

The Effects of Proper Understanding of Mathematical Language on the Mathematics Achievement of Students in Secondary Schools in Nakuru County, Kenya

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ABSTRACT

This study was carried out to determine the effects of the proper understanding of Mathematical language on the mathematics achievement of students in secondary schools in Nakuru County. The objective of the study was to establish the role which the English language plays in the mathematics achievement of students in secondary schools in Nakuru County. This study adopted ex post facto research design. The respondents were selected using both simple and stratified random sampling. Data was collected through the use of classroom observations, and students' achievement test items using unfamiliar mathematical terms and familiar mathematical terms. Analysis of data was done using both descriptive and inferential statistics. For descriptive statistics means were used. Anova was employed for the inferential statistics. The study found out that students performed better when they were given test items containing mathematical concepts which have been simplified as compared to students who were given test items containing unfamiliar mathematical concepts. It is recommended that the teaching and learning of mathematics should break down the language contained in mathematics syllabus into simpler language that the learners can easily understand.

Key words: Mathematics, vocabulary, teaching, learning, achievement.

INTRODUCTION

According to Kenya Certificate of Secondary Education (KCSE) Mathematics syllabus (2010), Secondary Mathematics aims at producing a person who will be numerate, orderly, logical, accurate and precise in thought. One of the objectives of teaching secondary mathematics in Kenya is to enable the learner to identify, concretize, symbolize and use mathematical relationships in everyday life. The other objective is to enable the learner to communicate mathematical ideas.

In Kenya, majority of the subjects at secondary school level of education are taught in English. English is not the first language to the majority of the learners but is taught as a second language. Teachers who teach mathematics use English as a medium of instruction in the classroom. All mathematics examinations at KCSE are written in English and the learners are expected to read, understand and interpret the English language into mathematical language.

In mathematics, ordinary (or natural) language has to illuminate and interpret the symbolic language. Mathematics language is precise, obeys exact rules, does not convey meaning except by exact interpretation of its symbols, and cannot express emotion, judgment or value. Language problem in mathematics is caused by common vocabulary. Many words have one meaning in normal English usage and a quite different one in mathematics. For example, root, solution, product, matrix, differentiate, integrate, function, coordinate, prime, index. Use of such words causes difficulties because of the semantic confusion involved. There is no easy way out of this – the words are part of standard mathematical vocabulary (Macnab and Cummine, 1986).

According to Macnab and Cummine (1986), there is another set of words which occur hardly anywhere else than in mathematics, though some have become part of ordinary English, for example, evaluate, isosceles,

commutative, polygon, rhombus, parallelogram, surds, conjugate, perpendicular, logarithm, mantissa, factorial, integers, calculus, histogram, cosine, sine, tangent, locus, discriminant, chord, congruent, exponent, integers, digit, tangent, transversal, truncate, knot, frustrum, inscribe, circumscribe, escribe, etc. Such words serve to create the impression that mathematics is more difficult than is actually the case, since difficult words suggest difficult ideas. There is also another set of words meaning the same for mathematics and ordinary English language, for example, between, outcome, midpoint, average, sum, radius, depreciation, subtraction, addition, division, sequence, ratio, mixture, proportion, multiplication etc.

According to Mbugua (2012), achievement in mathematics is highly related to students' understanding of mathematical language. Students make mistakes when solving mathematics problems due to lack of understanding of mathematical language. Thus mathematical language plays a major role in the understanding and achievement in mathematics.

According to Cockcroft (1982), the study of mathematics together with that of English is regarded by most people as being essential. Usefulness of mathematics arises from the fact that mathematics provides a means of communication which is powerful, concise and unambiguous. He pointed out that mathematics can be used as a powerful means of communication – to represent, to explain and to predict. Mathematics provides a means of communicating information concisely and unambiguously because it makes use of symbolic notation.

Cockcroft (1982) pointed out that the problems of learning to use mathematics as a means of communication are not the same as those learning to use one's native language. He emphasized the fact that mathematics does not come naturally to most people in the way which is true of native language but has to be learned and practiced. Mathematics conveys information in a much more precise and concentrated way than is usually the case with the spoken or written word. Many people take a long time not only to become familiar with mathematical skills and ideas but also to develop confidence in making use of them.

Wanjiru et al (2021) established that performance in mathematics is extremely associated to students' understanding of mathematical language. They pointed out that understanding of mathematics language can effectively improve students' performance in mathematics. They recommended that good performance in mathematics can be boosted by incorporating mathematical terms' definitions in lessons; prepare quizzes requiring definitions of mathematical terms, structures or symbols and award marks for definitions.

