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FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF MATHEMATICS



**AN INVESTIGATION INTO PROBLEMS FACED BY TEACHERS AND LEARNERS
IN THE TEACHING AND LEARNING OF PROBABILITY IN MATHEMATICS AT
ORDINARY LEVEL, A CASE STUDY OF MAGUNJE HIGH SCHOOL IN UMP
DISTRICT.**

BY

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BINDURA UNIVERSITY OF SCIENCE EDUCATION

APPROVAL FORM

The undersigned certify that they have read and recommended to Bindura University of Science Education for acceptances; a research project entitled, an investigation into problems faced by teachers and learners in the teaching and learning of probability in mathematics at ordinary level, a case study of Magunje high school in UMP District, Mashonaland East Province. Submitted by Musanhi Aquinata in partial fulfillment of the requirements for obtaining the degree of Honours of Bachelor of Science Education in Mathematics (HBSCED)

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Abstract

The purpose of the study was to explore problems encountered in the teaching and learning of probability at Ordinary level and to offer ways of addressing them. A convenient sample of seven mathematics teachers and twenty-five Ordinary level mathematics candidates participated in the study. A descriptive survey design was used. Data was collected from the teachers using a teacher questionnaire and teacher interview and from learners through the use of a learner questionnaire, diagnostic test and learner interview. Descriptive statistics and frequencies were used to analyse learner questionnaires, teacher questionnaires and learners' responses to a diagnostic test. Teacher and learner interviews were transcribed and classified according to themes. The results showed that teachers had difficulty in constructing and interpreting probability diagrams and tables and interpreting probability terminology. Also, the results showed that learners experienced difficulties in constructing and interpreting probability graphs and tables; and interpreting probability terminology. The results found possible causes of the teachers' difficulties to be their lack of probability content knowledge, inadequate textbooks and in-service programs which did not pay adequate attention to probability. Further, the findings of the study were that the probable causes of learners' difficulties were teachers' lack of content knowledge in probability, inadequate learning materials and learners' lack of conceptual knowledge of certain aspects of probability. Lastly, the results of the study recommended that the possible ways to address the problems in the teaching and learning of probability at ordinary level to be; textbooks should be well written (provide thorough explanations) and contain all the information necessary to teach probability (i.e. formulae, more examples); in-service teacher programs should meet the needs of the teachers by offering topics that teachers find difficult to teach and more and longer inset programs on probability.

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CHAPTER ONE

1.0 Introduction

This chapter will outline the background of the problem, clarifying the main objectives of the research and the significance to the teaching and learning of Mathematics. Limitations and delimitations will be highlighted in this chapter. Definition of key terms and the assumptions upon which the project will be based on will also be included.

1.1 Background to the Study

To adequately function in society, citizens need to acquire strategies and ways of reasoning that help them in making adequate decisions in everyday and professional situations where chance is present. Since uncertainty and randomness occur in many aspects of our life, having a good knowledge of probability helps us make sense of the uncertainties. This need for probability literacy has been recognized by educational authorities in Zimbabwe by including probability in the curricula at different educational levels and in the education of teachers. Mathematics is one of the core curriculum subjects at ordinary level and generally learning mathematics is not fun for a majority of the students but a nightmare. Probability as part of the mathematics curriculum has been a difficult concept to learn and teach. It utilizes a language and terminology that is demanding. Students often struggle with the material and some school teachers avoid teaching the topic hence Ordinary Level Mathematics is the foundation of Advanced Level Mathematics. Learners who want to do Science subjects at Advanced Level should have good grades in Mathematics at Ordinary Level in line with STEM. The New Curriculum seeks to have citizens who have knowledge in Mathematics among other cross cutting learning areas. According to Lyn and Bocado (2009) as cited in (Tshabalala & Ncube, 2012), "mathematics is a fundamental part of human thought and logic, and integral to attempt and understand the world and our self." Thus, therefore the researcher found it necessary to explore problems encountered in the teaching and learning of probability.

1.2 Problem Statement

Pupils' performance at schools has been a matter of concern especially in mathematics. In spite of the significant role played by mathematics both in enhancing comprehension of other school subjects and its general role in life, learners continue to fail the subject at various levels in the school system, particularly at Ordinary Level public examinations. The majority of Ordinary level mathematics learners is failing to solve probability questions and may not

attempt any question in relation to probability and also some school teachers avoid teaching the topic. There is, therefore need to investigate the problems faced by teachers and learners in the teaching and learning of probability in mathematics.

1.3 Research Questions

The study will be guided by the following questions

- i. What are the challenges faced by teachers in the teaching of probability?
- ii. What are the challenges faced by learners in learning probability?
- iii. What can be done to improve teaching and learning of probability?

1.4 Assumptions

In this study the researcher assumes that:

- i. The respondents will give correct and reliable information.
- ii. There are causes responsible for the difficulties in the teaching and learning of probability.

1.5 Significance (Justification) of the Study

The findings of the study will add to the pool of academic knowledge in mathematical areas. It is hoped that the study will be helpful to researchers, classroom teachers and learners in an effort to improve teaching of probability in the mathematics curriculum. The results will enable teachers to evaluate their teaching approaches and adopt those which improve performance in probability. It will shed light on the future needs and capabilities of the students of Magunje high school and change the attitudes of the learners, teachers and the entire society towards probability and mathematics as a whole. The study will also add to literature which can be adopted and used to compare to other studies done elsewhere.

1.6 Delimitations of the study

The research will be carried out at Magunje High School, a day school in UMP district. The school is located about 30 kilometers north of Murewa Growth Point in Mashonaland East Province. The school is in a communal area. The research will focus only on ordinary level learners of mathematics and mathematics teachers at this school. The findings of the research project will be restricted to the school at which the research will be carried out.

1.7 Limitations of the study

The study has several limitations. Firstly, the time allocated for conducting the research is limited, preventing the researcher from covering all schools in UMP district, which would

have provided a more comprehensive picture of the district. Additionally, financial constraints will restrict the scope of research instruments necessitating manageable sample size.

1.8 Objectives

The research study sought to:

- i. To investigate challenges faced by teachers in teaching probability.
- ii. To investigate challenges faced by learners in learning probability.
- iii. To come up with strategies to improve the teaching and learning of probability.

1.9 Definition of terms

Learner- According to (Gwarinda, 1993) learner is a person who is studying at a school

Attitude – (Trevors, 1993) defines attitude as the behavior towards something or somebody.

2.0 Summary

In this chapter the background to the study, statement of the problem, purpose, objective, research questions, significances, assumption, limitations, in the study were analyzed. The next chapter will dwell on the literature review.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter will try to analyze what other researchers say about the challenges in general.

2.1 Probability

Probability of a certain response is the relative frequency of that response in the population. It is a measure of a likelihood of a required outcome happening (Chong, Chong, Shahrill, & Abdullah, 2017a). (Bryant & Nunes, 2012) are of the view that probability is a quantity based on proportions, and is usually expressed as a decimal number, a percentage or a ratio. Mathematically, it is a numerical measure of the likelihood or a ratio that describes how likely the event will occur and is between zero and one. Probability constitutes a distinct approach to thinking and reasoning about real life phenomena.

2.2 The origins of probability

Probability theory was inspired by games of chance and gambling during the 16th century. Dicing, card games and lotteries, public and private, were important social and economic activities (Hald, 2003) as cited in (Batanero & Diaz, 2012). Gambling originated in the early stages of human history; it was not the invention of a single people but appeared in many places in the world (Burton, 2007). This was supported by Batanero and Diaz 2007 as cited in (Batanero, Chernoff, Engel, Hollylynne, & Sanchez, 2016), who said that, intuitive ideas about chance emerged very early in history in many different countries and were linked to problems related to setting fair betting in games of chance. The fundamental principles of probability theory were formulated for the first time in 1654 by two mathematicians, Blaise Pascal and Pierre de Fermat, after a well-known gambler, Chevalier de Méré, consulted Blaise Pascal about some questions concerning a popular game of dice (Burton, 2007). Originally the theory of probability was developed by Pascal (1628-1662) to describe games of chance (Batanero & Diaz, 2012). The theory of probability is in essence of a formal encapsulation of intuitive views of chance that lead to the fundamental idea of assigning numbers to uncertain events. Although there are a number of predecessors of Blaise Pascal and Pierre de Fermat who had solved problems on games of chance during the 15th and 16th centuries, no general theory was developed before Blaise Pascal and Pierre de Fermat (Burton, 2007).

Probability theory became popular, and the subject developed rapidly during the 18th century. The major contributors during this period were Christiaan Huygens, Jakob Bernoulli and Abraham de Moivre (Burton, 2007). In 1812 Pierre Simon Laplace introduced the new ideas and mathematical techniques in his book, *Théorie Analytique des Probabilités*. Before Laplace, probability theory was solely concerned with developing a mathematical analysis of games of chance. In the 18th century, the application of probability moved from games of chance to scientific problems. Laplace applied probabilistic ideas to many scientific and practical problems; mathematical theory of life insurance life tables, the theory of errors, actuarial mathematics and statistical mechanics are all examples of important applications of probability theory developed in the 19th century.

Currently, in the 21st century, probability theory is used in all kinds of risk assessment in the insurance industry, in medical research, in engineering, in finding the genetic makeup of individuals or populations, in quality control, in investment and in virtually every other human endeavor. Probability theory today is particularly valuable as it can be used to

determine the expected outcome in any situation, from the chance that a plane will crash to the probability that a person will win the lottery.

2.3 Challenges faced by teachers in teaching probability

Although there have been calls for an increased attention on probability in the school curriculum, one of the problems encountered is the inadequate preparation of teachers in probability (CBMS, 2001). Probability and statistics is harder to understand than ordinary mathematics because it needs much more interpretation and understanding of context (Batanero & Diaz, 2012, p. 5) The teaching and learning of probability is particularly challenging because it is an abstract concept. Mathematics teachers face problems in explaining probability concepts to learners; solving probability problems from past examinations papers; designing appropriate activities in probability for learners; determining syllabus objectives; and relating the teaching of probability to learners' real-life experiences.

(Atagana, et al., 2009), as cited in (Makwakwa, 2012), investigated topics perceived as difficult by learners and teachers in the teaching and learning of mathematics. The results of the study identified probability as one of the topics teachers experienced difficulties with. In (Atagana, et al., 2010) study results revealed probability as problematic topic for teachers (Makwakwa, 2012). (Wessels & Nieuwoudt, 2011), studied the profile of mathematics teachers' statistical knowledge, beliefs and confidence and they found out that many teachers indicated lower levels of confidence in aspects that involved probability topics. (Groth, 2009), observed that, at times, mathematics teachers showed some of the cognitive difficulties experienced by learners in understanding probability concepts.

It is clear from the preceding discussion that there are problems associated with the teaching of probability in schools. It is on this basis that the current study is being conducted with mathematics teachers and ordinary level learners in mathematics. If there are any problems found in the teaching of probability, solutions to these may be found with the view to improve the teaching of probability.

