BINDURA UNIVERSITY OF SCIENCE EDUCATION

TITLE: Exploring the most effective Genetics Pedagogies at Ndima Gvt High School

A dissertation submitted in partial fulfillment of the requirements for the degree of Honors Bachelors of Science Education Biology
June 2024

By

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In the

Faculty of Science Education

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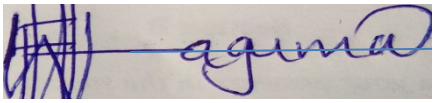

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Degree Title: Bachelor of Science Honours Degree in Biology Education

Year of completion: 2024

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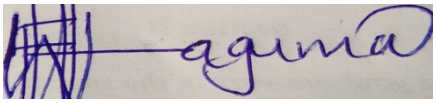
Signed  Date …16…/…07……./……24……

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ABSTRACT

The researcher is a student at Bindura University of Science Education majoring in HBScEdBz degree. This investigation is based on exploring the most effective genetics pedagogy at Ndima Gvt High School. The researcher discovered that learners at Ndima Gvt High School are developing disinterest in doing the subject of biology specifically genetics; this has influenced the investigator to find out the best pedagogy to teach genetics at Ndima Gvt High School this can motivate the learners in taking biology. A research done before by Chifwa focused on how genetics is taught in Zambia in the study Chifwa did not highlighted the best and suitable pedagogy in teaching genetics. This study tries to span that gap and provide the effective genetics pedagogy.

The research was carried out over a period of 5 months. 60 Biology learners comprised of boys and girls aged between 15 – 18yrs were randomly selected to participate in this study. Qualitative and quantitative analysis was used during the investigation. Questionnaires, tests and concept mapping were the research instruments used to obtain and gather data. The data collected was presented in form of tables.

The results from the study showed that technological pedagogy is the most effective genetics pedagogy as learners treated to this pedagogy managed to out-class other participants who were treated with inquiry based pedagogy and traditional pedagogy. This is cemented by the marks which are highlighted as % pass rate obtained by research participants- Traditional pedagogy scored 45%, Inquiry based pedagogy scored 55% and Technological pedagogy scored 85%.

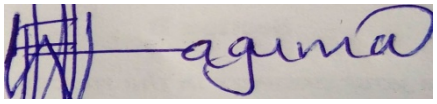
The research will help the learners to pursue their studies in the field of medicine and forensic which are unique as have become important fields nowadays. When learners drop subjects, it disrupts the continuity of their learning. Teachers plan lessons and curricula with the expectation that students will progress through the material sequentially. Dropping subjects can leave gaps in a student's knowledge and make it harder for them to keep up as the class moves forward.

High dropout rates can negatively impact a teacher's reputation and accountability measures. Schools and districts often use student retention and completion rates as metrics to evaluate teacher performance. Frequent subject drops by learners can make teachers appear less effective. The importance of learners studying genetics to a country can be significant in several include scientific and technological advancement. Genetics is a foundational field of study in biology and biomedical sciences. Educating learners in genetics can contribute to advancements in areas such as medicine, agriculture, biotechnology, and forensics. These advancements

can lead to improvements in public health, food production, and crime-solving capabilities, benefiting the country as a whole.

DECLARATION

I Taguma Fungai Willard, hereby declare that this dissertation is my own work and that it has not been previously submitted for a degree at Bindura University of Science Education or any other university.

Signed  Date 16/07/24

DEDICATION

This project is dedicated to my wife Runyararo Mutasa, my children Ruvheneko, Rujeko and Rudairo.

ACKNOWLEDGEMENTS

First and for most I would want to thank God for making it possible for me to start and finish my studies. I would like to give thanks to Dr. Dziva, my supervisor for advising and guiding me at every stage of this research project. May I also express my gratitude to the Government of Zimbabwe for giving me a chance to pursue my education under the teacher capacitating program. I am grateful to Mr O Dzakatira for taking time to proof read and edit my work. I would also like to thank fellow colleagues at Ndima Gvt High for moral support. Last but not least, I want to thank all my friends and relatives too numerous to mention for their unceasing unwavering support.

