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DEPARTMENT OF MATHEMATICS



An investigation into errors made by learners in simplifying algebraic expressions at ordinary level at Goteka secondary school.

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DEGREE IN MATHEMATICS**

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DEDICATION

This research is dedicated to my beautiful wife Hilda Munaki, my friends Calvin Kavaro, Aleck Chibadu and Tawanda Mawadza, brothers Fidelis Mpondi, Mashal Tevedzai and Last Mpondi. Most importantly to my lovely son Kyle T Mpondi, I am truly grateful.

ABSTRACT

Despite the increasingly importance and utility of Mathematics in technology and society, the performance in the subject at Ordinary level has been very low. The study sought on investigating into errors made by learners in solving algebraic expressions a case of form three learners at Goteka secondary school which will lead to low performance in the subject area. The study employed a mixed-methods approach, incorporating both quantitative analysis of student test scores and qualitative interviews with students. A sample of 32 form three learners was selected from Goteka secondary school where the research was carried out. Test and interviews were the research instruments. The test comprised of ten questions and the interview included open minded questions to enable learners to state their own opinions on what they think should be done to make Mathematics meaningful to them. The results revealed a number of factors on what errors learners made when solving algebraic expressions.

Major findings of the study were that teachers should motivate learners to love Mathematics, use of different teaching methodologies especially those involves learner participation, to enhance learners interest in Mathematics. The use of modern technology is also crucial. These recommendations can be used to help all those who want to do further studies on this particular problem.

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CHAPTER ONE

THE PROBLEM AND ITS SETTING

1.1 Introduction

Mathematics is an essential tool for scientific, technological and economic advancement of any nation. It is an important subject not only from point of view of getting an academic qualification at school or college but as a subject that prepares the students for the future irrespective of what kind of work they choose to be a part of. As a subject, it helps children to develop abilities to think critically and use ideas in their daily life activities. In addition, learning the subject enables learners to develop problem solving skills. Although one may not directly use mathematics in their everyday lives, mathematics plays an indirect role in how they make many day to day decisions such as finances or time management. However despite its importance, the researcher observed that learners make errors in simplifying algebraic expression. This chapter aims at providing information on the background of the study, statement of the problem, research objectives, research questions, assumption of the study, significance of the study, delimitations of the study, limitations of the study, definitions of terms and summary.

1.2 Background to the problem

While teaching at Goteka Secondary School, the researcher observed that learners were struggling to cope with learning algebraic expressions. Algebraic expression is a different concept to ordinary level learners since they were used to numerical and boxes for number in primary schools. Learners faced problems with change of signs especially negative signs and they also faced challenges in expansion and factorisation of algebraic expressions. By observing the learners the researcher found that they had some persistent misconception with algebraic expressions. The researcher was then pushed to make inquiries from other teachers concerning this matter. The researcher realised that their explanation for those types of errors were surprisingly consistent with his. This triggered

the researcher to carry out an investigation into errors made by learners in the learning of algebraic expression at form three levels.

1.3 Statement of the problem

Most learners were failing to correctly simplify algebraic expressions due to errors they made such as order of operations mistake, combining like terms mistake, sign errors among others. Mathematics is a compulsory subject in the current curriculum. It is also a requirement to tertiary institutions and mandatory in most careers. Despite the above, most learners who sit for ordinary level Mathematics examinations find challenge in passing the subject. The current country's pass rate for ordinary level Mathematics is below 28% (Nhandara2023). This means a lot need to be done to assist these failing learners. An algebraic expression is a major aspect of Mathematics. Each division of Mathematics make use of the fundamental ideas of algebra to reason about and model various phenomena. Landson-Billings (1998) stipulates that some of the most influential and central ideas in algebraic expression are concept of variable functions and relationship as well as understanding the unique language used in Mathematics. Many learners make several errors based on adding and subtracting algebraic expressions. If the research could characterise learner's errors when solving algebraic expressions it would be possible to design effective teaching method to reduce them.

1.4 Research objectives

1. Identify errors made by learners in simplifying algebraic expressions.
2. Methods that can be used to reduce errors made in simplifying algebraic expression.

1.5 Research questions

1. What are the errors made by learners in simplifying algebraic expressions

2. What are the methods can be used to reduce errors made in simplifying algebraic expressions

1.6 Assumptions of the Study

An assumption is the statements that are accepted as true for the purpose of particular study or investigation, but which may not be universally accepted as true Creswell (2014). In this study the researcher assumes that the chosen sample will be responsive, willing and able to be examined. Another assumption is that some members of the staff at Goteka secondary will also be assisting in the time of study willingly participating and giving contribution. The researcher also assumes that learners fail Mathematics not because it's a difficult subject but it is because of errors they made in solving mathematics and the methodology used by the teachers.

1.7 Significance of the study

The study is of great significance to the learners. The researcher wants to equip learners with the necessary skills to incorporate real life situations into solving mathematics. It is aimed at identifying the common errors made by learner in the learning of algebraic expressions so that new approaches and techniques would be introduced which should be presented in a justifying and motivating context. The context should be familiar and real.

It is aimed at building a better foundation for more complex mathematical problems for example solving quadratic equations. The researcher wants to enlighten teachers that they would recognise that the legitimate use of symbols and teachers' perceptions may be different from the learners' idea of what is happening.