2.4 Challenges faced by learners in learning probability

Learners' have conceptual difficulties in understanding probability concepts such as sample space; outcome tables, tree diagrams and probability laws. (Behr, Lesh, Post, & Silve, 1983) as cited in (Makwakwa, 2012), mentioned that learners appeared to have difficulties in developing intuition about fundamental ideas of probability for the reason that many learners

have underlying difficulties with rational number concepts and proportional reasoning, which are used in calculating, reporting and interpreting probabilities.

Ben-Zvi and Garfield (2004) in (Makwakwa, 2012) are of the view that, many learners have difficulty with the underlying mathematics (such as fractions, decimals, proportional reasoning) and this interferes with learning the related probability concepts. The context in many probability problems may mislead the learners, causing them to rely on their experiences and often faulty intuitions to produce an answer, rather than selecting an appropriate probability procedure, for example (Ghinis, Korres, & Bersimis, 2009),” learners’ identified the difficulties that teachers face mainly in the presentation and organization of data in the classroom, they encouraged the use of computers, slides and teachers being better informed about probability.

2.5 Factors contributing to challenges in Probability

The following are different factors that have been identified as contributing to challenges faced in Probability.

2.5.1 Mastery of basic facts

Poor mastery of basic mathematical facts leads to use of time consuming and distracting methods resulting in incorrect solution to problems. (Han, et al., 2016), pointed out that anxiety appears to be more easily around in learning mathematics than it is in other subjects. This anxiety is as a result of pupils’ incompetence in the subject matter. Pupils’ confidence in their own ability to learn mathematics largely influences the extent with which they master basic facts. The inadequacy in basic fact induces anxiety in learners, affects pupils’ critical mathematical reasoning and leads to errors in solving problems. This anxiety also influences pupils’ recalling of basic facts which are necessary in probability. Anxiety however, is subject to the teaching strategies which teachers use in delivering lessons.

2.5.2 Teaching strategies

Content presentation and methodology directly influences mastery of basic facts and their application. (Chong, Chong, Shahrill, & Abdullah, 2017a), noted that without instructional intervention pupils continue with error patterns of a long time. Implications are that teaching strategies in the learning of mathematics influences the extent of difficulties in probability. It is the responsibility of the teacher to choose appropriate teaching methods which suits a particular topic so as to enhance learning. Topics in Mathematics require different teaching methods. For example if the lecture method is used to teach probability, students will not be

able to understand the concepts. The teacher will be doing most of the talking. The topic requires students to be actively involved in the teaching and learning process. The choice of a teaching method matters in Mathematics as main focus in mathematics teaching is to instruct pupils so that they acquire skills and be able to interpret problems. Therefore strategies whose methodology encourages rote learning, falls short in equipping pupils with full skills to use in question answering. Experiments in probability can be very exciting and interesting to students. Questions require the demonstration and justification of knowledge (Chong, et al., 2017).

Teachers should adopt strategies that encourage pupils to demonstrate and justify their knowledge, as undesirable approaches can create anxiety and lead to difficulties. Two such strategies that foster anxiety and errors are an overemphasis on memory, where pupils are encouraged to memorise facts without understanding, leading to a weak grasp of basic concepts; and an emphasis on speed, where pressurising slow learners to complete tasks quickly can lead to memorisation rather than genuine comprehension, hindering their progress .

2.5.3 Attitude towards the subject

Achievement of students in a subject is determined by their attitudes rather than inability to study. Pupils failure in understand the topic probability has been partly associated with their negative attitude towards mathematics as a whole. This was supported by (Olatunde, 2010) in (Emmanuel, Adom, & Josephine, 2014) showed in a research conducted on students' self-concept and Mathematics achievement that, students who have positive self-concept of themselves performed well in mathematics. According to (NCTM, 2014) attitude is the relatively ending orientation that individuals develop towards various objects and issues they encounter during their lives and which they express verbally as opinions.

Parents' attitude towards mathematics has an impact on students' performance in the subject. (O'Neil, 2011), is of the view that parents' expectation encourages their children to pursue goals with hard work, enhance self-efficacy and nurture good habits of studying. If this is done towards mathematics pass rate will be improved. According to (Anderson, 1999), attitudes are learned throughout life and are held in the way children are socialized at home and at school. Students whose parents' attitude towards mathematics is encouraging performed better in the subject compared to those whose parents have a negative attitude towards the subject, as children are good observers. However according to (Kafata &

Mbetwa, 2016) many of the pupils acknowledged that some of the challenges they face, were as a result of lack of their commitment and negative attitude towards the subject hence resulted in lack of study groups and lack of study time table to plan their studying. According to (Sikwali, 2014), A student with a negative academic self-concept, for example, might just avoid studying hard because he would regard the subject content as too difficult.

Teachers' attitudes are also crucial in the teaching and learning of Mathematics. Students learn mathematics through the experiences that teachers provide. (Anderson, 1999), points out that negative attitude of a teacher towards the subject have negative effects towards pupils' performance as well as their career in life. A teacher should have a positive attitude towards his or her work. (Bandura, 1977), cited in (Yara, 2009), pointed out that behaviors are acquired by watching another person or model performing a particular task or activity. In the classroom, teachers are seen as role models by the students. Teachers are regarded as the source of knowledge and information. From the teachers' disposition, students will form their attitudes which may eventually affect their learning outcomes. (Mwamwenda, 1995), argued that teachers who have a positive attitude towards their subjects and pupils are more motivating than those who have a less positive attitude and personality. Teachers will work hard towards the success of their students. Thus therefore, attitude is a contributing factor in the poor performance of learners in probability at ordinary level mathematics since many regard the topic as difficult.

2.6 Strategies for overcoming the challenges

Variation of teaching methods is important because different teaching methods draw attention to different competencies in Mathematics. Variation of teaching methods eliminates boredom in Mathematics lessons. The interest of the students will be aroused in learning Mathematics. Teachers' lack of effective methods of teaching Mathematics scares away students from Mathematics. Once students are scared from doing Mathematics, the end result is students dropping the subject. Methods of teaching should cater for the needs of all the students. Teachers must focus on more challenging teaching style which focuses more strongly on students understanding the work. He further asserted that teachers must pose fewer routine problems by encouraging collaborative learning where students have time to explore and refine their thinking. More time should be allowed for developing Mathematical concepts. Teachers should not rush when teaching Mathematical concepts. (Bruner, wood, & Gail, 1976), argued that the discovery method should be used for learning Mathematical concepts. When using the discovery method, confidence is created in the students. Discussions, project

and discovery methods create an enabling environment for the learners and ensure that individual differences are taken care of. If inappropriate methods of teaching are used, poor performance in examination will persist even if a highly qualified teacher is teaching Mathematics. Teaching should be learner centered in order to make learning more relevant to the learner and to make students self-reliant.

2.7conclusions

In summary, the study's review of related literature highlighted several factors that contribute to difficulties faced in the teaching and learning of probability in ordinary level mathematics as researched internationally, regionally and locally. The impact of these factors raised is applicable to all learners of mathematics regardless of the socio-economic background of the learners. From the international researches, it can be deduced that difficulties faced in probability by pupils' and teachers in mathematics is not a problem confined to Magunje High School only and also in the UMP District in Zimbabwe, but the problem also exists globally, as highlighted by international and local literature. The next chapter will focus on the methodology that will be employed to collect data on this research.

CHAPTER THREE

Research Methodology

3.0 Introduction

This chapter focuses on the methods of collecting data, population, research instruments, sampling and data collection procedures in the analysis of problems encountered in the teaching and learning of probability at ordinary level. (Han, et al., 2016) , describes a research as a process of arriving at a dependable solution to problems through planned and systematic collection, analysis and interpretation of data. (Chong, Chong, Shahrill, & Abdullah, 2017a) , viewed, methodology as an operational framework within which facts are placed so that their meaning makes sense and may be perceived more clearly. Each component will be discussed separately below.

3.1 Research Design

This study will adopt a qualitative research approach and follow a descriptive survey research design. In a survey study information is assessed on “attitudes, opinions and behavior or characteristics of a population” (Creswell, 2011, p. 376). (Michael, 2003), describes the descriptive survey as a method of collecting data directly from the people about different aspects such as their personal background, attitudes wishes and feelings. In the current study, teachers' and learners' views and opinions on problems encountered in the teaching and learning of probability will be explored. (Cohen, Manion, & Mornison, 2011) are of the view that a descriptive survey seeks to establish, describe and interpret practices and trends in given places such as schools. This design will allow the researcher to interview, ask participants to complete a questionnaire and write a diagnostic test to uncover problems encountered in the teaching and learning of probability in schools. The descriptive survey was opted as the best method to be used in this research as it permits only a few members in a population to respond but those selected members are to represent the whole population under investigation. (Chiromo, 2006, p. 29) “A descriptive survey deals with a view to drawing up conclusions that cover the generality of the whole group. The descriptive survey is a method of research that looks with intense focus at the problem of that moment and then

describes what the researcher sees. This design is useful in obtaining both qualitative and quantitative data hence suitable in obtaining students and teachers' opinions on the problems encountered in the teaching and learning of probability.

3.2 Population

In this research the researcher will consider all one hundred and sixty-eight Ordinary Level students doing mathematics at Magunje high school in UMP District as population, that is form three and form four students since probability is introduced at ordinary level and seven mathematics teachers at the school as the population of the study. The researcher will work with a sample since the population is too big to deal with in its entirety. This is due to factors of expense, time and accessibility. Therefore there is need for sampling so as to get a manageable number of participants who would be involved in the study.

3.3 Sampling Procedure

(Chong, et al., 2017) Defined a sample as a group on whom data is collected and for whom comparisons are made. Sampling means selecting a given number of people from a defined population. According to Ary, Jacob and Razavieoh (1972), a sampling fraction of between 5-15 % of the total population in a descriptive research is acceptable. The researcher adopted the purposive sampling method in collecting data. According to (Cohen, Manion, & Mornison, 2011), in purpose sampling the cases to be included in the study sample are handpicked by the researcher on the basis of the researchers' judgment of their small number. The research will be carried out using twenty-five ordinary level Zimsec candidates who registered for mathematics at Magunje High School, through purposive sampling. For the teachers all the seven Mathematics became part of the sample because of their typicality. Thus, basing on this sample, the researcher hopes to get relevant data on the problems faced by learners and teachers in the teaching and learning of probability at Magunje High School.

3.4 Research Instruments

Data collection was done through questionnaires (a teacher questionnaire and a learner questionnaire), a diagnostic test, and semi-structured interviews (teacher interview and learner interview) to collect the data. The data collection instruments will be administered by the researcher in person. The respondents will be the learners, and Mathematics teachers.

