar, plane, plot, reflection, congruence, regular, similar, enlargement, expansion, expression, translation and simplify. When variables were correlated, the study revealed a moderate correlation of 0.387 between mathematical meaning (correct) and visual representation (correct). Some of the meanings of words stated by students are given as follows:

> **Characteristic**: The behaviour
> **Simplify:** To solve equations
> **Plane:** Empty paper
> **Plot**: is draw a line or sketch
> **Regular:** This is a figure that you can count its sides
> **Similar**: The two shape or number that are *similar* [sic]; same
> **Enlargement**: This is the way of increasing size of a figure (Questionnaire responses in SCS)

Results of students' level of interpretation of specialised meanings of words in mathematics in CS category indicate a strong correlation (0.598) between mathematical meaning and visual representation of concepts as presented in Table 4. The vocabulary that most students, 167 out of 335, representing 50.1%, stated the correct mathematical meaning is 'parallel' as shown in table 2. Just like SCS category, participants didn't have any idea at all in the following words: Power, plane, plot, reflection, congruence, similar, regular, enlargement, expansion and expression. Likewise, the vocabulary that was most correctly matched with its mathematical symbol is 'root' with a score of 52.2% (174 out of 335 participants). All the students gave the symbol of square root, √, though power notation such as $a^{¼}$ read as "the fourth root" or generally $a^{1/n}$ (n^{th} root) were possible responses but none was given in the entire sample.

Table 4. Students' Level of Proficiency in Every Day Words with Specialised Meanings (CS)

S/N	List of Vocabulary	Mathematical meaning			visual illustration, diagram, symbol OR example		
		Correct	Confused	Blank	Correct	Confused	Blank
1	Table	15.1	69.8	15.1	25	40	35
2	Parallel	50.1	35	14.9	50	10.8	39.2
2	Root	24.6	60.4	15	55.2	30	14.8
3	Factor	10	55	35	25	35	40
4	Power	0	74.9	25.1	20	40.7	39.3
5	Base	25	40	35	50	30	20
6	Characteristic	11.1	45	44.9	20	30	50
7	Bar	5	50	45	5	40	55
8	Plane	0	25.6	74.4	41.4	0.6	60
9	Plot	0	30	60	10	5	85
10	Point	5	65	30	30	20	50
11	Product	20	45	35	30	5	65
13	Reflection	0	50	50	10	0	90
14	Congruence	0	15	85	5	10	85
15	Regular	0	25	75	0	25	75
16	Similar	0	45	55	10	15	75
17	Enlargement	0	54.5	45.5	0	10	90
18	Expansion	0	60	40	0	24.3	75.7
19	Expression	0	30	70	0	10	90
20	Solution	35	40	25	20	20	60
21	Mean	25	45	30	10	25	65
22	Area	5	70	25	10.7	29.3	60
23	Segment	10	10.1	79.9	5	10	85
24	Translation	5	30	65	5	5	90
25	Simplify	30	35	35	15	30	55

From classroom observation it was revealed that even though there is classroom talk in mathematics lessons, learners rarely explore the meanings of vocabulary. Take an incident in one of the classes where the lesson was about 'SURDS'. The teacher while marking class work came across a student's work that portrayed misconception of a right-angled triangle as illustrated in Figure 1. He wrote his comment in the student's book while thinking aloud probably to attract attention of the class. However, he never utilised the moment for learning purposes may be to evoke a class discussion of features of a right-angled triangle with corresponding symbolic representations to bring out conceptual understanding. As claimed by Otuma (2022), mismatch between vocabulary and corresponding semiotic representation stifles learner's relational understanding of concepts and by same token conceptual understanding.

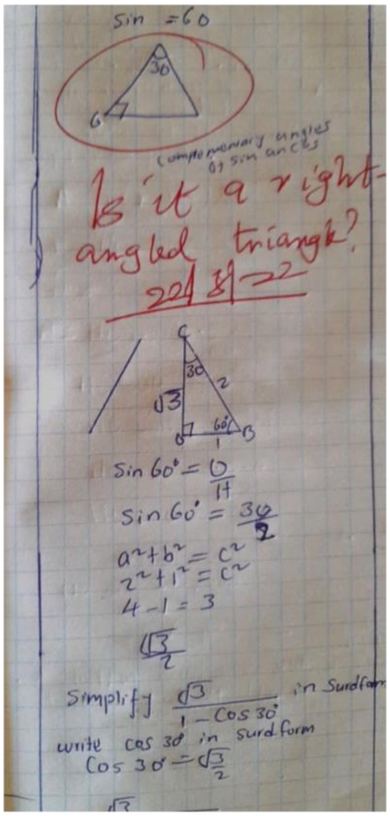

Figure 1: Classroom observation, August 22nd, 2022.

Student interview noted that students define mathematical vocabulary in class although the study could not establish if it was a routine or incidental event as only one lesson was observed in the class. There is also a possibility that the class may have discussed and even revised the concept before hence the teacher didn't see the need of eliciting whole class discussion. An excerpt of student interview went as follows:

R: Do you define mathematics vocabulary in your lessons?
Chorus: Yees!
R: Tell us examples of those vocabulary that you have defined?
S8: Truncation
R: Tell us. What is truncation? (A specialised word in mathematics)
S8: To cut or chop [sic] a number (Everyday language/lay-talk)
R: When you meet new words, do you take time to discuss them before you move on to calculations and drawing diagrams?
S9: Yes we define the word and even the teacher try to explain in Kiswahili [sic] for better understanding.
(Student interview, September 2, 2022).