The researcher wants to enlighten schools so that they stream learners according to their ability for them to be taught effectively and encourage teachers to trace the background of learners from primary schools through revision before teaching algebraic expressions.

Policy makers may benefit from this research where education with production is encouraged and commercial farmers use algebra to solve their real life situations.

1.8 Delimitations of the study

The research was carried out at Goteka Secondary School in Mazowe District in Mashonaland Central Province. One class of form 3 were used in the research. The class was of mixed abilities. The average age of learners was 15. A sample of 32 learners used.

1.9 Limitations of the study

Methodological limitations

In carrying out this study, the researcher used Goteka Secondary school as a sample. Various schools have various environments. The results of the study may not fit very well in certain school environments which will make it difficult since the researcher cannot involve all the schools in the district because of the research design method which calls for the use of a sample only.

Time constraint.

This is because the researcher was at work most of the time, that is, from 7a.m to 4p.m every day as it is a government requirement. Having limited time to gather information was a challenge thereby compromising the validity and reliability of the research results. The researcher did not have much time to interact with the pupils as the school time table would not allow for free periods hence the teacher could see the pupils on his time for the lesson only.

Financial constraints.

There was a need to visit a number of places to get permission as well as information so this meant money for transport was needed and this was a challenge. The researcher also met some expenses on typing, printing as well as photocopying of documents like test and interview guides. The researcher asked for permission to use the school's printing machine to reduce the expenses. This helped to improve the validity and reliability of the research.

1.10 Definition of terms

Investigate- to make a careful study of something in order to discover the truth about it.

An error refers to a deviation from accuracy or correctness regardless of the cause.

Problem - something difficult to understand.

Simplify- to make easy to understand by reducing to small terms.

Expand- to unfold, spread out or remove brackets.

Algebraic expression -is a mathematical sentence with letters representing the unknown.

Terms- is a part of an algebraic expression contained between two signs either positive signs or negative signs or both positive and negative signs, in the expression $a + ba$ is one term and b is another term.

Similar terms- these are terms whose literal parts are alike

Equation –a statement in algebraic symbols that shows that two things are equal.

A monomial-is an expression of one term e.g. $2x$.

A binomial- is an expression of two terms e.g. $x+y$

A trinomial- is an expression of three terms e.g. $a+b+c$

Performance –the level of achievement shown in a given test.

1.11 Organization of the Study

This research constitute into five chapters. Chapter 1 focuses on introduction to the study that is the background to the study, purpose of the study, problem statement, research questions, assumptions of the study, significance of the study, delimitations, limitations, definition of terms and summary. Chapter 2 reviews relevant literature on errors made by learners in simplifying algebraic expressions at O level mathematics. Chapter 3 describes the research methodology, including the research design, data collection methods, and data analysis procedures. Chapter 4 presents the findings of the study and discusses the implications for practice and policy. Chapter 5 provides a summary of the study, conclusions, and recommendations for future research.

1.12Summary

This chapter has outlined the problem and its setting, thus the background of the study, statement of the problem, research objectives, significance of the study, delimitations of the study, limitations of the study, definition of terms and summary. The next chapter will focus on the review of related literature.

CHAPTER 2

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter intends to review the related literature on the errors made by learners in learning algebraic expressions at form three levels. The chapter focuses on the causes of problems encountered by learners in Algebra, the appropriate methods and the activities used in teaching algebra as supported with related literature from different authors.

2.2 Errors made in simplifying of algebraic expressions

Learners tend to face problems in translating English words to algebra. For learners with limited English proficiency, understanding algebraic terminology and notation can be significant challenge Abedi (2004). Algebra is a language of symbols. As a result the problem faced by learners is to learn to translate from English language to the language of symbols and also from symbols to words. The following examples support the idea.

Words

Symbols

The sum of a and b	$a + b$
Three times a number equals 12	$3m = 12$

This was supported by Jaroslav (2006) who emphasizes that before learners go further with algebra they should become thoroughly familiar with some new words and some forms of algebraic symbolism as they may hinder understanding.

Word problems are extremely difficult to rush directly into solution. Learners face problems in solving word problems as Joyrup (2016) argues that too often, when a learner reads a word problem and decides that he or she cannot solve it, he or she immediately gives up.

Learners have difficulty in dealing with multi-term expressions. Hitzler et al (2009) say learners have difficulty in dealing with multi-term expressions as a single unit and do not

perceive that the surface structure for example, $4(2r + 1) + 7 = 35$ is the same as $4x + 7 = 35$ where $2r + 1$ is represented by x . Kieran (2007) suggest that learners often struggle with simplifying algebraic expressions due to a limited grasp of fundamental concepts and algebraic operations.

Learners often face problems with change of signs for example, $-(3x - 4y - 7) = 3x + 4y + 7$. Learners often encounter problems with removing brackets and fail to realise changes of signs. On this aspect Rudolph (2009) says where an explanation on removing brackets was stated as in removing brackets preceded by a minus sign, multiply each term by -1 which changes the sign of the term. Such an explanation confuses ordinary learners much.

Another error made by learners in learning algebraic expressions is expansion and factorisation of algebraic expressions. Yannis (2006) pointed out that the process of finding factors of an expression is called factorising. Two common errors are generally made by students in expansion and factorisation for example,

$$\begin{aligned}(a + b)(a - b) &= a^2 + ba - ba - b^2 \\ &= a^2 - 2ab - b^2\end{aligned}$$

Learners also face problems in adding and subtracting signed numbers for example $6 + x$, can be simplified by learners as $6x$.