3.4.1 Questionnaires

(Christensen & Johnson, 2012) Describes a questionnaire as "a self-report data collection instrument that each research participant fills out as part of the research study. (Kalof, Dan, & Dietz, 2008) Assert that, "a questionnaire consists of a series of questions that respondents

read themselves and answer”. The questionnaire have both closed and open ended questions. The open ended type of questions aimed at getting the reasons from the respondents and more clarity on the issues of probability. These questions will allow the respondent freedom to express his/her feelings without being guided by limited choice. Closed ended questions will be used so as to direct respondents’ thinking and views and to allow a single answer from given alternatives. Closed answers will allow for a greater scope of quantification as many respondents will give their views on the matter being researched. This will allow respondents to answer similar questions so that it will be easy to analyse them. The respondents will not fill in their names. Copies of the questionnaire will be distributed to the respondents by the researcher in person and will collect soon after completion to counter non-return. Since questionnaires assure respondents of their anonymity, the researcher hopes that respondents will not give dishonest and evasive answers; this ensures reliability and authenticity of the research results.

3.4.1.1 Questionnaire for Teachers

The questionnaire had four sections. Section A: which consist of demographic information such as gender, age, educational level, teaching experience and level of the class being taught. These questions were asked to ascertain whether gender and age have an influence on the problems encountered in the teaching of probability. Educational level and teaching experience were vital in the assessment of the relationship between the teaching of probability and qualification level as well as experience in the field of teaching the respondents had.

The Likert scale was used for measuring attitudes in Section B and C of the questionnaire by asking respondents to respond to a series of statements on the content related to the difficulties encountered in the teaching and learning of probability and the possible reasons for the difficulty. Section D concentrates on suggestions on how to solve the problems encountered in the teaching of probability. Likert-type scale used a fixed choice response format designed to measure attitudes and show the level of agreement and disagreement using a continuum from strongly agree, agree, not sure, disagree to strongly disagree. The questionnaire had a set of pre-coded responses for which they indicated their level of agreement or disagreement.

3.4.1.2 Questionnaire for Students

The researcher developed a learner questionnaire consisting of sections A, B, C and D. Section A focuses on extracting learners’ demographic information such as gender. Section B

deals with content related to difficulties they face in probability. Section C deals with the possible causes of the difficulties they face in probability. Section D concentrates on ways to improve the teaching and learning of probability. The Likert scale was used in sections B and C of the questionnaire by asking respondents to respond to a series of statements on the content related to the difficulties encountered in the teaching and learning of probability and the possible reasons for the difficulty.

3.4.2 Interviews

The researcher uses an interview guide for the interviews with the teachers and mathematics learners. All the interviews were formal that is face to face, where an interview guide will be used. The interview schedule for both teachers and learners was semi-structured that is questions will not offer choices from which the respondent can select an answer; rather, the questions will be phrased to allow for individual responses. The teacher and learner interview schedules was used to draw information from teachers and learners on the problems they encountered in the teaching and learning of probability; the causes of problems they encountered in the teaching and learning of probability; and ways of improving on these problems. The interviews complements the information gathered from the questionnaires. This enabled the researcher to get overall information on the difficulties faced in probability and the causes as well as suggestions on improvement. During the interviews the researcher was taking notes. Immediately after each interview, the researcher reviewed the notes taken during the interview expanding the short hand and adding important comments or points made.

According to (Widjaja, Vale, Groves, & Doing, 2015) , 'In an interview, there is room for clarification, control and probing for more information'. Thus, the interview has an advantage of having a flexible control of the interview situation, high response rate and collection of supplementary information although interviews are costly to administer and supervise. .

3.4.3 Diagnostic test

Diagnostic tests are designed to identify areas where a learner is experiencing difficulty with an academic skill (Christensen & Johnson, 2012). In this study, a diagnostic test was used to identify difficulties learners experience in probability. A written test was given to the students in the form of a worksheet. This test technique (work sheet) was chosen because of its benefits. Firstly, it enables students to express themselves in writing and can help to provide more information regarding the students thought processes with regards to probability. Some

questions were selected from past examination question papers and other questions were extracted from a Mathematics Today textbook four. Finally, the criteria for selecting and developing these questions was based on their ability to solicit students' difficulties with regards to aspects of tree diagrams, outcome tables, and addition and product laws.

3.5 Ethical Issues

It was noted that the researcher had to be ethical in order to ensure that the study is authentic, valid and reliable. Some ethical principles guided the researcher throughout the whole study. The researcher considered these as moral guidelines or dos and don'ts of research; hence was observing the following among others:

The researcher informed the participants on why the study was to be conducted. In this regard the researcher guided by the principle of informed consent which views it unethically to collect data from people without informing them why the study will be conducted. The researcher gave a fair explanation of the procedures to be followed and their purposes, a brief description of the benefits reasonably to be expected and the instruction that the person is free to withdraw consent and discontinue participation in the project anytime. In order to address this, respondents were asked to fill in an informed consent form. Respondents were not forced to participate, they were voluntarily contributed and were given the room to withdraw if ever they decide so during the process of data collection. The names of participants remained anonymous and data collected was treated as confidential. No names were written on the questionnaires and during interviews; however the names that was used were not be the respondents' real names.

All stake holders namely, the head, parents, teachers, the teaching service department and students of the school were informed before embarking on the research work at the proposed school. A letter seeking permission was written to the school head as well as parents informing them of the intended project and solicited their maximum cooperation in this regards. Parents and the head of the school requested to acknowledge by signing the permission seeking letter authorizing their students to partake in the research after school. After the research was done the researcher shared the results of the study with the community concerned. This was so as to make the participants aware on why such a study was done and what could be the benefits from such an undertaking.

3.6 Conclusion

This chapter presented the research design, data collection method, data presentation and analysis procedure, population sample and sampling technique. Research designs which were used for this study was described and explained that is the case study. The next chapter will present and analyze the data obtained for the study.

CHAPTER FOUR

Data presentation and analysis

4.0 Introduction

The main focus of this chapter is to present, analyse and discuss the findings concerning problems faced by learners and teachers in the teaching and learning of probability in ordinary level mathematics at Magunje High School. Data was collected using questionnaires, interviews and a diagnostic test. Results from questionnaires administered to participants are summarized in tables, bar charts and pie charts. Explanations and illustrative information gathered from face to face interviews were also added. Both qualitative and quantitative data are then analysed and discussed.

4.1 Data Presentation

. 4.1.1 Results on teachers' professional qualifications

H_0 : There is no significant difference in the qualifications of the teachers.

H_1 : There is a significant difference in the qualifications of the teachers.

Table 1: Observed and expected frequencies on teachers' professional qualifications

Gender	Diploma in education		BED		Grade CE		MED		CE		Total
	Observed	Expected	O	E	O	E	O	E	O	E	
Males	3	2.857	1	1.429	1	0.174	0	0	0	0	5
Females	1	1.143	1	0.571	0	0	0	0	0	0	2
Total	4		2		1		0		0		7

$$\text{Expected frequency} = \frac{\text{Raw total} \times \text{Column total}}{\text{Grand total}}$$

Chi-square calculated

$$X^2 = \sum \frac{(O - E)^2}{E} = 0.007 + 0.129 + 0.115 + 0.011 + 0.018 + 0.322$$

$$= 0.602$$

$$\text{Degrees of freedom} = (5-1)(2-1) = 4$$

$$\text{Significance} = 0.05$$

$$X_4^2 \text{ Critical} = 9.488$$

We fail to reject the null hypothesis since $X^2 \text{ critical} > X^2 \text{ calculated}$ and conclude that there is no significant difference between qualifications of the teachers. Therefore teacher's qualification has nothing to do with the difficulties faced in probability. From the observed results, teachers at this school are highly qualified since their qualifications are higher than the levels they teach. (Macibi, 2003), asserts that when the right quantity and quality of human resources is available, it can manipulate other resources towards realizing institutional goals and objectives.

4.1.2 Problems experienced by teachers when teaching probability

Below are some of the areas teachers face challenges when teaching probability as from the teachers' questionnaires.

1. Teaching learners to construct Venn diagram from a given word problem.

2. Teaching learners to construct outcome tables from a given word problem
3. Teaching learners to construct tree diagrams from a given word problem.
4. Teaching learners to use Venn diagrams for problem solving
5. Teaching learners to use tree diagrams for problem solving.
6. Teaching learners to use Venn diagram to solve probability problems where events are not necessarily independent.
7. Teaching learners to use tree diagrams to solve probability problems where events are not necessarily independent.
8. Teaching learners to calculate the probability of two independent events by applying product rule for independent events: $P(A \text{ and } B) = P(A) \cdot P(B)$
9. Teaching learners to calculate the probability of two mutually exclusive events by applying addition rule: $P(A \text{ or } B) = P(A) + P(B)$

A four point Linkert scale was used in the questionnaire where teachers indicated their degree of competency in teaching aspects of probability. The results are summarized in the table below

Table 2: Teachers' degree of competency in teaching probability

Item	Very competent		competent		Slightly competent		Not at all competent	
	FREQ	%	FREQ	%	FREQ	%	FREQ	%
1.	3	42.9	3	42.9	1	14.3	0	0
2.	5	71.4	2	28.6	0	0	0	0
3.	1	14.3	4	57.1	2	28.6	0	0
4.	1	14.3	6	85.7	0	0	0	0
5.	3	42.9	2	28.6	2	28.6	0	0
6.	2	28.6	2	28.6	3	42.9	0	0
7.	1	14.3	3	42.9	3	42.9	0	0

8.	3	42.9	4	57.1	0	0	0	0
9.	4	57.1	2	28.6	0	0	1	14.3

The table shows that teachers are highly competent in teaching learners to construct outcome tables from word problems but are slightly competent in teaching learners to use Venn diagrams in solving probability problems that are not necessarily independent. Only 14.3% of the teachers' is not at all competent in the use of addition law. Therefore, the results in table 2 indicated that teachers had problems with all the aspects listed above as almost on every aspect there are some teachers who are slightly competent. Thus, teachers encounter problems in the teaching of probability concepts.

The same teachers when interviewed the same as the above observations were made, that teachers had difficulties with some concepts of probability. Only one teacher indicated that the teaching of probability presented no difficulties to him.

4.1.3: The cause(s) of problems teachers encounter in teaching probability

Below are some of the causes for the problems teachers experience in the teaching of probability as stated in the teacher's questionnaire. A five point Linkert scale was used where teachers' indicate whether they agree or disagree with the issues linked to teachers' content/ knowledge of probability, teachers' attitudes toward the teaching of probability, in-service education and training programmes and teaching material. Then the overall percentages of teacher responses were determined for each level of agreement or disagreement.

1. Lack of probability content knowledge.
2. Lack of interest in the teaching of probability.
3. There is no importance of probability in the syllabus.
4. Less experienced in the teaching of probability.
5. Lack the problem solving skills to deal with probability problems.
6. Lack of enough time to prepare properly for the teaching of probability.
7. Most of the in-service training programs that I have attended did not cover probability topics.
8. Lack of support to attend teacher development programs to improve probability knowledge.