TABLE OF CONTENTS

TABLE

FIG

APPENDICES

ACRONYMS

B.U.S.E	Bindura University of Science Education
CRP	Culturally Relevant Pedagogy
DNA	Deoxyribonucleic Acid
Gvt	Government
MEGA	Multiplayer Educational Gaming Application
O level	Ordinary level
P.S.P	Problem solving pedagogy
TPACK	Technical Education and Content Knowledge
TK	Technical Knowledge
PBL	Problem Based Learning
Zimsec	Zimbabwe schools examination council

CHAPTER 1

INTRODUCTION /THE PROBLEM AND ITS SETTINGS

1.0 INTRODUCTION

This section includes background to the investigation, statement of the problem, research questions, importance of the research, and limitations of the study, delimitations, assumptions and definition of key terms. This chapter also gives an overview of the chapters that follows in this research in their chronological order.

1.1 BACKGROUND OF THE STUDY

Pure biology is a subject taught at Ndima gvt in the third year of high school. Biology has many topics, including genetics. The scope of genetics has been narrowed down to selection, mutation, monohybrid inheritance, chromosomes, sex determination, blood type and genes. The main concern is that many students drop out of biology classes. The real challenge comes down to one thing: genetics. The topic of genetics is regarded as problematic and challenging amongst learners. Former scholars championed that any concept can be taught at any level if proper pedagogy are used. There is a high chance that students are dropping biology because teachers are not using proper pedagogies

which are useful in making concepts of genetics understandable. This led the researcher to investigate the methods which genetics is taught at Ndima Gvt secondary schools. Genetics is the main subject of education today and its applications are relevant to daily life. Additionally Venville et al (2005) argued that in today's biotechnological world, understanding genetics is very important for the accumulation of scientific knowledge for the future population. The application of genetics in sectors of health, agriculture, crime investigation, and genetics should be better understood through studies of biology as postulated by Zulu (2011). Concerning health sector, genetics can help predict what diseases will occur or how an individual will respond to certain specific treatments. genetics in agriculture promotes plant productivity by using agricultural chemicals and hormones to protect plant and stimulate vegetative growth this has led to food abundance (Dendekar etal. 2000). The study of genetics is also used to catch, confirm or eliminate suspects in criminal investigations. Deoxyribonucleic acid (DNA) solves criminal cases by taking a sample of the suspect's DNA and comparing it to evidence at the scene. (2024). If the criminal cannot be caught, biological samples at the crime scene can be analyzed and differentiated with that of perpetrator’s DNA database to help identify the perpetrator of the crime (William, Johnson, &

Martin, 2004). Genetics can also help solve the problems of parents and children as in DNA tests which limit family's disputes.

Learners dropping out of biology have a mammoth disadvantage to themselves, community and the nation at large. Some of the negative impacts of learners' not studying biology especially genetics are as follows;

- It reduces career opportunities' especially in the field of medicine, forensic and other genetic related fields.
- Limits chances to discover and explore in new researches to solve worlds' problems for example drugs' to eradicate corona virus and HIV AIDS
- Decreases levels of scientific (biological) understanding.
- It affects teachers' to pupils' ratio at the school.

The researcher took ideas of constructivist learning theory which highlights that learners make their knowledge from pre-existing experiences. Constructivist's opinions are based on that the making of new understanding is the mixture of previous knowledge and new knowledge. Good students create their own knowledge with the help of facilitators. Social constructors encourage the student to achieve their own version of reality, such as their own history and culture. Social constructors take into account the student's history and culture throughout the teaching and learning time. The learner's

background helps shape the knowledge and facts that the learner creates, discovers, and acquires throughout the learning process (Creswell, 2003). Students are responsible for their own learning (Petty, 2009) Constructivist educators recognize the role of pre-existing knowledge in student learning and recognize that students are not blank pages or empty vessels waiting to be filled with knowledge. More so, they take into account that pupils bring with them a variety of experiences, knowledge, and beliefs that they can build on to create new understandings (Jones, 2002).