2.3 Source of errors made in algebra

Algebraic expression is a new topic at secondary level hence learners' face problems when solving it. One source of problem is to manipulate algebraic expressions. Lesh (2000) points out that the source of problems in manipulating algebraic expressions is that of beginning algebraic expression. Learners are not consistent in the way that they partition algebraic

expressions into component parts for example they might simplify $4(6x - 3y) + 5x$ as $4(6x - 3y + 5x)$ on one occasion but do something on another occasion. The brackets should be removed first before combining similar terms.

Poor arithmetic skills are another source of errors encounter by learners. There are some learners with weakness in basic arithmetic operations such as subtraction, addition, division and multiplication these can lead to errors in simplifying algebraic expressions as stipulated by Wolfram (2023).

In as much as learners face problems to solve algebraic expression, teachers are also noted as a source of errors madeby learners when solving algebraic expression. Teachers are the ones who perpetuate the errors madeby learners (Paul 2000). Teachers should alwayscorrecting children's work and it is necessary to check each step of their working since it is sometimes possible for them to obtain right answers by the compensation of two errors or by fundamentally wrong method for example, $\frac{x^2-a^2}{x-a}=x-a$ by cancelling x into x^2 and a into a^2 .

Algebraic expression is unpopular with learners since it is a new concept at form three level. Teachers are the ones who cause problems, the main contributing factor is that algebra is unpopular with many children. Becky (2005) proclaims that algebra is a source of considerable confusion and negative attitudes among learners. Becky (2005) added that there are two obvious possible sources of confusionand what might appear to be stumbling blocks, one being unhelpful teaching and the other being what is referred to as learning difficulties.

2.4Methods that can be used to reduce errors madein simplifying algebraic expressions. Learners often face problems with change of signs for example, $-(3x - 4y - 7) = 3x + 4y + 7$. Learners should know that on such cases they should multiply the bracket by the coefficient of bracket which is -1 . Discovery learning should the best way of teaching learners on multiplying algebraic expressions (Yannis, 2006). He points out that a factor

multiplying a sum enclosed in brackets should be used to multiply each term of the sum i.e. $-5(3x - 2y + 7) = -15x + 10y - 35$. In removing brackets around terms with a plus sign preceding the brackets, rewrite the included terms unchanged. This means that in removing brackets preceded by a minus sign, multiply each term by -1 which changes the sign of each term. Kilpatrick (2001) stipulates that regular practice simplifying algebraic expressions helps build proficiency and reduce errors.

In any sum, two products whose symbols involve the same literal parts are called similar terms. The direction to collect similar terms means to add them which give just one term. To collect similar terms, add their numerical coefficients and multiply by their common factor i.e. $-9ab + 4ab = ab(-9 + 4)$.

In modern intermediate algebra, Joyrup (2014) argues that errors due to faulty division of common factors are very numerous. Learners should have enough knowledge on type of algebra they are dealing with. They should not attempt to cross out the letters or expressions just because they look alike above or below a line in a fraction. The simple rule to be applied is that any algebraic expression being used in division between a numerator and a denominator of a fraction must be a factor of the whole numerator and also a factor of the whole denominator.

Factorising can be taught logically and connected with previous knowledge of multiplication and division. The first thing is to see whether there is a factor which is quite evident. Thus in $8a^2 - 16ab$, $8a$ should at once come into the child's mind. In such algebraic expression the other factor is obtainable by dividing each term by $8a$. The teacher will also have to create among the students a sense of grouping connected terms. A useful tip here is to spot some letter that occurs only in two terms together.

There are several ways that can be used in dividing two polynomials. One of the methods is to use the principle of variable. The procedure involves dividing one polynomial by another. Arrange each polynomial in descending powers of some common variable to be called principlevariable (Janas 2007). Divide the first term of the dividend by the first term of the quotient. Multiply the division by the first term of the quotient and subtract the product from the dividend until the remainder is of lower degree than the divisor in the principal variable.

Dove (1986) as quoted by Alexis (2007) states that “common sense suggests that teachers however well educated, trained are rendered less effective if schools lack basic resources for learning to take place”. Teachers need to motivate learners with shortage of resources especially those learn at remote schools. Alexis (2007) further observes that “In Africa, only 4% of the national revenue is spent on materials while 96% is spent on salaries. The situation is even worse in rural areas where there is shortage of classrooms, textbooks and exercise books”. This reflects that parents need to take part in creating a conducive environment for learning of algebraic expressions by buying personal textbooks for learners. Lesson should be learner centred approach and avoid lecture method.

According to National Council of Teachers (2014) use of visual aids such charts or diagram to visualize the expression can reduce errors made in simplifying algebraic expressions. Learners have different learning ability some are good learning by seeing things. Visual learning is powerful approach to understanding and retaining information, especially in Mathematics. It can help in clarifying complex concept, increase engagement and foster connections.

2.5 Summary

This chapter have look at related literature on errors made in learning of algebraic expressions, sources of errors made in algebraic expressions and methods that can be used to reduce errors made in algebraic expressions. The next chapter will discuss the research methodology and research design used to collect data for this research.