Bernal and Mligalig (2023) carried out a study to determine the English proficiency level of the teachers teaching Mathematics and English. Their interest was the aspects of the English language which cause them particular difficulty. They pointed out that those grammar items identified as problematic should be included in a professional development program specifically devised for teachers at that centre. Adamu (2019) carried out a study on the effect of English language comprehension on achievement in Engineering mathematics. The findings indicated a significant difference exist between word based problems and wordless problems in Engineering mathematics. The study revealed that the medium of instruction influence the attainment of instructional objectives in mathematics. The study also found out that language problem is one of the major factors contributing towards the poor performance of many students in mathematics especially those who are bilingual and multilingual. Mathematics is a language of its own with unique vocabularies, phrases, symbols and peculiar reading comprehension method. Many students fail in mathematics examinations because they don't understand several words which are used.

Wilkerson et al (2021) carried out a study on the effects of language on children's understanding of Mathematics. The study pointed out that it is important for teacher education programs to consider ways of developing students' conceptual mathematical understanding, meaning making and effective communication of their understanding through language. They pointed out that teacher educators should discuss the need for instructional precision and appropriate use of mathematical symbols with connections with their students.

Most of the studies that have been carried out on the effect of proper understanding of mathematical language on the achievement of students in mathematics have been carried out in other countries outside Kenya. The current study has been carried out to determine if the findings from other countries are applicable to Kenyan situation.

Purpose and objectives of the study

The main purpose of this study was to investigate the importance of understanding mathematical vocabulary in the teaching and learning of Mathematics in secondary schools in Kenya. The objective of the study was to determine the effect of proper understanding of Mathematical language on mathematics achievement of students in secondary schools in Nakuru County. The null hypothesis to be tested was:

Ho: There is no significant difference between the achievement scores of students who were given test with familiar mathematical terms and those given test with unfamiliar mathematical terms.

Conceptual Framework

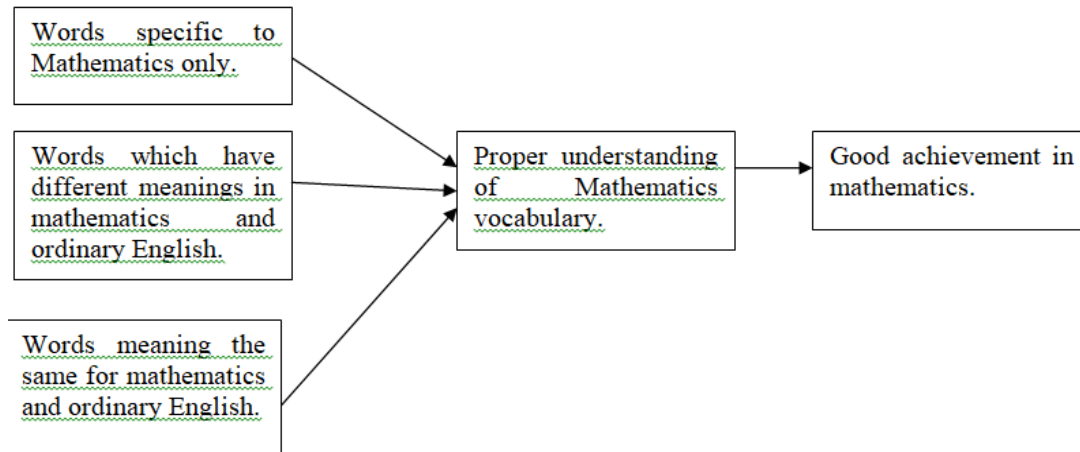


Figure 3.1. Conceptual Framework involving mathematical vocabulary and achievement in mathematics . Source (Author ,2024)

Proper understanding of mathematics vocabulary is key to good performance in mathematics. Mathematics vocabulary can be classified into three categories namely: words which are found in mathematics syllabus and are only specific to mathematics, words which have different meanings in mathematics and ordinary English language and finally words which mean the same for mathematics and ordinary English language. The proper understanding of three categories of mathematics vocabulary play a big role in the performance of students in mathematics. Mathematics teachers should ensure that the three categories of mathematics vocabulary are very clear to the learners. Mathematics teachers need to devise a mechanism of ensuring that these mathematical vocabularies are integrated in the assessment tests given to the learners. That is the only way that learners will master these technical mathematical vocabularies found in mathematics. As cockroft(1982) has put it , mathematical language does not come naturally to most people in the way which is true of native language but has to be learned and practiced. Constant use and practice of mathematical vocabulary will enable the learners to master and internalize the common mathematical terms which are normally encountered in a mathematics classroom. As a result, learners will be in a position to interpret mathematical language properly and this will lead to better achievement in mathematics. Proper understanding of mathematical language is closely related with better performance in mathematics.