Of significant importance is students' definition of the term 'truncation' as 'cut' or 'chop' transferring everyday meaning (lay-talk) to mathematics meaning. To cut or to chop is an action that involves the use of tools such as a panga or an axe, tools that have no room in mathematics learning. Researchers in language and mathematics have argued that language is a tool that facilitates reasoning (Prediger & Zindel, 2017) and further opine that proper use of language enhances development of conceptual understanding of which mathematics is not exemption.

The most confused vocabulary from mathematical statements was 'power' with a score of 74.9% representing 250 out of 335 participants. Some of the responses given for meaning of 'power' are as follows:

Is a number that is being put on a number
The number has two or more information like a 2^2
Is the number that is up there to a number
This is are the steps that a decimal moves
These are number found upon the other that shows a value of exact
Is a term used to give a number *some strength* [sic]
(Questionnaire responses from CS).

The findings further reveal that students had no idea at all in stating meanings of four vocabulary items but at least they gave some correct symbols or examples as illustrated in parenthesis. Power (20%), Plane (41.4%), Plot (10%) and Reflection (10%). Students had no mathematical idea at all either by stating meanings or giving symbols in the following four terms: regular, enlargement, expansion and expression. Some of the responses for the four aforementioned items and others are given in Table 5.

Table 5. Every Day Words with Non-Mathematical Meanings

Vocabulary	Meaning
Plane	It simply means a paper which is plain [sic] This is a flat part of a given figure
Plot	Are something that used to plot anything
Reflection	These are objects that result after taking rotation at the origin [sic]
Parallel	Is when the two lines are drawn in an angle [sic] and they have the arrow they are parallel Is a line that add up to 180 when drawn on a paper
Factor	To find more multiples [sic] of a given number
Characteristic	It is the behaviour of something

Results of students' level of proficiency in everyday words with specialised meanings in ECS display same trend with the result of CS. There was a strong correlation (0.774) between mathematical meaning (correct) and visual representation (correct). As illustrated in Table 6 the vocabulary that most students defined correctly was 'parallel' with a score of 64.3%. The most confused vocabularies were characteristic, plot, reflection, congruence, regular, similar, enlargement and translation.

Table 6. Students' Level of Proficiency in Every Day Words with Specialised Meanings (ECS)

S/N	List of Vocabulary	Mathematical meaning			visual illustration, diagram, symbol OR example		
		Correct	Confused	Blank	Correct	Confused	Blank
1	Table	14	64	22	22	36	42
2	Parallel	64.3	14.3	21.4	58	28	14
3	Root	7	36	57	57	0	43
4	Facror	7	64	29	14.3	35.7	50
5	Power	64	21	15	64	21	15
6	Base	28.6	50	21.4	64	21	15
7	Characteristic	0	29	71	0	7	93
8	Bar	21	36	43	29	14	57
9	Plane	14.3	28.6	57.1	21	7	72
10	Plot	0	92	8	0	71	29
11	Point	14	50	36	30	35	35
12	Product	78.6	14.2	14.2	64.3	14.3	21.4
13	Reflection	0	64.2	35.8	7.1	28.6	64.2
14	Congruence	0	28.6	71.4	0	7.1	92.9
15	Regular	0	50	50	0	14.3	85.7
16	Similar	0	71.4	28.6	7.1	35.7	57.2
17	Enlargement	0	71.3	28.7	0	57.1	42.9
18	Expansion	7.1	57.1	35.8	21.4	14.3	64.3
19	Expression	7.1	50	42.9	14.3	0	85.7
20	Solution	42.9	14.2	42.9	21.4	0	78.6
21	Mean	42.9	35.7	21.4	35.7	28.6	35.7
22	Area	7.1	50	42.9	35.7	28.6	35.7
23	Segment	21.4	28.6	50	21.4	14.3	64.3
24	Translation	0	21.4	78.6	0	14.3	85.7
25	Simplify	14.3	57.1	28.6	35.8	21.4	42.9

V. CONCLUSION

The study looked into specialised mathematical English (language) as a resource of learning secondary school mathematics. Results from SCS show that students hardly stated correct mathematical meaning of vocabulary such as characteristic, bar, plane, plot, reflection, congruence, regular, similar, enlargement, expansion, expression, translation and simplify. Just like SCS category, participants in CS didn't have any idea at all of the mathematical meaning of following words: Power, plane, plot, reflection, congruence, similar, regular, enlargement, expansion and expression. In the case of ECS, findings indicate that students had challenges in interpreting the same vocabularies most confused in SCS and CS such characteristic, plot, reflection, congruence, regular,

VI. RECOMMENDATION

The study recommends integration of mathematical language as a strand in the curriculum of mathematics in secondary schools. The ministry department in charge of curriculum design, KICD, should be cognizant to language features of mathematics that are necessary for learning mathematics with conceptual understanding. Such features include syntactics-the study of how linguistic signs, or symbols or words behave in relation to each other; semantics-how meaning is conveyed through signs and language and pragmatics-the study of how contexts affect meaning.

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