CHAPTER 3

RESEARCH APPROACH, DESIGN AND METHODOLOGY

3.1 Introduction

The chapter seeks to analyze suitable methods to be used to collect data for the research study. The chapter will focus on the research design, population, sample and sampling procedure and research instruments.

3.2 Research design

Newman (2017) defines research design as a programme that guides investigation or a logical model of proof that allows the researcher to draw influences concerning casual relations among variables under investigation. The design helps the researcher to plan and structure the process of the research as a whole. Therefore it means the research design will be an overall plan the researcher uses during the research.

3.3 Population

According to Small (2018) population is a complete data set from which samples might be drawn. Turkmen (2003) described population in a study as a group in which a research is interested in gaining information and drawing necessary conclusions. This research will target 32 learners in Form three at Goteka Secondary School in Mazowe District, Mashonaland Central Province.

3.4 Sample and Sampling procedure

Francis (2000) defines sample as the small representative subset of the population. From 50 learners the researcher used 32 learners, 16 girls and 16 boys of the age between 15- 16 years. Stratified random sampling procedure was used to make sure both boys and girls are included. Crashaw & Chambers (2002) contends that stratified sampling is used when the population is split into distinguishable layers or strata that are different from each other

3.5 Research instruments

Research instruments are the tools or materials to be used by the researcher to carry out the research project. The researcher will look at each of the instruments used and highlight the advantages and disadvantages drawn from each of the instruments.

3.5.1 Tests

Kulm (2013) states that in general tests seek to measure students' ability in a specific skill and relate it to the table of norms for children of different ages. The researcher administered a pre-test and post-test to the respondents.

Advantages of test

A pre-test is a test given to the students before any interventions that the researcher intends to use. Kulm (2013) explains that pre-test provides actual information about children's ability and performance. Also tests helped the researcher identify some errors made by learners when simplifying algebraic expressions. A test was used because it provides available information on each pupil and it allows the researcher to know the depth of understanding the concept in learners.

Disadvantage of test

However test do not give a complete picture of what happened for example a student might not be knowledgeable in that area and score very poorly on an examination for a variety of reasons. Test demotivates learners as they can assume that they are failures and cannot achieve something.

3.5.2 Interviews

Descombe (2014) point out that a face-to-face interview involves two people, that is, the interviewer and the interviewee. The same author further outlined that the perspectives and the views only come from one source which is simple to manage. On face-to-face interview questions are asked directly to the subject and the subject responds verbally. The researcher used face-to-face interviews to get more detailed data on the teachers' perceptions on the

errors and misconceptions inherent in learners in solving algebraic expressions. Furthermore, Creswell in Mutambara (2018) postulated that face-to-face interviews are helpful since they offer interviewees the opportunity to pose questions and or even further ask supplementary questions. In the same vein, it is important to note that these interviews also provide a wealth of detail and rapport between respondent and the interviewer. In other words, an interview in general is a conversation between two or more subjects (interviewer and interviewee) where questions are asked by the interviewer to collect information from the interviewee.

3.5.3 Interview guide

The researcher typed and printed the interview items on an interview guide which were clearly asked to the key informants that is the six learners at Goteka Secondary School involved in the research. The questions for the interview were accurately planned and carefully worded and various techniques were used which include the use of open questions to allow participants to be able to describe and define a situation. The interview questions were simple and clearly stated for the respondents to clearly grasp them. The researcher conducted face to face interviews with the interviewees. This is a method of evoking responses from research subjects through face-to-face interaction.

3.5.4 Advantages of interviews

An interview has got some advantages as a method of data collection. The researcher is able to get more in depth with each subject by asking open questions and follow up questions. The researcher can get much information from non-verbal responses such as facial expressions and tone of voice. The researcher can get a sense of the collective attitude and experience of a particular group. In group interviews, time is saved since many subjects are included.

3.5.5 Disadvantages of interviews

The research also took note of the disadvantages that are associated with the use of interviews. It takes much time to conduct each interview, thus the researcher cannot go to

many learners and teachers. There are difficulties in record the responses. It requires trained interviewers and can be more expensive. The method can be time consuming and tiresome. In group interviews, it is difficult to take notes while organizing the discussion

3.6 Data collection procedure

In this study the researcher used research instruments like interviews and test. The pre test and post test were administered to 32 learners. The researcher used the letter from the university to seek for permission from the school head to carry out the study in their school. The researcher explained the purpose of the study and assured the school head that information obtained would be used for academic purposes only. This was necessary to get free cooperation of the respondents. The researcher explained to the learners what the research was all about before administering interview to them. The researcher then distributed the interview questionnaires himself to the learners. This helped to ensure that the distribution process has no loopholes and a thorough follow-up was made that all interview questioners were returned.

3.7 Data presentation and analysis procedure.

The researcher presented the collected data in form of tables. The tables which were made to indicate frequency of each response on the scale. The raw frequencies were converted to percentage frequencies. After constructing tables, the data was analyzed, discussed and a conclusion in relation to errors made by learners in simplifying algebraic expressions was drawn. This is called triangulation of ideas that is comparing the same ideas from two sources or instruments.