Research Design and Methodology

This study adopted ex post facto research design. Ex post facto research refers to those studies which investigate possible cause- and –effect relationships by observing an existing condition or state of affairs and searching for plausible causal factors. In ex post facto research, researchers ask themselves what factors seem to be associated with certain occurrences, or conditions, or aspects of behavior. In this type of research, researchers can report only what has happened or what is happening by trying to hold factors constant by careful attention to the sampling (Bhattacharjee, 2012).

According to Kerlinger (1973), ex post facto research is a type of research in which the independent variable or variables have already occurred and in which the researcher starts with the observation of a dependent variable

or variables. The researcher takes the effect (or dependent variable) and examines the data retrospectively so as to establish causes, relationships or associations, and their meanings. This type of research design is relevant to the current research since the researcher is only interested in observing the effect of proper understanding of mathematics vocabulary on the achievement of students in mathematics. The researcher is interested in finding out the situation on the ground.

Target Population

The study was conducted in Nakuru County. Form IV Secondary school students formed the target population. They were chosen for the study because they have been exposed to very many different types of vocabularies contained in mathematics syllabus. In form four, learners will have been taken through the reading and comprehension of words, the reading and comprehension of mathematical symbols, transforming problems into mathematical operations and attaching of meaning to the mathematical symbols.

Sampling technique and sample size

Simple random sampling and stratified random sampling techniques were used. Stratified random sampling was used to ensure that there is an adequate representation of the different categories of schools. Out of the eleven sub counties in Nakuru County, Kuresoi South Sub -County was chosen. Schools were categorized into Extra County, County and Sub county schools. A sample of 160 students from the three categories was sampled for the study. 80 students were given an achievement test containing familiar mathematics vocabulary whereas another group of 80 students were administered an achievement test containing unfamiliar mathematics vocabulary.

Research Instruments

Quantitative and qualitative data collection techniques were used for the study. The main data collection instruments include the following:

- (a) Students' mathematics achievement test containing familiar mathematical terms.
- (b) Students' mathematics achievement test containing unfamiliar mathematical terms.
- (c) Classroom observations.

Research Variables

The independent variable was the mathematical language whereas the dependent variable was the mathematics achievement scores.

Data Analysis

Quantitative and qualitative data analysis techniques were used. Quantitative data was processed by editing, coding and analyzed using the SPSS version 20. For descriptive statistics, means were used whereas for inferential statistics, ANOVA was used. For qualitative data analysis, classroom observations sheets were used and the information collected was put into themes or categories.

FINDINGS AND DISCUSSION OF THE RESULTS

The objective of the study was to determine the effect of the proper understanding of Mathematical language on the mathematics achievement of students in secondary schools in Nakuru County. The hypothesis that was to be tested was:

Ho: There is no significant difference between the achievement scores of students who were given test with familiar mathematical terms and those given test with unfamiliar mathematical terms.

The data collected was analyzed using both descriptive and inferential statistics.

Table 5.1 Descriptive statistics.

| Group Statistics | | | | | |
|------------------|-----------------|----|---------|----------------|-----------------|
| | Vocabulary | N | Mean | Std. Deviation | Std. Error Mean |
| Achievement | Technical terms | 80 | 63.7000 | 11.88880 | 1.87978 |
| | Familiar terms | 80 | 74.2250 | 10.44764 | 1.65192 |

Source (Author, 2024)

The results of the descriptive statistics showed that when learners were given an achievement test containing technical terms, they had a mean of 63.70. The test items had mathematical vocabularies which are not found anywhere else except only in mathematics. When the learners were given an achievement test containing familiar or common terms in mathematics, they had a mean of 74.225. This seems to suggest that learners who were given a test comprising of familiar terms in mathematics performed better than those who were given a mathematics test containing technical or unfamiliar mathematical terms. The difference in the two means was 10.525. The finding of this study seems to suggest that performance in mathematics is closely related to students' understanding of mathematical language. Proper understanding of mathematical language can significantly improve the performance of the learners in mathematics.

On further analysis, ANOVA was applied to see whether the difference in academic achievement between the two group means was significant. The results are shown in the table 5.2 below.

Table 5.2 Analysis of Variance

| ANOVA | | | | | |
|----------------|----------------|-----|-------------|--------|------|
| Achievement | | | | | |
| | Sum of Squares | df | Mean Square | F | Sig. |
| Between Groups | 4431.025 | 1 | 4431.025 | 35.831 | .000 |
| Within Groups | 19538.750 | 158 | 123.663 | | |
| Total | 23969.775 | 159 | | | |

Source (Author, 2024).