It affects the teaching strategies they use to deliver problematic and challenging topics such as genetics. These skills include group work, discussion, homework, drama, study, worksheets, games and songs. These ideas allow students to create their own knowledge. It turns out those students' biases are resistant to change. Preconceptions are based on children’s early experiences and emotions and create filters for future learning. To gain understanding, teachers need to capitalize on students' preconcepts and structure these concepts during instruction. To support the development of the concept, teachers should first provide technical training that addresses concepts or provides contradictions. The use of cognitive dissonance is to put the student in a situation where they can use their own understanding of a challenging problem they need to solve (Jones, 2002). Additionally, Jones (2002) stated that constructivism

provides teachers with consistency with current educational research. By treating learning as an active process that involves students' prior knowledge, develops biases, and creates conflict, teachers can create activities such as group work, demonstrations, exercises, problem solving, computer simulations, videos, and cases. Constructivist teaching encourages critical thinking and creates a motivated, independent student. Mohan (2010) believes that social constructivism emphasizes the importance of student participation in the learning process. Jones (2002) and Creswell (2003) agreed that students not only think about what they read, but also create their own understanding. Social constructivist scholars views learning as an active process in which students can discover principles, concepts, and facts for themselves. Students also actively participate in construction rather than receiving information. Intelligence is a human product and is social and cultural. In the classroom, architecture teachers often encourage their students to imagine what they are doing using learning techniques such as practice, collaboration, group discussion, brainstorming, and drama videos, animations, simulations, slideshows, and real-life solutions. Do things to create knowledge and solve problems. The teacher makes sure he understands the student's experience and suggests activities to address that experience. As learners acquire knowledge through experiences, it is of significance for teachers to prepare students to

participate in classroom activities across the curriculum. Students should be given the opportunity to work independently, which can be done individually, in twos, or as group work, through exercises such as writing the major points of the lesson. They also need to provide thinking skills such as discussion, problem solving, and data analysis to facilitate analysis, synthesis, and evaluation of learning. Additionally, students should be given practical activities such as study and practical work so that they can analyze laws and principles. Teachers should use different teaching methods to help students retain what they have learned.

1.2 STATEMENT OF PROBLEM

The purpose of this study is to explore effective genetics pedagogy that can improve students understanding and performance in genetics courses. Specifically the study aims to identify the most effective teaching methods and materials that can help students develop a deep understanding of genetics concepts and their applications.

While evidence of this relationship has been established in Zambia Kitwe district in the research by Chifwa (2015) investigated the teaching of genetics in different schools in Kitwe District in Zambia. In this study Chifwa examined how genetics was taught in 3 schools considering the qualification of teachers, lessons preparations and lesson delivering. Chifwa did not highlight the most suitable

pedagogy to be used when teaching genetics. However this study needs to span the gap indicated and explores effective genetics pedagogy in rural areas in Zimbabwe specifically at Ndima gvt high school. Researches that have been carried out so far have only identified genetics as a difficult and problematic topic to teach and learning. Also the study conducted by Chifwa (2015) it did not identify the newest pedagogy of technology pedagogy. This is a knowledge gap which needs to be addressed as to highlight the most suitable ways or strategies which educational practitioners can use to teach genetics in rural schools in Zimbabwe. This investigation will also recognize innovative pedagogy as genetics pedagogy. This will demystify that topics in genetics are difficult and challenging. Statistics obtained from Biology teachers indicated that 70% of the learners that started attending biology classes in 2021 dropped biology only 30% registered for Zimsec in 2022. From discussions with the learners it indicated that learners were failing to understand genetics. This made the researcher curious on what genetics pedagogies that are used at the school.

1.3 RESEARCH QUESTIONS

1.3.1 What factors contribute to students dropping out of biology classes?

1.3.2 What are the specific concepts in genetics that learners struggle with the most?

1.3.3 Which genetics pedagogies are currently used at Ndima Gvt High School?

1.3.4 What are the characteristic of alternative teaching pedagogy could improve student understanding and engagement with genetics at Ndima Gvt High School? (Traditional pedagogy, Inquiry-based pedagogies and Innovative pedagogies

1.3.5 What resources are available to support genetics instruction at Ndima Gvt High School, and are they used effectively?