3.8 Validity and Reliability

Validity is an evolving complex concept because it relates to the inferences regarding assessment results. Focusing on the consequences of the inferences made implies that they should be appropriate and adequate. Messick (1989) points out those inferences are

hypotheses, and when these inferences are validated it amounts to hypothesis-testing. As a result, validity is seen as evaluative judgments that are made on the inferences of assessment results or test scores, that is whether correct interpretations are made and actions are taken based on the inferences. These evaluative judgments need to be correct and reflective of the truth. Many efforts will be taken to check the authenticity and reliability of the data in the proposed study. One of these techniques will be to keep precise records of participant responses, including the use of specific reports and quotes. The goal was to ensure that the study's findings were interpreted consistently and transparently. Through avoiding manipulation of field answers, the study also limited researcher bias

3.9 Ethical Considerations

Trustworthiness of the study involves all the relevant steps that the researcher takes in order to convince his audience that the research is worth their consideration. Bless et al (2013) is of the view that Credibility is measured by the extent the research findings reflect the actuality of the reality being studied. These ethical considerations include informed consent, avoidance of norm, elimination of bias and also anonymity, privacy and confidentiality.

Informed consent

Ethical issues that were considered in this study were informed consent. According to Walliman (2011:47), informed consent is important in getting approval from the participants about the nature of the research process and context. In this study informed consent were obtained from the teachers and the mathematics learners.

Avoidance of Norm

This research focused on the correct and accurate results despite the rules and expectations that socially enforced that may hinder the smooth running of the research.

Anonymity, Privacy and Confidentiality

Anonymity, Privacy and Confidentiality are ethical practices designed to protect the privacy of human subjects while collecting, analyzing and reporting data. Maintaining privacy and confidentiality helps to protect participants from potential harms that include psychological harm such as embarrassment or distress, social harm such as loss of employment or damage to one's financial standing. Hence, this research sought to respect all of the above in order to get true opinions on the topic of research.

Handling of data results

Handling of data results involves respecting the context in which data is collected and not using the data out of context or in ways the person would not expect or agree to. In this research, the researcher ensured that data that belongs to people is correct and that it is collected processed and if necessary shared on fair terms that are understood by everyone involved. The researcher complied with policies and demonstrates responsible practice. He also ensured that data is accessible and the research outputs are visible.

Ethical Clearance

The researcher obtained a letter from the school authorities showing that he was conducting a research in the given topic, thus this letter was used to get authority to do a research from the other parties involved. Ethical clearance is necessary for legal and moral reasons.

Elimination of Bias

To minimize acquiescence bias, the researcher reviewed and adjusted any questions, which elicit a favourable answer including binary responses such as the YES/NO questions. Bias can occur in the planning, data collection, and analysis and publication phases of research. Understanding research bias allows readers to critically and independently review the literature and avoid treatments that are potentially harmful

3.6 Summary

This chapter looked into research design, population, sample and sampling procedure, research instruments used by the researcher to collect data. The next chapter will look into data presentation, interpretation and analysis.

CHAPTER 4

DATA PRESENTATION, INTERPRETATION, ANALYSIS

4.1 Introduction

This chapter focused on presentation, interpretation and analysis of data collected using instruments outlined in Chapter 3 namely tests and interviews. Tables, pie chart and bar graphs were used to present the data.

4.2 Errors made in simplifying of algebraic expression

The study showed errors made by learners in learning algebraic expression in Form three at Goteka Secondary School. Tests were written to measure learner performance. Also to obtain more information on the issue interviews were administered. To verify the responds from the interviews the researcher conducted a questionnaire. All the thirty two learners wrote the test and they showed that they make errors in simplifying algebraic expressions.

Table 4:1 below shows errors made by learners in simplifying algebraic expressions.

Fig 4.1 table on the errors made by learners in learning algebraic expressions.

Errors made	Frequency
Grouping positive and negative items	4
Mathematics vocabulary	6
Change of signs	10
Learning directed terms	9

Figure 1SOURCE: Data collected from the tests wrote by learners at Goteka Secondary School

From the table above it was noted that learners make errors in grouping positive and negative which was frequently repeated for 4 times, learners had challenges in understanding Mathematical vocabulary which was frequently repeated for 6 times, change of sign was frequently 10 times and learning directed terms was 9. This was supported by tests as 2/3 of the sample failed to obtain more than half on the test. This is a clear indication that learners

face problems in solving algebraic expressions. This was due to lack of adequate Mathematical background. This concurs with Alexis (2007) who suggests learners find learning of algebraic expressions difficult because they lack Mathematical background.

4.3 Sources of errors made in simplifying algebraic expressions.

The study aimed to find sources of errors made by Form three learners in learning algebraic expressions at Goteka Secondary School. Interviews were mainly used. However, to verify the information obtained from test the researcher used interview. The researcher also used interview because it probe learners to keep on providing information on the source of errors in algebraic expressions.

The pie chart fig 4.2 shows the source of errors made in algebraic expressions.

Fig 4.2 pie chart on the sources of errors made in algebraic expressions.