9. The text books do not explain thoroughly and do not have enough examples.
10. Lack of sufficient teaching resources to teach probability.
11. My learners do not pay enough attention

4.1.3.0 Teachers content

Table 3: Teacher content

Item		Percentage of teachers				
		Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
1	Lack of probability content knowledge.	0	57.1	0	0	42.9
4	Less experienced in the teaching of probability.	0	28.6	28.6	0	42.9
5	Lack the problem solving skills to deal with probability problems.	0	0	57.1	0	42.9

	Average Column %	0	28.6	28.6	0	42.9
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From the above table, on average 42.9% of the teachers agreed that they encountered problems because they lacked content knowledge in probability whilst 28.6% disagreed and another 28.6% are not sure whether they encounter problems because they lack content or not. 42.9% strongly agreed that they lack experience in the teaching of probability concepts. This had been noticed by (Batanero & Diaz, 2012) as already noted in chapter two that, Probability and statistics is harder to understand than ordinary mathematics because it needs much more interpretation and understanding of content.

4.1.3.1 Teacher attitude

Table 4: Teacher attitude

Item	Percentages				
	Strongly disagree	disagree	Neither disagree nor agree	Agree	Strongly agree
Lack of interest in the teaching of probability.	71.4	14.3	0	0	14.3
There is no importance of probability in the syllabus.	71.4	14.3	0	0	14.3
Lack of enough time to prepare properly for the teaching of probability.	14.3	14.3	0	0	71.4

My learners do not pay enough attention.	0	0	0	28.6	71.4
Average Column %	39.3	10.7	0	7.2	42.9

From the table above, on average 50% (i.e. 7.2% of agree + 42.9% of strongly agree) of teachers encountered problems resulting from their own attitude towards teaching of probability whilst another 50% disagreed that they encounter problems from their own attitudes. 71.4 % strongly disagreed that probability is of no importance in the syllabus, which shows that probability is an important topic to be included in the syllabus. Also 71.4% of the teachers indicated that learners do not pay enough attention in probability lessons and another 71.4% admitted that they lack enough time to prepare properly for the teaching of probability. As noted in chapter two, that one of the problems encountered is the inadequate preparation of teachers in probability.

4.1.3.2 In-service and training programmes

Table 5: In-service and training programmes attended

Item	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
Most of the in-service training programs that I have attended did not cover probability topics.	0	42.9	14.3	14.3	28.6
Lack of support to attend teacher development programs to improve probability knowledge.	0	14.3	0		28.6
Average Column %	0	28.6	35.7	7.2	28.6

The data in the table above shows that on average 35.8% (i.e. 2% of agree + 28.6% of strongly agree) of the teachers encountered problems in in-service education training programmes. In this category, 42.9% of the teachers disagreed that they encountered problems because the programmes they had attended did not cover probability topics, and 57.1% were not sure whether they lack support to attend teacher development programmes to improve their statistics knowledge.

4.1.3.3 Teaching resources

Table 6: Teaching resources

	Item	Strongly Disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
9	The text books do not explain thoroughly and do not have enough examples.	28.6	57.1	0	0	14.3
10	Lack of sufficient teaching resources to teach probability.	0	14.3	0	28.6	57.1
	Total Row %	14.3	35.7	0	14.3	35.7

The results reflected in table above reveals that 25 % (i.e. 20.67% of agree + 4.33% of strongly agree) of teachers agreed that they encountered problems because of inadequate

teaching material. 33% (i.e. 24% of agree + 9% of strongly agree) of them claimed that the textbooks they are using do not explain thoroughly and do not provide enough examples; 29% (i.e. 26% of agree + 3% of strongly agree) of the teachers agreed that they did not have adequate teaching resources to teach probability.

4.1.4: problems encountered by learners in the learning of probability

In order to collect information on the problems encountered in the learning of probability, the researcher asked teachers and learners to indicate in their questionnaires whether the learners had difficulties in the aspects below where a four point scale was used where they indicated learners' level of difficulty. The aspects were divided into construction and interpretation of probability diagrams (items 1, 2, 3, 4 and 5) and interpretation of probability terminology (items 6 and 7).

1. Constructing a Venn diagram from a given word problem
2. Constructing an outcome table from a given word problem.
3. Constructing a tree diagram from a given word problem.
4. Using Venn diagrams to solve probability problems.
5. Using tree diagrams to solve probability problems.
6. Calculating probability of two independent events by applying a product rule for independent events: $P(A \text{ and } B) = P(A) \cdot P(B)$.
7. Calculating probability of two mutually exclusive events by applying the addition rule ; $P(A \text{ or } B) = P(A) + P(B)$

Table 7: Teachers' opinions about problems encountered in the learning of probability

Problems learners encounter in probability		Percentage of teachers			
		Not difficult	Less difficult	Difficult	Highly difficult
Item	Category A: construction and Interpretation of probability diagrams				
1.	Constructing Venn diagrams from a given word problem to solve	14.3	57.1	14.3	14.3

	probability problems.				
2.	Constructing outcome tables to solve probability problems.	14.3	71.4	14.3	0
3.	Constructing tree diagrams from a given word problem.	57.1	0	42.9	0
4.	Using Venn diagram to solve probability problems where events are not necessarily independent.	0	57.1	42.9	0
5.	Using tree diagrams to solve probability problems where events are not necessarily independent.	0	57.1	42.9	0
	Total Average Column % of category A	17.1	48.5	31.5	2.9
	Category B: interpretation of Probability terminology				
6.	Calculating probability of two independent event by applying a product rule for independent events: $P(A \text{ and } B) = P(A) \cdot P(B)$.	28.6	57.1	14.3	0
7.	Calculating probability using the addition law : $P(A \cup B) = P(A) + P(B)$	85.7	14.3	0	0
	Total Average Column % of category B	57	36	7	0

The data in category A in the table above shows that the teachers believed that their learners had difficulty with all the concepts of probability because more than 50% of the teachers are

for (less difficult, difficult and highly difficult) options except for the construction of tree diagram from a given word problem.

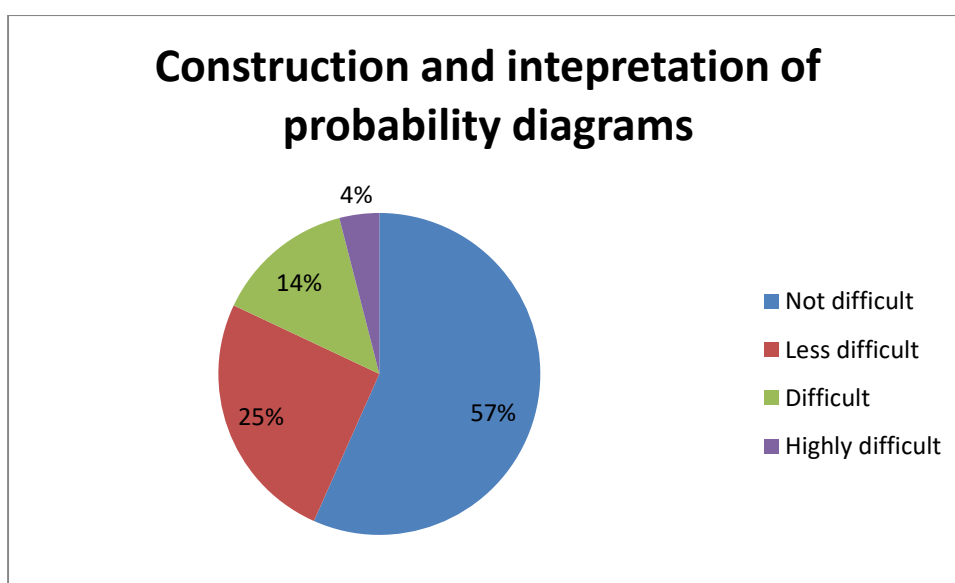
It is also clear from the table that most learners are able to calculate probability using the addition law as indicated by 85.7% of the teachers. Also 71.4% of the teachers admitted that their learners face challenges in calculating probabilities using the product rule for independent events: $P(A \text{ and } B) = P(A) \cdot P(B)$.

Therefore, the data in table 8 suggests that the learners experienced difficulties with the interpretation of probability terminology and also with construction and interpretation of probability diagrams and tables.

4.1.5: Learners opinions on problems they encounter in the learning of probability

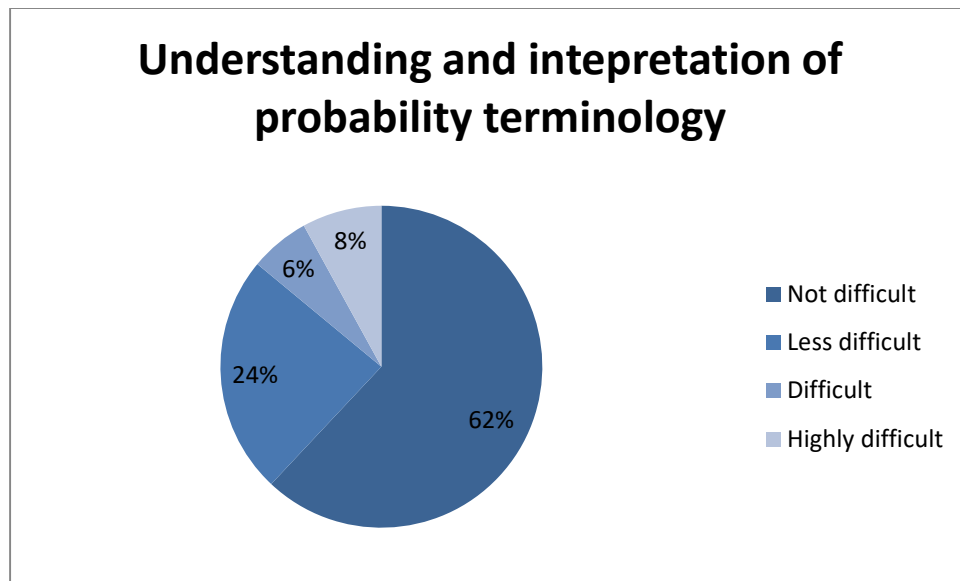
A total of 25 Ordinary level mathematics candidates completed the learner questionnaire.

Fig 1: Construction and interpretation of probability diagrams



The data in the figure above shows that 18% (i.e. 14% for difficult and 4% for highly difficult) of the learners had difficulty with the construction and interpretation of probability diagrams and tables that is: constructing a tree diagram from a given word problem; constructing a Venn diagram from a given word problem difficult; using Venn diagrams to solve probability problems and using tree diagrams to solve probability problems. 57% of the learners indicated that they had no challenges with probability diagrams and 25% had fewer difficulties.