The table 5.2 above shows the overall analysis of variance, including the between groups, within groups, and the total sum of squares, degrees of freedom, and mean squares. The F ratio for this analysis is 35.831 with a probability of 0.000. Since the p-value of $0.000 < 0.05$, the null hypothesis is therefore rejected and the conclusion is that the two groups do not have similar academic achievement. This therefore implies that learners who were given an achievement test with familiar mathematical terms performed better than the learners who were given an achievement test with unfamiliar mathematical terms. This implies that language plays a big role in the academic achievement of the learners. Learners who were given achievement tests with unfamiliar mathematical vocabularies made mistakes in solving the given mathematical problems due to poor interpretation of the given mathematical vocabularies.

The findings of this study are consistent with the findings of Wanjiru et al (2021) who found out that performance in mathematics is extremely associated with students' understanding of mathematical language. Proper understanding of mathematical vocabularies can improve the learners' achievement in mathematics to a large extent. The findings of this study are also in agreement with the findings of Mbugua (2012) who found

out that achievement in mathematics is highly related with the students' understanding of mathematical language. Students make mistakes when solving mathematical problems due to lack of proper understanding of mathematical language. The findings of the study are also consistent with the findings of Curcio (1990) who found out that mathematics requires development of a mathematical language in which abstraction of mathematical concepts can be made.

For qualitative data, the information was collected using classroom observation sheets. The interactions between the teacher and the learners during mathematics lessons were recorded and analyzed. The findings showed that when a mathematics teacher used engaging mathematical talk in the classroom, the learners were able to demonstrate their understanding of the abstract concepts in mathematics and their meanings. Seventy percent of Mathematics teachers were able to attend to the development of mathematical language and assisted the learners in mathematical understanding and meaning making. The presence of a teacher in the classroom plays a critical role in the communication process that forms the context for mathematics learning. Sixty percent of the teachers were able to guide the learners towards the effective use of mathematics vocabulary, mathematical meaning and understanding in the classroom. While introducing a new topic in mathematics, 65 percent of the teachers were able to assist the learners in making meaning of new mathematical terms and vocabulary. Ten percent of the teachers were able to use digital technologies and interactive media in their teaching and this assisted a lot in students' sense making and understanding of new mathematical vocabularies.

CONCLUSION

Poor knowledge of English, the medium of instructions in Kenyan secondary schools, has led to bad results in other subjects including mathematics. Most of the questions in mathematics are usually given in structured form. Students are expected to translate the English language into mathematical language. Without proper command of the English language, many students are unable to comprehend and answer mathematics examination questions well. Most students who don't do well in mathematics misunderstand questions due to poor knowledge of the English language. The students should understand that different areas of mathematics demand the same skills and that failure to master such skills has adverse consequences in the students' performance in the subject.

In the learning of mathematics, the learners are expected to master the lower order skills before they are introduced to higher order skills. If the lower order skills are not mastered, the hierarchical nature of mathematics makes the mastery of higher order skills difficult. Right from the lower secondary, mathematics teachers need to clearly point out words which are specific to mathematics only, words which have different meanings in mathematics and ordinary English language and finally words meaning the same for mathematics and ordinary English language.

The interpretation of worded statements into mathematical language seemed to have been a problem to some students. Mathematics teachers should break down the language contained in mathematics syllabus into simpler language can easily be understood by the learners.

Mathematics teachers should be very keen in selecting appropriate level of English language that is suitable to the level of the learners in the classroom so as to help them attain the set instructional objectives. The mathematical ability and numerical manipulative skills of the learners can be affected by proper understanding of the English language.

RECOMMENDATIONS

Mathematics syllabus in Junior and Senior secondary schools should include mathematical language as part of the content to be taught to the learners since the learning of mathematics language has to be learned and requires a lot of constant practice. Learners should be familiarized with the common mathematical vocabularies and terminologies since proper understanding of mathematical language has a positive correlation with performance in mathematics.

The government of Kenya through Kenya Institute of Curriculum Development (KICD) should design specific

teacher training programs which address ways in which language and mathematics can be supported in the teaching and learning of mathematics. There is also the need to develop glossaries of Mathematical terms and incorporate language based practice exercises in mathematics textbooks.

The teaching and learning of mathematics in Kenya should integrate digital technologies, interactive media and multilingual teaching strategies since these strategies have been proven to effectively support language and mathematical learning.

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