1.4 SIGNIFICANCE OF THE STUDY

The purpose of this study is to explore effective genetics pedagogy in rural areas in Zimbabwe especially at Ndima gvt high school and the researcher will also consider the difficulties faced by teachers, learners and the school on teaching genetics. Information obtained from this study will be useful for teachers, school leaders, curriculum developers, and authors to modify the teaching and learning of genetics. Teachers will be equipped with enough knowledge to carefully choose the most effective strategy on how to teach genetics. This will make the teaching of genetics easy and learners will grasp the content easily and demystify that genetics is difficult. The research can provide teachers with effective assessment and evaluation methods that can help to measure students learning and understanding more accurately. More so teachers are provided with strategies to increase learners' engagement and motivation in genetics education. This can include hands on activities, real world

application that can help students to see relevance of genetics to their lives and interests.

As for the learner they are able to learn and understand biological concepts which will help them to pass their exams and further their studies in biology and can lead to improved learning outcomes. The learners also have better preparation for future careers having studied genetics which include the field of biotechnology, medicine and agriculture.

Curriculum developers get an insight into how students learn genetics concepts and what teaching strategies are most effective. This information can be used to design curricula that are tailored to the learner's needs and learning styles and incorporate best practices in genetics education.

1.5 LIMITATIONS OF STUDY

The investigation took place at Ndima Gvt High school "O" level biology learners 2024.The results cannot be applicable to other schools and subjects. The study was carried on limited time of 5 months which at some point may have required more time. This have a greater disadvantage to the study as it will result in rushed research leading to incorrect conclusion lack of thoroughness due to lack of time . Carrying out a research in a short space of time is stressful to the researcher which

can impact the researchers work and personal life. Qualitative data was used which can be subjected to bias of participants.

1.6 DELIMITATIONS OF STUDY

Geographically the findings of this study are generalized to a rural setup targeting Ndima gvt high school which is located in Rusitu valley in Chimanimani district. It also focuses on genetics a topic found in the subject of biology and the information cannot be related to other subjects.

1.7 ASSUMPTIONS

In this study the researcher assumed that the learning environment for the learners was conducive for learning to take place with adequate space, lighting and equipment. For the teacher, the researcher takes into cognizance that the teachers have attained high expertise in genetics and are effectively able to convey information to the learners

1.8 DEFINITION OF KEY TERMS

The following definitions are given as they are used in this research.

Active learning refers to the teaching method that involves all learners in the learning process. It differs from traditional teaching methods in which learners passively

accept knowledge of expects. Active learning can take many forms and be done in every discipline.

Allele – one of the other forms or patterns of genes found at a particular genomic location. A person inherits two alleles of a gene from each parent and the alleles may be the same (homozygous) or different (heterozygous).

Chromosome – are linear structures consisting of nucleic acids and proteins that are found in the nucleic of most living cells and carry genetic information.

Collaborative Learning – refers to the teaching methods where learners work together in groups to achieve learning goals.

Constructivism: Is the approach of teaching and learning which advocates that students build their own knowledge through experiencing things.

Dominant- refers to the relationship between two versions of a gene where one allele is expressed over the other. It describes the characteristics or trait the characteristics or trait that is expressed when an individual has one copy of dominant allele which come from just one parent.

Inquiry-based learning is an educational approach that advocates student questions, ideas, and analyses, aiming to trigger curiosity and engage learners in the learning process through active participation and real life experience. It allows students to

ask questions to find information create data and knowledge and use information in new ways to combined their findings and make suggestion.

Inheritance- refers to the processes by which genetic traits are passed from parents to offspring through their DNA. It involves the transmission of genetic material from one generation to the next influencing the physical and biological makeup of an organism

Gene – a specific nucleotide sequence in DNA or RNA that is usually involved in the chromosome arrangement of a polypeptide.

Genotype- It represents the genetic makeup of an organism including the alleles or variant forms of genes carried in an individual. In diploid organisms each genetic position has two alleles inherited from each parent forming specific genotypes for each gene. Genotypes can be homozygous or heterozygous influencing individual observable traits.