Fig 2: Understanding and interpreting probability terminology



The data in fig 2 above also shows that the learners had no challenges in understanding and interpreting probability terminology that is: calculating probability of two independent events by applying a product rule for independent events; and identifying mutually exclusive events

4.1.6: Learners' opinion on causes of problems they encounter in probability

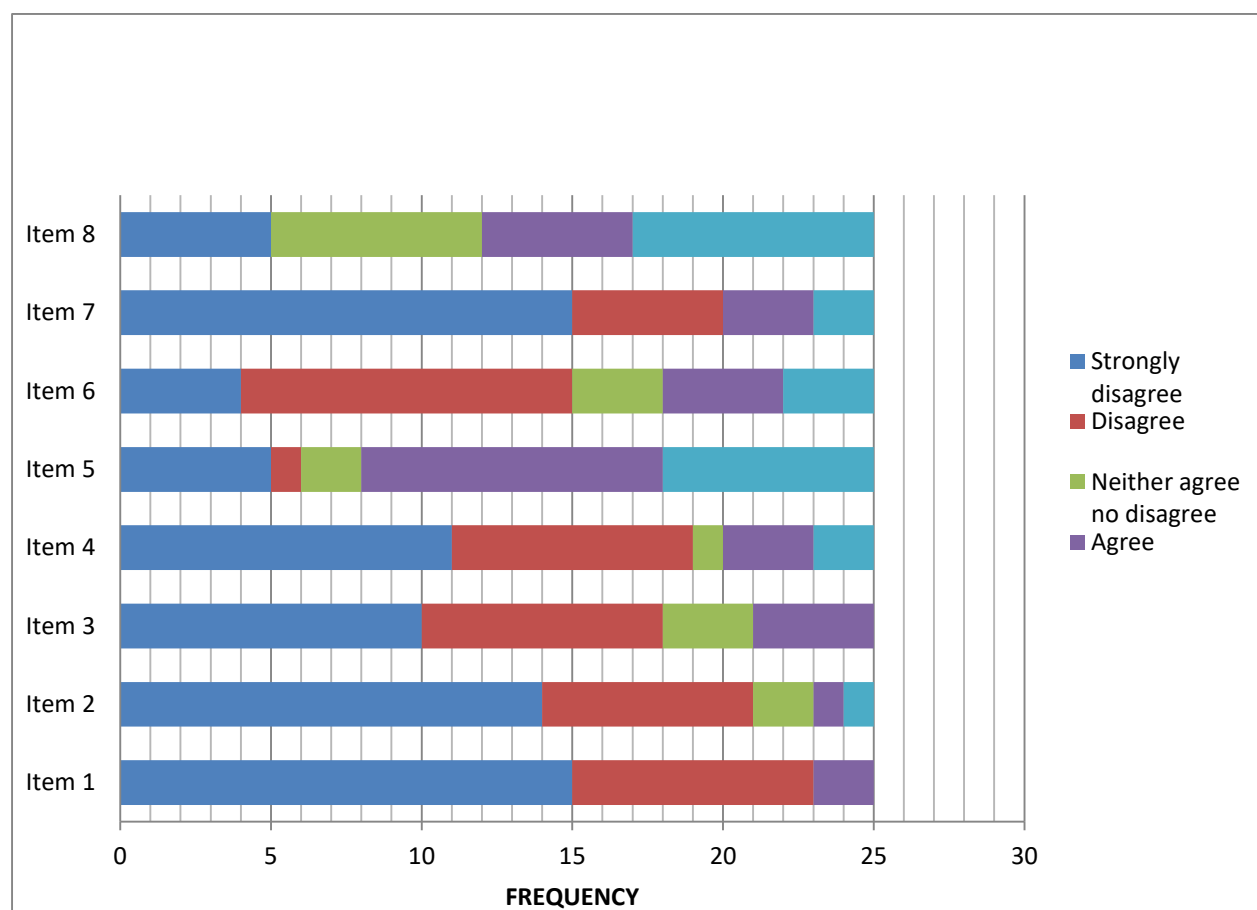
The study explored issues linked to teachers' content knowledge of probability, learning material and learners' attitudes. In order to collect information on the causes of problems learners encounter in the learning of probability, the researcher asked learners to indicate in their questionnaires whether they agree or disagree with the aspects below where a five point Linkert scale was used(i.e. strongly disagree, disagree, neither disagree nor agree, agree and strongly agree).

1. I encounter problems because my teacher finds it difficult to explain concepts/ does not explain clearly.
2. I encounter problems because my teacher does not understand some of the concepts of the topic.
3. I encounter problems because my teacher teaches some concepts but leaves others for us to do on our own.
4. The teacher does not give learners enough exercises to practice probability.
5. I encounter problems because I do not have a mathematics textbook.

6. I encounter problems because I do not have access to previous examination papers with solutions.
7. I encounter problems because I do not give myself enough time to practice probability problems.

The findings are presented on the chart below.

Fig 3: Learners' opinion on causes of problems they encounter in probability



From the chart above, item 1 reveals that 2 out of 25 learners indicated that their difficulties arose because: their teachers experienced problems in explaining concepts to them whilst 23 out of 25 disagreed (i.e. 15 strongly disagreed + 8 agreed); 2 out of 25 believed their teachers did not understand some of the concepts of the topic whilst 21 of the 25 disagreed and 2 neither disagreed nor agreed; 4 out of 25 agreed that their teachers taught some topics but left others for learners to do on their own whilst 18 disagreed and 3 are in between; 5 out of 25 revealed that their teachers did not give them enough exercises to practise probability, 19 out of 25 disagreed and 1 is in between. 5 out of 25 said they were studying probability on their own and the rest are not studying on their own. More than half of the learners indicated that they experienced difficulties because: they did not have a mathematics textbook. Also more than

half of the learners indicated that they did not have access to previous examination papers with solutions. Lastly 13 out of 25 learners of the learners believed that they encountered difficulties because of their attitude towards probability. On this item, learners indicated that they encountered problems because: they did not give themselves enough time to practise probability problems.

4.1.5.4 Summary of analysis of learner questionnaire

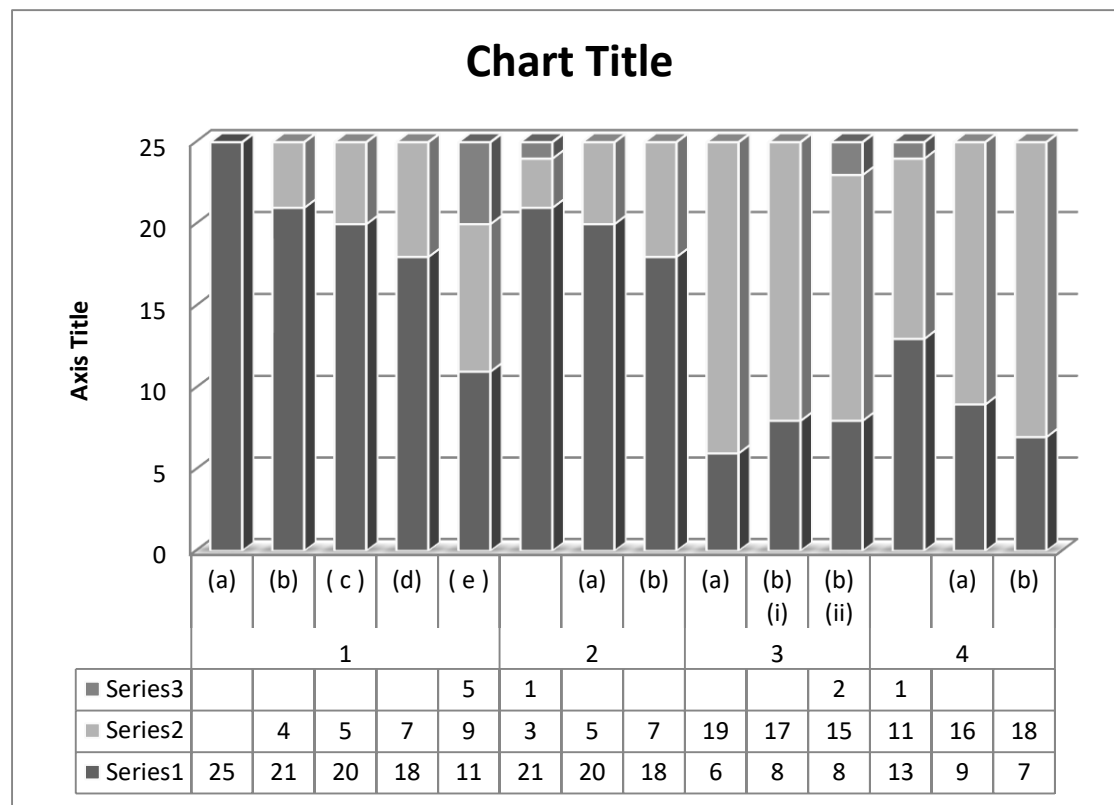
Some of the learners had difficulty with construction and interpretation of probability graphs and tables and some find it difficult to understand and interpret probability terminology.

4.1.8: Diagnostic test

The diagnostic test used in this study consisted of four questions. Questions 1 and 2 tested whether learners could construct and use outcome tables in solving probability problems. Question 3 tested learners on: construction of Venn diagrams and computation of probabilities using the Venn diagram. Question 4 tested learners on construction and use of tree diagrams. The purpose of using a diagnostic test was to identify any difficulties learners might have in the mastery of probability concepts (Christensen & Johnson, 2012). Twenty-five Ordinary level mathematics candidates of Magunje High School wrote this test. The test was 45 minutes in duration. The researcher administered it herself to ensure that it was written according to the requirements.

The analysis of the learners' performance in each sub-question are shown in figure 4 below as well as frequencies of correct answers, wrong answers, and no answers provided by each learner with series 1- correct answers, series 2- wrong answers and series 3- no answers.

Fig 4: Performance of learners in the diagnostic test set.



Question 1

In the figure above, we observe that all learners performed exceptionally well in question 1(a), where all the 25 students were able to complete the outcome table correctly. On questions 1(b) up to 1(d) more than half of the learners were able to get correct answers with a few getting it wrong. For instance, in question 1 (b), 16% of the learners performed badly by adding face totals of the dice (i.e. $6 + 6$ instead of 6×6 or by counting the outcomes physically) thereby obtaining 12 outcomes instead of 36 outcomes. In question 1(c), (20%) performed badly failing to count the number of fives they have on the outcome table thereby failing to get question 1(d) correct. Also, in question 1(e), 44% of the group performed well, 36% wrongly answered the question and 20% left out the question unanswered. This is so because maybe learners were not able to define a prime number. See the vignettes A of learner answers to questions 1