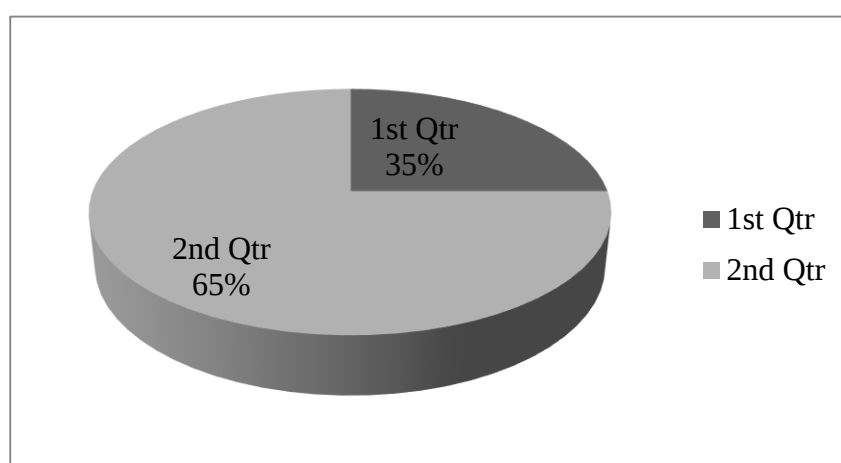


Figure 2 Source: data collected from the questionnaire of 32 learners at Goteka Secondary SchoolKey

1stQtr: inconsistence in the way that they partition algebraic expression into components parts.

2ndQtr: lack of adequate Mathematics background.

From the above pie chart it was noted 65% of learners lack adequate Mathematics background and 35% of learners are not consistent in the way they partition algebraic expressions into components parts. The researcher observed that most learners who had poor Mathematical background failed the test. This is in line with Alexis (2007) who argues that if the learner has poor mathematical background the learner is likely to make errors in simplifying algebraic expressions.

4.3.1 Methods that can be used to reduce errors made in simplifying algebraic expressions

The study attempted to reduce errors made by learners and teachers in simplifying and teaching algebraic expressions. Susan & Judith (2006) assert that teaching methods refers to the ways that can be employed by the teacher in order for the learner to comprehend the concept. The bar graph below shows the most preferred teaching methods by teachers at Goteka Secondary School.

Fig 4.3 bar graph showing teaching methods used by teachers at Goteka Secondary School.

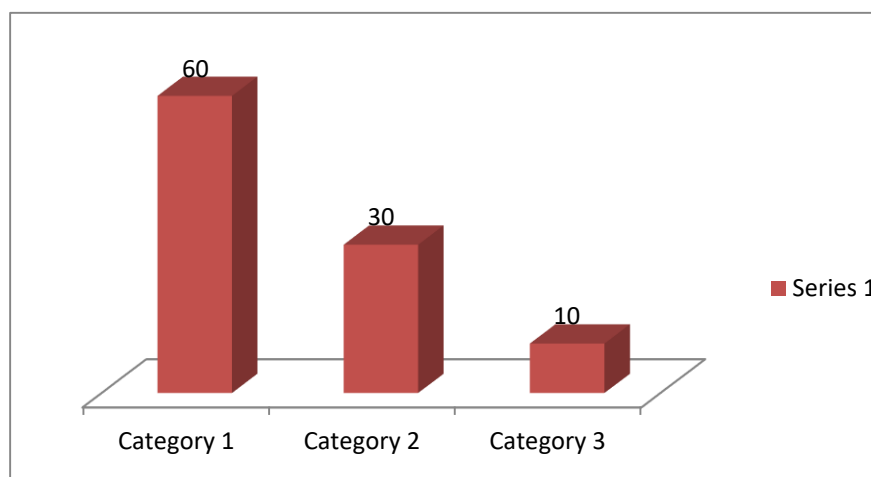


Figure 3 Sources: data collected from interviews of teachers at Goteka Secondary School.

Category 1: student authored word problem

Category 2: Motivation

Category 3: Learner centred approach

From the graph above, it was noted that two of Mathematics teachers at Goteka Secondary School prefer discovery learning when simplifying algebraic expressions that is 60% of them. From the graph it is clear that teachers usually use the discovery learning as compared to other ways of teaching algebraic expressions. Hanze (2005) claims that when learners write their own algebraic expression problems it increases their ability to comprehend and solve such problems as well as to increase problem solving ability in general. However, Winogrand (1995) argues that a good strategy for simplifying algebraic expression needs proper selection of the appropriate operations that will yield the correct solution. One teacher view the use of learner centeredness and motivation to improve performance of learners in understanding algebraic expressions.

4.4 Summary

This chapter looked on data presentation, interpretation and analyses. Tables, pie charts and bar graphs were used to present data which was collected during the study. In the next chapter the researcher will conclude the research by looking at summary, conclusion and recommendations.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATION

5.1 Introduction

In this chapter, the researcher summarizes, gives conclusions and recommendations which makes the teaching and learning process effective for the learners to be able to simplify algebraic expressions.

5.2 Summary

The study focused on Form three learners studying Mathematics at Goteka Secondary School. The main aim of this study was to find out errors made by learners in learning algebraic expressions. The interest of studying the topic was triggered by the way learners simplify algebraic expressions.

5.3 Conclusions

Results obtained from respondents concurred with what most scholars say regarding errors made in learning algebraic expressions for example lack of Mathematical background makes learners fails to simplify algebraic expressions. Failure to understand mathematical vocabulary, change of signs especially negative sign and inconsistency in the way they partition algebraic expressions into component parts were the main challenges.

5.4 Recommendations

The researcher came with recommendations to minimize errors made by learners in learning algebraic expressions.