PROBABILITY

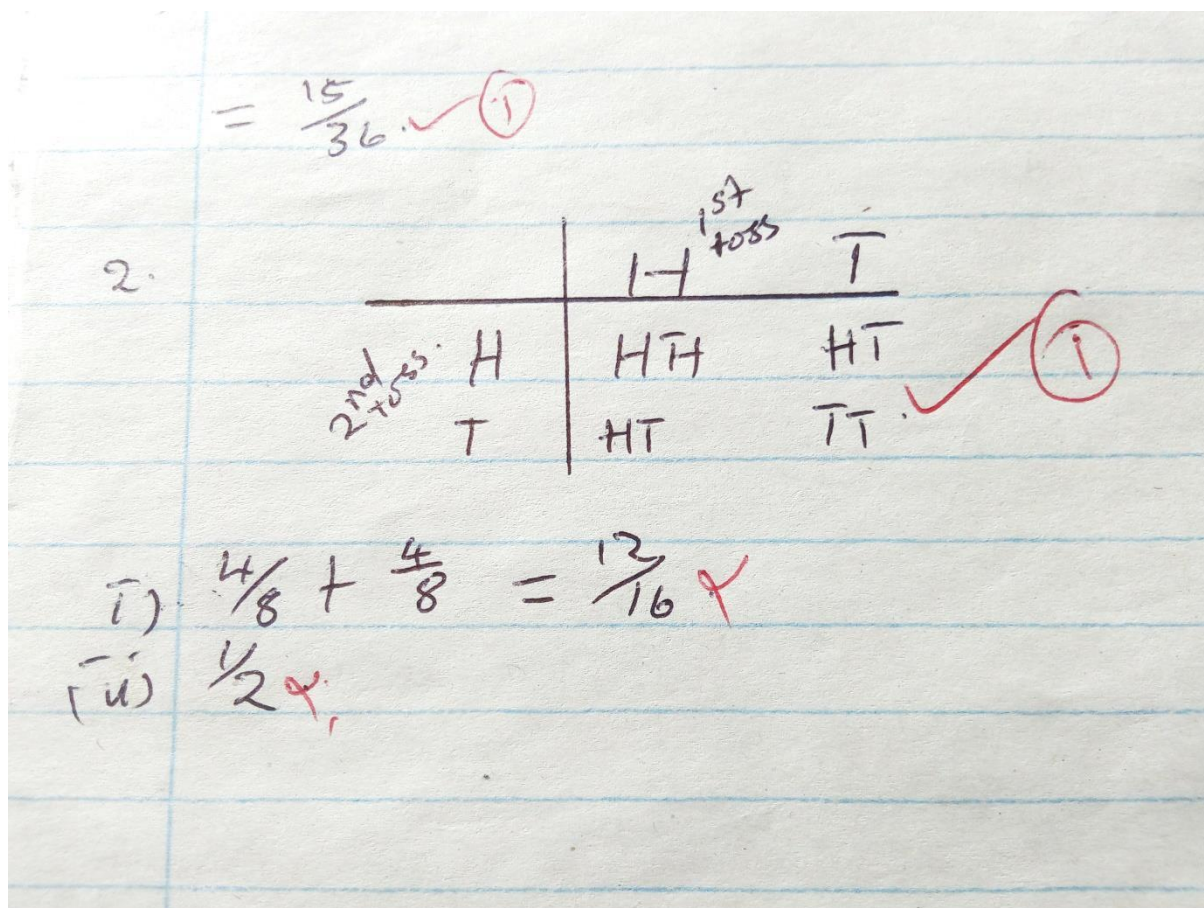
		1 st die					
		1	2	3	4	5	6
2 nd die	1	2	3	4	5	6	7
	2	3	4	5	6	7	8
	3	4	5	6	7	8	9
	4	5	6	7	8	9	10
	5	6	7	8	9	10	11
	6	7	8	9	10	11	12

b There are 12 possible outcomes. ✗
 c Outcomes give a total of 5 for the two dice are 1. ✗
 d The probability of getting a total of 5 are ✗
 e The probability that the total score is prime number ✗

Vignette a show that the learner was able to complete the outcome table but was not able to interpret it thereby providing completely wrong answers to questions that follow.

Question 2

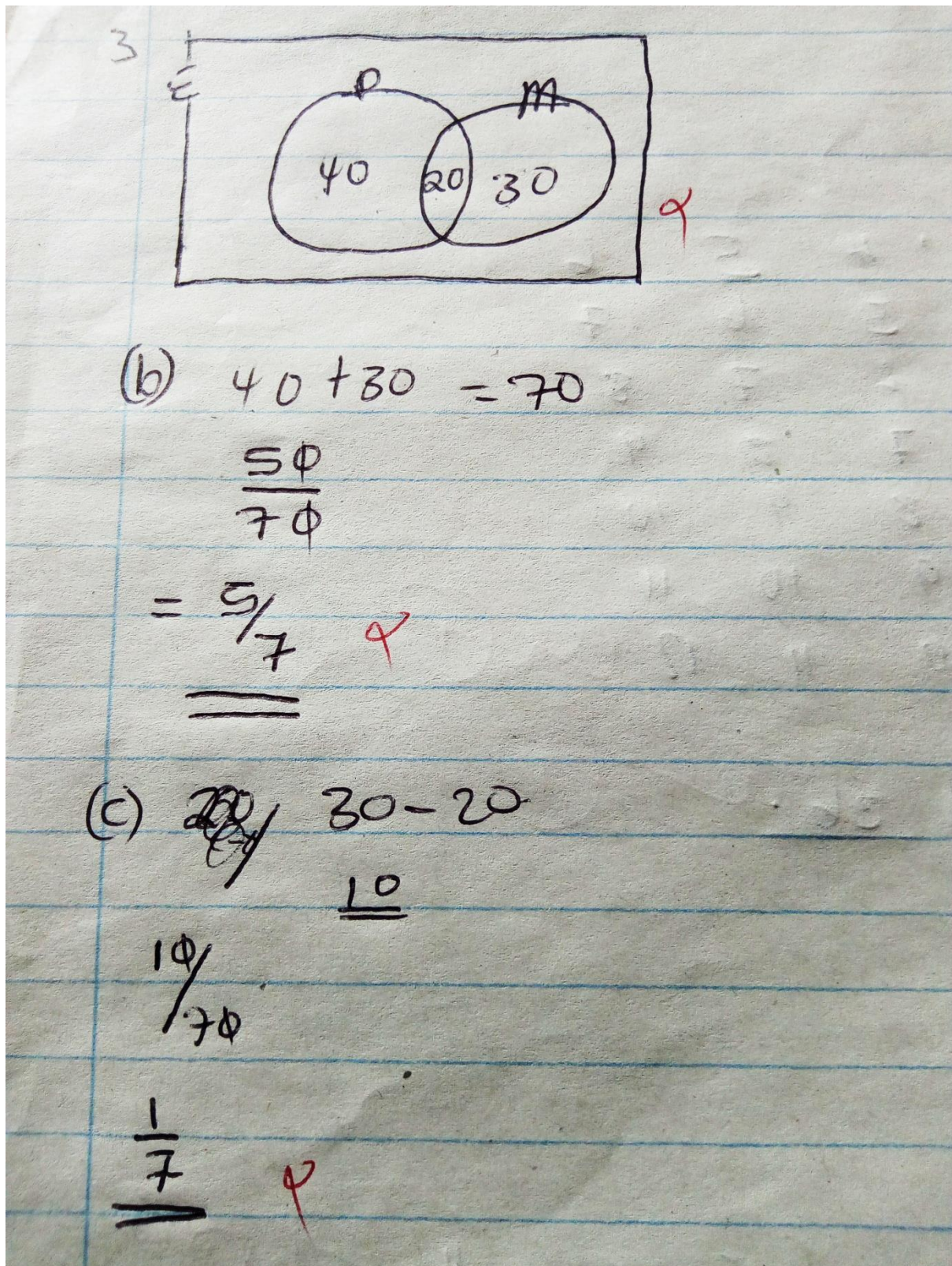
Most learners performed well in question 2, which dealt with construction and interpretation of outcome tables. For instance, on the construction of the outcome table 84% of the learners were able to correctly construct it whilst 12% did not manage to and 4% left the question out. In questions 2(a) and 2(b) learners failed because they were not able to use the outcome table to find the solution. See the vignette B of learner answer to question 2.



The learner was able to construct the outcome table but was unable to come up with the total number of outcomes (i.e. 4 instead of 8) leading to incorrect answers on the other two questions. This learner had some challenges with fractions as shown in her work that $\frac{4}{8} + \frac{4}{8} = \frac{12}{16}$. This has been noted by Ben-Zvi and Garfield in (Makwakwa, 2012) when they said that, “many learners have difficulties with the underlying mathematics (such as fractions) and this interferes with the learning of related probability”.

Question 3

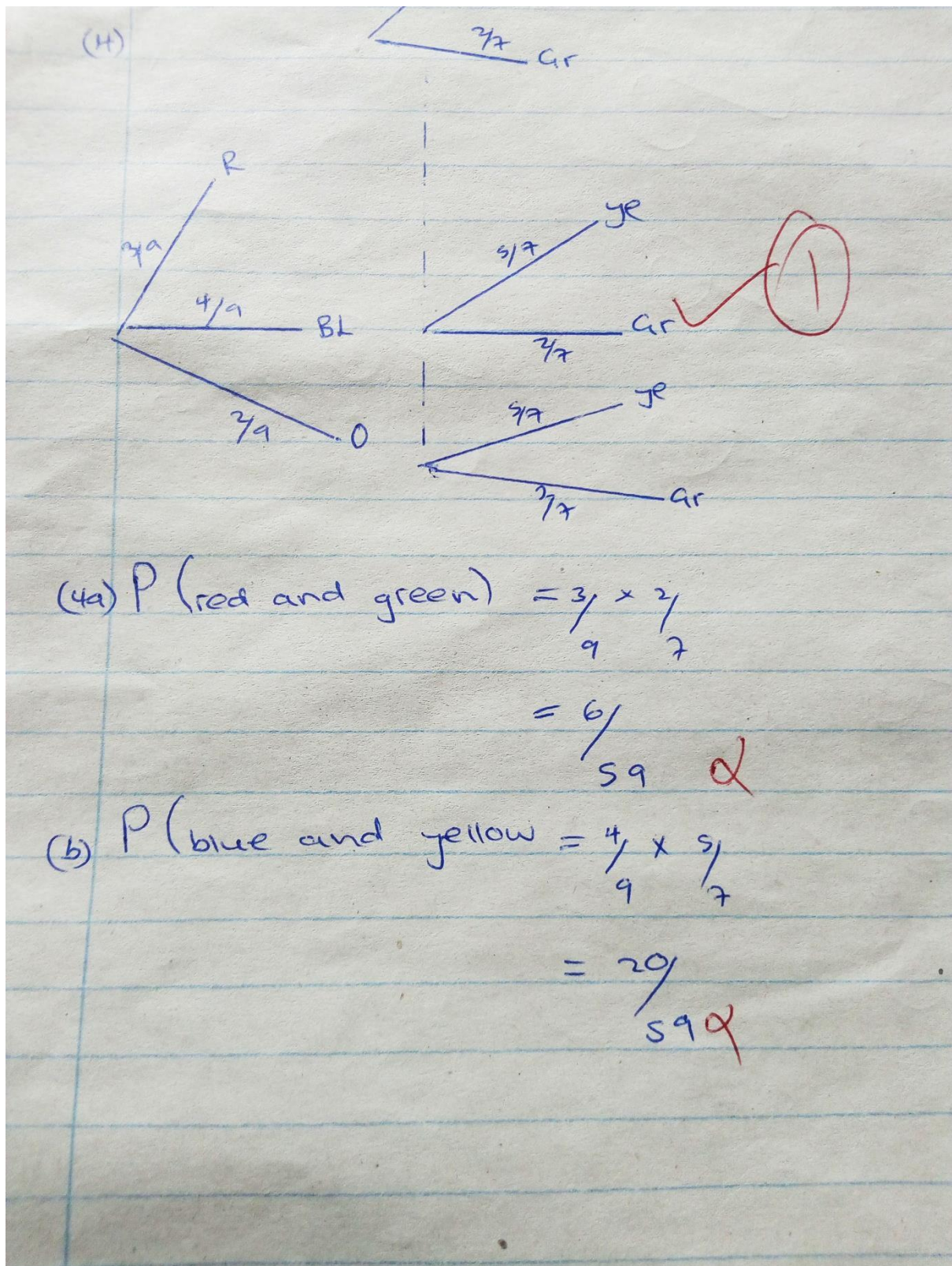
Fig 4 indicates that most learners performed badly in question 3, which dealt with the construction and interpretation of Venn diagrams. It shows that most learners have challenges with the aspects of Venn diagrams. For instance, in question 3.b (i) and b (ii), 32% of the learners were able to interpret the Venn diagram and the rest failed. See vignettes C of learner's script for question 3



The learner shows that he/she faces problems with Venn diagrams

Question 4

The majority of learners performed badly in question 4, which covered the aspects of construction and interpretation of tree diagrams. For instance, some of the learners were able to construct the tree diagram but then failed to use it in questions 4(a) and 4(b), calculating the probabilities. Thus, learners have problems in the construction and interpretation of tree diagrams. See vignette D of learner's script for question 4 below



The learner managed to construct the tree diagram but made computational error i.e. $9 \times 7 = 59$ instead of 63.

4.1.9: Interviews with learners and teachers

The objectives of the interviews were to gain further insight, understanding, meaning, constructions and perspectives of the interviewee's own experiences or knowledge on various issues (Denzil & Lincoln, 2005). Interviews were conducted with a group of five teachers and five learners from the school. The interviews for both teachers and learners took place immediately after the diagnostic test had been administered; all the interviews were conducted by the researcher. All questions for learners and teachers were in English and posed to all respondents in the same sequence as they appeared in the interview schedules, in an attempt to reduce bias as much as possible. All learners and teachers were individually interviewed. The outcomes of these interviews are presented below.

4.1.9.1: Teachers' problems with teaching probability

When asked about the problems encountered when teaching probability, some teachers' indicated that they had difficulties in constructing probability diagrams, tree and Venn diagrams and difficulties in understanding probability terminology that is mutually exclusive events and independent events. Only one teacher indicated that the teaching of probability presented no difficulties.

4.1.9.2: Teachers' views on possible causes of problems they may have had with probability

When asked what they think are the causes of their problems with the teaching of probability, two teachers admitted that they encountered problems because of a lack of content knowledge. The data from the teacher interviews indicated that some teachers encountered problems when teaching because they lacked content knowledge, textbook and workshops were not consistent regarding certain topics in probability.

4.9.1.3 Learner interviews

The findings from the learner interviews were that most of the learners interviewed encountered problems with the construction of tree and Venn diagrams and with understanding and calculating probability of mutually exclusive and independent events. The interviews revealed that the majority of the learners, encountered problems because teachers taught only some and not all topics; teachers do not explain some of the concepts in probability thoroughly. The pupils indicated that teachers should attend their lessons without fail and also indicated that pupils should have extra lessons during the holidays and weekends. Most of the pupils indicated that the school should allow pupils to take text books home during the holidays so that they have more time to work on the problems.

4.1.9.4 Suggestions by teachers and learners on ways to improve the teaching and learning of probability

The data from the interviews and questionnaires of teachers and learners suggested some possible solutions to the problems encountered in teaching and learning of probability. The suggestions are as follow;

- in-service teacher training programmes meeting the needs of teachers by offering the topics they find difficult in their teaching;
- Offering longer and more frequent programmes on probability; use of internet rather than waiting for the workshops and upgrading themselves.
- Parents should pay school fees in time to avoid disturbances during the course of the term.
- Teachers should attend their lessons without fail and also pupils should have extra lessons during the holidays and weekends.
- The school should allow pupils to take text books home during the holidays so that they have more time to work on the problems.

4.1.8 Conclusion

This chapter presented and analysed the data that was gathered from pupils and teachers through diagnostic test, questionnaires and interviews. This was done in order to see whether what the researcher had in mind as the main problems encountered in the teaching and learning of probability and their causes at Magunje High School are true. From the data collected, the researcher managed to identify some of the problems and causes basing on the information given by respondents. From the findings, the school, the teachers and the pupils, all played a role in the causes of the problems encountered in probability in mathematics at the school. The researcher is of the opinion that, if all the groups responsible for the causes come together and find the way forward, the teaching and learning of probability improves for the better.

Chapter Five

Summary, Conclusion and Recommendations

5.0 Introduction

The main thrust for this undertaking was to explore problems encountered in the teaching and learning of probability at ordinary level and to investigate ways of addressing these problems. This chapter therefore gives a summary of the study, conclusion and recommendations thereto.

5.1 Summary

5.1.0 Chapter one

The background to the research problems and the research statement were discussed in this chapter. The purpose of the study, the research questions and the significance of the study were also highlighted in this chapter.

5.1.1 Chapter two

This chapter reviewed the relevant literature on probability with special focus on challenges faced by learners in probability, challenges faced by teachers in probability, factors contributing to challenges in probability and strategies of overcoming them. The works of (Batanero & Diaz, 2012) and (Makwakwa, 2012) were acknowledged in this chapter.

5.1.2 Chapter three

This chapter provides a detailed description and explanation of the research design, the research instruments and how these instruments were developed. Descriptions of the population sample, how the research instruments were administered, the validity and reliability of these instruments and steps taken to analyze both the written test and interview were discussed in this chapter.

The data were drawn from twenty – five Ordinary level mathematics students and seven mathematics teachers of Magunje high school in UMP District. Purposive sampling was used in the research to select the respondents. The sample comprised of both male and female students. Data on teachers' problems and their causes were collected through a questionnaire for teachers, teacher interviews and learner interviews, while data about learners' problems and their causes were collected from a questionnaire for learners, a diagnostic test, a teacher questionnaire and learner interviews.

5.1.3 Chapter four

This chapter focused on the analysis and interpretation of data obtained from questionnaires, interviews and the diagnostic test administered to learners and teachers.

The data was analyzed and it was found that teachers and learners indeed encounter difficulties when teaching and learning probability. The findings were that teachers had difficulties with the construction and interpretation of probability diagrams and tables (i.e. Venn and tree diagrams) and with understanding and interpreting probability terminology (i.e. mutually exclusive events, independent and dependent events). The findings also revealed that the majority of learners seemed to find the construction and interpretation of probability graphs and tables very difficult, as well as understanding or interpreting probability terminology (i.e. construction of tree and Venn diagrams, and understanding and computing the probability of mutually exclusive and independent events).

Possible reasons for teachers' problems were revealed as their lack of content knowledge in probability, textbooks lacking in explicit explanations, with inadequate examples, most of the in-service teacher programs they attended did not cover probability, and teachers did not attend in-service teacher workshops. Possible causes of learners' problems emerged as the inadequate teaching of probability, teachers' lack of probability content knowledge and poor methods of teaching (i.e. teachers experienced difficulties in explaining concepts to learners), learning material (i.e. the prescribed learner textbook did not cover all the topics suggested by the curriculum nor did it provide explicit examples and explanations) and learners' lacked conceptual knowledge of certain concepts in probability.

Learners' attitudes also contributed. The findings in chapter four revealed that 71.4% of the teachers indicated that their learners do not pay attention in probability lessons and also the 13 out of 25 of the learners believed that they encounter problems because of their negative attitude towards probability. There is a strong relationship between teaching, learning resources and academic performance and also mathematical attitude and academic performance. In order to address these problems in the teaching and learning of probability, the findings revealed that the following should be taken in to consideration: in-service teacher programs should meet the needs of the teachers by offering those topics that teachers find problematic during instruction and textbooks should provide explicit explanations and contain all information necessary to the teaching and learning of probability.

Data collected was then presented, discussed and analysed. The data was presented on tables, bar charts and pie charts. Discussions were based on the data given by the respondents. The researcher then analysed the data and came up with some conclusions on the factors that could be the causes of challenges in the teaching and learning of probability at Magunje High School.

5.1.4 Chapter five:

A presentation of the summary of all research processes, findings, recommendations and limitations of the study were unveiled in this chapter, with the findings exposed the limitations of textbook learners were using at this school in probability. Thus it does not cover all the topics in the curriculum and the ones it did were not adequately explained.

5.2 Conclusion

This study has shown that there are problems associated with the teaching and learning of probability at Ordinary level. Teachers still do not have a complete grasp of some aspects of probability which they are expected to teach, and this in turn has presented learners with difficulties in learning those aspects. The study therefore confirms that problems encountered in teaching tend to affect learning as well.

Thus, problems noted in probability are attributed to lack of material, attitudes of both teachers and students towards the topic and teachers' knowledge of the concepts of probability among others. Thus for better results in probability, most of the factors above should be addressed. Learning is strengthened when there is enough reference material such as textbooks, teaching aids and laboratories and academic achievements illustrate per excellence the correct use of these materials.

5.3 Recommendations

From the conclusions drawn, the researcher therefore has the following recommendations to put forward:

- Teachers should actively challenge the misconception that probability is a difficult topic. Provision of teaching learning adequate resources positively change the attitude of teachers to the teaching of probability and make the topic very interesting, meaningful and exciting to the students. This will keep them alive and thinking during lessons and will help them to realize the applications of probability.

- Examples that should be used must be real and closer to the environment of learners themselves.
- The school should make textbooks available to pupils. From the data collected, it was noted that the school does not allow pupils to take textbooks home for the holidays. Pupils should have more time with the textbooks so that they have maximum use of them.
- The findings of this study exposed the limitations of the textbook learners were using. This implies that the Ministry of Education and school advisors/inspectors need to look more closely at the selection of textbooks in order to recommend those which will improve academic performance in probability. Authors of textbooks must ensure that they cover all topics included in the curriculum in appropriate depth and provide correct content and instructional support.
- The current study has shown that teachers lack content knowledge of probability topics. It is suggested that in-service workshop organizers should consider the results of this study when conducting workshops topic and should focus more on content knowledge on probability.

5.4 Suggestions for further studies

Since the researcher studied one school in UMP district, other researchers can analyze problems encountered in probability in Mathematics in different schools around the district to give a discrete view of the causes of these problems.

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APPEINDIX A: COMMUNICATION

DEPARTMENT OF CURRICULUM STUDIES



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BINDURA UNIVERSITY OF SCIENCE EDUCATION

4 September 2017

TO WHOM IT MAY CONCERN

RE: NAME: MUSANHI AQUINATA

REGISTRATION NUMBER: B1441460

PROGRAMME: HBScED MATHEMATICS

PART: 3.2

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 Bachelor of Science Education Degree programme. The topic of the research is:

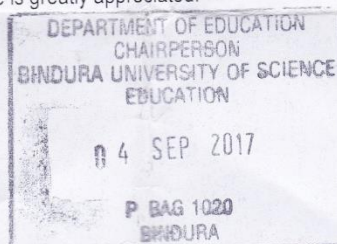
"Factors contributing to ordinary level pupils' poor performance in mathematics."

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

Your co-operation and assistance is greatly appreciated.