- Learners are encouraged to revise their work frequently so that they comprehend mathematical vocabulary
- Through consultation meetings, trained teachers should encourage parents to support their children financially by buying textbooks to ensure that learners have the required necessities in the learning of Algebra.

- Teachers are encouraged to relate Mathematics concept taught to real life problems so that the abstract nature of the learning area such as worded decimal fractions is minimized.
- The school administration is encouraged to closely monitor teachers' records including remedial and extension exercises as well as lesson observations to ensure a fair learning environment for both slow and fast learners
- The school to enrich its source of revenue to run the school to ensure that textbooks are sufficient to cater for learners who are less privileged at home.
- Teachers to vary their methods of teaching Algebra as well as remediating learners where necessary so as to reduce the continual failure in learning algebraic expressions.

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APPENDIX 1: Request for permission to carry out a research

GOTEKA SECONDARY SCHOOL

P. BAG 3032

NZVIMBO

21 MARCH 2024

PROVINCIAL EDUCATION DIRECTOR

MINISTRY OF PRIMARY AND SECONDARY EDUCATION

MASHONALAND CENTRAL PROVINCE

BINDURA

RE: Application for Research on Investigation into errors made in simplifying algebraic expressions at o level at Goteka secondary school.

Dear Sir/Madam

I am writing to formally request your permission and support for conducting a research study titled "**on Investigation into errors made in simplifying algebraic expressions at o level at Goteka secondary school in Mazowe**" in Mashonaland Province as a partial fulfillment of the Honours Bachelors Science Education in Mathematics at Bindura University of Science Education. The sampled target school is Goteka secondary schools. As an aspiring researcher I want to investigate into errors made by ordinary learners in simplifying algebraic expressions. The final report is intended to be submitted by 30 June 2024

May you please find attached the research abstract, the introductory letter from the university, national and school IDs. The Ministry of Education plays a pivotal role in ensuring equitable

and quality education for all students. I will fully comply with all relevant policies, guidelines, and ethical considerations set forth by the ministry while conducting this research. The research will strictly adhere to the principles of confidentiality and privacy, and no breach of the Official Secrecy Act or the safety of respondents will occur during any stage of the study.

I assure you that any data collected during the research will be used solely for the purpose for which it was collected. The data will be securely stored and analyzed to derive meaningful conclusions that can inform policy recommendations. The research report, upon completion, will be submitted to the Ministry of Education for review and consideration. It is my intention to contribute to the body of knowledge in this area and assist in the formulation of evidence-based policies and practices to address the errors made in mathematics specifically algebraic expressions.

I kindly request your approval and support for this research endeavor. I am prepared to provide any additional information or clarification you may require regarding the research proposal. Furthermore, I am open to any suggestions or modifications that align with the goals and objectives of the Ministry of Education.

Thank you for considering my application. I look forward to the opportunity to contribute to the advancement of education in Bindura Province. Should you require any further information, please do not hesitate to contact me at your convenience.

Yours sincerely,

Mpondi Arnold EC NO 1996026S

Mpondiarno@gmail.com 0784062094

APPENDIX 2

PERMISION LETTER FROM BINDURA UNIVERSITY

SAMED

P Bag 1020
BINDURA
ZIMBABWE

Tel: 0271 - 7531 ext 1038
Fax: 263 - 71 - 7616

 BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date:

TO WHOM IT MAY CONCERN

NAME: MWENDI, ARNOLD REGISTRATION NUMBER: B2131338

PROGRAMME: HBSCed MATHS PART: 2.2

This memo serves to confirm that the above is a bona fide student at Bindura University of Science Education in the Faculty of Science Education.

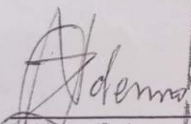
The student has to undertake research and thereafter present a Research Project in partial fulfillment of the HBSCed MATHS programme. The research topic is:

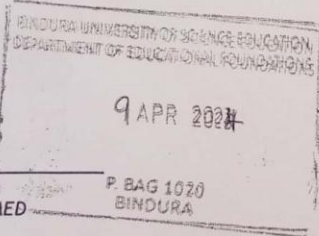
AN INVESTIGATION INTO ERRORS MADE BY LEARNERS
IN SIMPLIFYING ALGEBRAIC EXPRESSION AT ORDINARY LEVEL
AT GOTEKA SECONDARY SCHOOL.

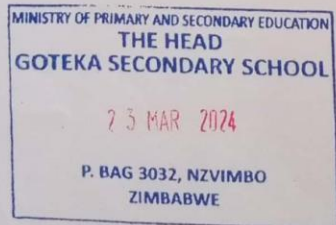
In this regard, the department kindly requests your permission to allow the student to carry out his/her research in your institutions.

Your co-operation and assistance is greatly appreciated.