Thank you

L. P. Kusure (Mr)
Chairperson, Curriculum Studies Department



APPENDIX B: TEACHER QUESTIONNAIRE

TEACHER QUESTIONNAIRE

I am an undergraduate student currently enrolled at Bindura University of Science Education doing an Bachelor of Science Honours Degree in Mathematics. I am conducting a research on problems encountered by teachers and learners in the teaching and learning of probability in Ordinary level mathematics in UMP District.

You have been chosen to take part in this research. Please help me by responding to the questionnaire as honestly as possible. All responses will be treated with the greatest confidentiality and used for the purposes of this research only.

Purpose of the questionnaire: This questionnaire is designed to obtain the problems teachers encounter in the teaching of probability. This is in order to proffer useful solutions to improve teachers' performance in teaching and also to help learners to perform better in probability.

Instructions:

1. Please tick (☐) in the provided boxes what is appropriate to you.
2. There are no correct or wrong answers, if you make a mistake cross out and tick another opinion.
3. Do not write your name on the questionnaire.

Section A: Demographic information

Gender	Male	☐	Female	☐
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Age of Respondent

20-30 years	☐
31-50 years	☐
51+ years	☐

Academic Qualifications

‘O’ Level	☐
‘A’ level	☐

Professional Qualifications

B.ed	☐
C.E	☐
Dip Ed	☐
Grade CE	☐
Masters	☐

Any other specify	
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Teaching experience

Less than 5 years

11-20years

6-10 years ‘

21-30 years

31+ years

Section B: Problems encountered in the teaching of probability topics

Indicate how competent you feel when doing the following teaching activities in probability?
Please choose in one of the response below by placing a tick (☐) in the appropriate box.

	Very competent	Competent	Slightly competent	Not at all Competent
1. Teaching learners to construct Venn diagram from a given word problem.				
2. Teaching learners to construct outcome tables from a given word problem				
3. Teaching learners to construct tree diagrams from a given word problem.				
4. Teaching learners to use Venn diagrams for problem solving				
5. Teaching learners to use tree diagrams for problem solving.				
6. Teaching learners to use Venn diagram to solve probability problems where events are not necessarily independent.				
7. Teaching learners to use tree diagrams to solve probability problems where events are not necessarily independent.				
8. Teaching learners to calculate the probability of two independent events by applying product rule for independent events: $P(A \text{ and } B) = P(A) \cdot P(B)$				
9. Teaching learners to calculate the probability of two mutually exclusive events by applying addition rule: $P(A \text{ or } B) = P(A) + P(B)$				

The following reasons might be some of the causes for the problems teachers experience in the teaching probability. Please rate how strongly you agree or disagree with each of the statements

by placing a tick (☐) in the appropriate box.

	Strongly disagree	Disagree	Neither disagree nor agree	Agree Strongly	Agree
1. Lack of probability content knowledge.					
2. Lack of interest in the teaching of probability.					
3. there is no importance of probability in the syllabus.					
4. less experienced in the teaching of probability.					
5. lack the problem solving skills to deal with probability problems.					
6. Lack of enough time to prepare properly for the teaching of probability.					
7. Most of the in-service training programs that I have attended did not cover probability topics.					
8. Lack of support to attend teacher development programs to improve probability knowledge.					
9. The text books do not explain thoroughly and do not have enough examples.					
10. Lack of sufficient teaching resources to teach probability.					
11. My learners do not pay enough attention.					

SECTION C: Problems encountered by learners in the learning of probability

The following items seek your opinion about the level of difficulty learners have with learning some aspects of probability. Please put your response in a rating format by placing a tick (☐) in the appropriate box below.

	Not difficult	Less difficult	Difficult	Highly difficult
1. Constructing Venn diagrams from a given word problem to solve probability problems.				
2. Constructing outcome tables to solve probability problems.				
3. Constructing tree diagrams from a given word problem.				
4. Using Venn diagram to solve probability problems where events are not necessarily independent.				
5. Using tree diagrams to solve probability problems where events are not necessarily independent.				
6. Calculating probability of two independent event by applying a product rule for independent events: $P(A \text{ and } B) = P(A) \cdot P(B)$.				
7. Calculating probability using the addition law : $P(A \cup B) = P(A) + P(B)$				

The following statements are considered to be some of the reasons for learners not to do well in Probability. Please rate how strongly you agree or disagree with each of the statements by placing a tick (☐) in the appropriate box.

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly Agree
1. Learners encounter problems because teacher experiences problems in explaining concepts to learners.					
2. Learners encounter problems because teachers do not understand some of the topics in the syllabus.					
3. Learners encounter problems because the teacher do not study probability at tertiary level.					
4. Learners encounter problems because the teacher do not have enough teaching experience.					
5. Learners encounter problems because they do not have a mathematics textbook.					
6. Learners encounter problems because they do not give themselves enough time to practice probability problems.					
7. Learners encounter problems because probability is too difficult for them.					

SECTION D: Ways to improve the teaching and learning of probability

What do you think can be done to improve the teaching and learning of probability in schools?

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LEARNER QUESTIONNAIRE

I am an undergraduate student currently enrolled at Bindura University of Science Education doing an Honours Degree in Bachelor of Science in Education. I am conducting a research on problems encountered by teachers and learners in the teaching and learning of probability at Ordinary level mathematics in UMP District.

You have been chosen to take part in this research. Please help me by responding to the questionnaire as honestly as possible. All responses will be treated with the greatest confidentiality and used for the purposes of this research only.

Purpose of the questionnaire: This questionnaire is designed to obtain the problems learners encounter in the learning of probability. The information gathered will help to improve the learning of probability and also help learners to perform better in Mathematics.

Instructions:

1. Please give an answer for every question.
2. Tick (☐) in the provided boxes what is appropriate to you.
3. There are no correct or wrong answers, if you make a mistake cross out and tick another opinion.
4. Do not write your name on the questionnaire

Section A: Demographic information

What is your gender? Please tick (☐) one choice.

Male ☐

Female ☐

Section B: Probability-possible problems encountered

The following reasons might best explain the causes of the problem(s) you encounter in the learning of probability. Please rate how strongly you agree or disagree with each of the reasons below by placing a tick (☐) in the appropriate box

	Not difficult	Less difficult	Difficult	Highly difficult
1. Constructing a Venn diagram from a given word problem.				
2. Constructing an outcome table from a given word problem.				
3. Constructing a tree diagram from a given word problem.				
4. Using Venn diagrams to solve probability problems.				
5. Using outcome tables to solve probability problems.				
6. Using tree diagrams to solve probability problems.				
7. Calculating probability of two independent events by applying a product rule for independent events: $P(A \text{ and } B) = P(A) \cdot P(B)$.				
8. Calculating probability of two mutually exclusive events by applying the addition rule ; $P(A \text{ or } B) = P(A) + P(B)$				

Section C: Possible cause of the problems

The following reasons might best explain the causes of the problem(s) you encounter in the learning of probability. Please rate how strongly you agree or disagree with each of the reasons below by placing a tick (☐) in the appropriate box.

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1. I encounter problems because my teacher finds it difficult to explain concepts/ does not explain clearly.					
2. I encounter problems because my teacher does not understand some of the concepts of the topic.					
3. I encounter problems because my teacher teaches some concepts but leaves others for us to do on our own.					
4. The teacher does not give learners enough exercises to practice probability.					
5. I encounter problems because I do not have					

a mathematics textbook.					
6. I encounter problems because I do not have access to previous examination papers with solutions.					
7. I encounter problems because I do not give myself enough time to practice probability problems.					

SECTION D: Ways to improve the teaching and learning of probability

What do you think can be done to improve the teaching and learning of probability in schools?

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This is the end of the questionnaire. Thank you very much!

APPENDIX D: TEACHER INTERVIEW

INTERVIEW SCHEDULE FOR TEACHERS

PROBLEMS ENCOUNTERED BY ORDINARY LEVEL TEACHERS IN THE TEACHING OF PROBABILITY.

Teacher background

1. What is/are your teaching qualification(s)?
2. What is your subject or area of Specialisation?
3. Which level are you currently teaching mathematics?
4. As a mathematics teacher do you also teach probability as a topic?
5. How many years have you been teaching Probability?

Teacher knowledge

6. Do you think you have sufficient content knowledge to teach probability at ordinary level?
7. Have you done anything to improve your knowledge in Probability?

Teachers' problems and the cause(s) in the teaching of probability

8. What problems do you experience when teaching probability?
9. What do you think are the causes of the problem(s) you experience in the teaching of probability? And how best can they be addressed?

Thank you very much. Your participation is highly appreciated

APPENDIX E: LEARNER INTERVIEW

INTERVIEW SCHEDULE FOR LEARNERS

PROBLEMS ENCOUNTERED BY ORDINARY LEVEL MATHEMATICS LEARNERS IN THE LEARNING OF PROBABILITY.

1. Do you like learning probability? Why?
2. Do you encounter problems in the learning of probability?
3. What do you think are the cause(s) of the problems that you experience in the learning of probability?
4. What can be done to deal with the challenges?
5. Do you think your teacher is encountering problems with the teaching of probability?
6. Which aspects of probability do you think your teacher find difficult to teach and why?
7. Given a chance to decide the topics for the 'O' Level syllabus, do you think Probability is an important topic that it should be in that syllabus?

Thank you very much. Your participation is highly appreciated

APPENDIX F: DIAGNOSTIC TEST

DIAGNOSTIC TEST

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. This question paper consists of four questions.
2. Answer ALL the questions.
3. Clearly show ALL calculations, diagrams, graphs, etc., that you have used in determining your solutions.
4. Write all steps because answers only will not necessarily be awarded full marks.
5. If necessary, round answers off to TWO decimal places, unless stated otherwise.
6. Number questions according to the numbering system used in this question paper.
7. DO NOT WRITE ON THE QUESTION PAPER.
8. Write legibly and present your work neatly.

1. Two dice were thrown at the same time and their total is noted.

a) Copy and complete the table below (1)

		1 st die					
		1	2	3	4	5	6
2 nd die	1	2	3	4	5	6	7
	2	3	4	5	6	7	8
	3	4	5	6			
	4						
	5						
	6						

- b) How many possible outcomes are there? [1]
- c) How many of these outcomes give a total of 5 for the two dice? [1]
- d) What is the probability of getting a total of 5? [1]
- e) Find the probability that the total score is a prime number? [1]
2. Two coins are tossed together. Construct an outcome table (1) and use it to calculate the probability of getting
- a) a head and a tail [1] b) two tails [1]
3. In a group of 40 students all of whom are studying Physics or Mathematics or both, 20 are studying Physics and 30 are studying Mathematics.
- a) Illustrate the information on a Venn diagram. (2)
- b) Find the probability that a student chosen at random is
- i) Studying Physics and Mathematics (3)
- ii) Studying Mathematics but not Physics (1)
4. A counter is chosen from a box of 3 red, 4 blue and 2 orange counters. A second counter is chosen from a box of 5 yellow and 2 green counters. Draw and label a tree diagram to show the possibility of picking out (2)
- a) A red and green counters (2)
- b) A blue and a yellow counter (2)