Thank you


Z. Ndemo (Dr.)
CHAIRPERSON - SAMED


P. BAG 1020
BINDURA


P. BAG 3032, NZVIMBO
ZIMBABWE

APPENDIX 3

Pre-test

- Answer all questions
- Clearly present your work
- Number of marks are given at the end of each question
- Total 15 marks

1. Simplify the following

(a) $a - 5a + 8a - 2a$ [2]

(b) $6x - 2y - 5y - 3x$ [2]

2. Remove brackets from the following

(a) $-5a(-5x - 7y)$ [2]

(b) $-x(2x - 11y)$ [2]

(c) $(-5m + 2n)(-9m)$ [2]

(d) $-p(p - 5q)$ [2]

3. Remove brackets and simplify the following

(a) $3(6a + 3b) + 5(2a - b)$ [3]

(b) $2(3x - y) - 3(2x - 3y)$ [2]

Solutions

- $1(a)a - 5a + 8a - 2a$
- $= a + 8a - 5a - 2a$
- $= 9a - 7a$ *grouping + and - terms 1 mark*
- $= 2a$ *1 mark*
- (b) $6x - 2y - 5y - 3x$
- $= 6x - 3x - 5y - 2y$ *1 mark*
- $= 3x - 7y$ *1 mark*

Removing brackets

- 2(a) $-5a(-5x - 7y)$
- $= 25ax + 35ay$ *multiplying directed terms 2 marks*
- 2(b) $-x(2x - 11y)$
- $= -2x^2 + 11xy$ *2 marks*
- 2(c) $(-5m + 2n)(-9m)$
- $= 45m^2 - 18nm$ *2 marks*
- 2(d) $-p(p - 5q)$
- $= -p^2 + 5pq$ *2 marks*

Removing brackets and learning

- 3(a) $3(6a + 3b) + 5(2a - b)$
- $= 18a + 9b + 10a - 5b$ *removing brackets 1 mark*
- $= 18a + 10a + 9b - 5b$ *grouping + and - terms 1 mark*
- $= 28a + 4b$ *simplifying 1 mark*

- $3(b) \quad 2(3x - y) - 3(2x - 3y)$
- $= 6x - 2y - 6x + 9y$
- $= 6x - 6x - 2y + 9y \quad 1mark$
- $= 7y \quad 1 mark$

APPENDIX 4

Post test

- Answer all questions
- Clearly present your work
- Number of marks are given at the end of each question
- Total 15 marks

1. Remove brackets and simplify the following

(a) $x(x - 7) + 4(x - 7)$ [3]

2. Expand and simplify the following

(a) $(2c - 9e)(4c + 5e)$ [3]

(b) $(4m - n)(3m - 3n)$ [3]

(c) $(m + 4n)^2$ [3]

(d) $(2c - 3d)^2$ [3]

Solutions

Removing brackets and learning

1(a) $x(x - 7) + 4(x - 7)$

$$= x^2 - 7x + 4x - 28 \quad 1 \text{ mark}$$

$$= x^2 - 3x - 28 \quad 2 \text{ marks}$$

Expand and simplify

$$2(a)(2c - 9e)(4c + 5e)$$

$$= 4c(2c - 9e) + 5e(2c - 9e) \text{removing brackets 2 marks}$$

$$= 8c^2 - 36ce + 10ec - 45e^2$$

$$= 8c^2 - 26ce - 45e^2 \text{simplifying 1 mark}$$

$$2(b)(4m - n)(3m - 3n)$$

$$= 3m(4m - n) - 3n(4m - n) \quad 1 \text{ mark}$$

$$= 12m^2 - 3mn - 12nm + 3n^2 \quad 1 \text{ mark}$$

$$= 12m^2 - 15mn + 3n^2 \quad 1 \text{ mark}$$

$$2(c) \quad (m + 4n)^2$$

$$= (m + 4n)(m + 4n)$$

$$= m(m + 4n) + 4n(m + 4n) \quad 1 \text{ mark}$$

$$= m^2 + 4mn + 4mn + 16n^2 \quad 1 \text{ mark}$$

$$= m^2 + 8mn + 16n^2 \quad 1 \text{ mark}$$

$$2(d)(2c - 3d)^2$$

$$= (2c - 3d)(2c - 3d)$$

$$= 2c(2c - 3d) - 3d(2c - 3d) \quad 1 \text{ mark}$$

$$= 4c^2 - 6dc - 6dc + 9d^2 \quad 1 \text{ mark}$$

$$= 4c^2 - 12dc + 9d^2 \quad 1 \text{ mark}$$

APPENDIX 5

INTERVIEW QUESTIONS FOR FORM 3 LEARNERS

INTRODUCTION

I am Mpondi Arnold, a student at Bindura University of Science Education (BUSE) in Zimbabwe. I am conducting a research about errors made by learners in simplifying algebraic expressions at Goteka secondary school.

Your response will be anonymous and the information gathered will help to reduce errors made by learners in simplifying algebraic expressions. I would appreciate your commitment to participate in this interview session. Your responses will be kept confidential and will only be used for research purposes. Please answer the following questions to the best of your knowledge and experiences.

NAME OF STUDENT

AGE..... MALEFEMALE.....

1 Do you consider mathematics as an important subject?

2 Which topics in mathematics do you find difficult?

3 What major errors have you made when simplifying algebraic expressions?

4 What are the major causes of the errors you encountered when solving algebraic expressions?

3 Which actions are you taking as a learner together with parents and teachers to restore normal performance in solving algebraic expressions?

4 What do you think is the most common difficulty learners face when simplifying algebraic expressions?

5 How do you think learners can over the challenges of combining like terms?

- 6 *What strategies can learner use to understand the concept of distributive property?*
- 7 *How can you address the issue of failing to complete fully the concept?*
- 8 *How can you assist learners struggle with negative signs and integers in algebraic expressions?*
- 9 *What do you think are common misconceptions learners have when simplifying algebraic expressions and how do address them?*