Genetics –is the systematic way of studying of genes, genetic variation and heredity in organisms. It encompasses the examination of how traits are passed down from parents to offspring over time through patterns of inheritance.

Learner is the person being given instructions.

Learner Centered Lesson: It refers to the method of teaching and learning where the students are actively involved in the proceedings during learning. The student does most of the activities for learning while the teacher is there for helping and guiding the learners.

Mutation- is any unusual conversion in the DNA sequence of a living organism. Mutations result from errors in DNA replication during division cell, exposure to mutagens or viral infections.

Teacher Centered Lesson: this refers to an approach of pedagogy where the teacher uses the lecture method.

Teaching Strategy these are the techniques and ways used by educators to achieve objectives of an intended lesson.

Recessive-Refers to a trait that is expressed only when genotype is homozygous this quality is often subsumed by other genetic factors but is still present in heterozygous genotypes.

Phenotype- individual observable traits such as height, eye color and blood type. It is the physical expression of one or more genes in an organism influenced by both genotype and environmental factors.

Variation – these are differences that exist within living organisms. Variation may be shown in mass, height earlobes and blood types.

Pedagogy refers to the art of science and practice of teaching. It encompasses the study of teaching methods, educational psychology, philosophy, and theories of learning.

1.9 SUMMARY

This section was organized as follows: presented the background to the study, statement of the problem, significance of the study, research questions, limitations, and delimitation of the study, assumptions and definitions of terms. In chapter two, related literature to effective genetics pedagogy is reviewed together with the theoretical framework. Chapter 3 focuses on research sample, research instrument, data collection, data analysis and qualitative research methodology. Chapter 4 highlights data response and demographic data. In chapter 5 the research focuses on summary of the study and recommendations.

CHAPTER 2

LITERATURE REVIEW

2.0 INTRODUCTION

This chapter present literature review related to genetics pedagogy. The chapter contains the following sections; introduction, theoretical framework, literature review and summary.

2.1 THEORATICAL FRAMEWORK

Constructivism is an educational approach that emphasizes the central role of students in constructing their own understanding. Instead of absorbing information, students build on their previous situations, make psycho representations, and integrate new information into their schemas.

While explaining the concept of constructivism, Alozie (2010) stated that constructivism believes that learners derive meaning from experiences and that meaning is affected by the interaction of previous knowledge and new situations.

The main pillars of constructivism learning theory are that students learning are constructed and learners create new knowledge based on previous learning. This experience influences people to create new knowledge or adapt through new learning.

Constructivism, a learning theory that assumes that students construct their own knowledge and understanding through experiences and social interactions, can be applied to genetics pedagogy in several ways. Some key points to consider:

Active Learning:

Help students build their understanding of genetics concepts by encouraging them to engage in active learning strategies such as problem solving, group discussions, and hands-on activities.

Collaborative Learning:

This can be done through group projects, peer reviews, and discussion forums. Contextual learning: Provide students with real-world examples and case studies that illustrate the application of genetics in a variety of fields, such as medicine, agriculture, and forensics. This can help students understand the relevance of genetics to their lives and interests.

Inquiry-based learning:

Encourages students to question, explore, and solve problems related to genetics. This can be achieved through inquiry-based learning activities such as laboratory experiments, modeling, and data analysis.

Personalized learning:

Use technology and other tools to tailor learning to each student's needs, interests, and abilities. This may include adaptive learning software, personalized learning plans, and differentiated instruction.

By incorporating these constructivist principles into genetics pedagogy, educators can create a dynamic and engaging learning environment that promotes active learning, collaboration, and critical thinking, ultimately leading to increased student achievement and a deeper understanding of genetics concepts While the negative view of teaching calls students "empty boxes" requiring knowledge, constructivism believes that students can create meaning simply by participating in the world.

Knowledge can be acquired, but understanding is not possible because it must come from the effective communication of existing knowledge, new knowledge, and learning processes.

John Dewey viewed reallife situations and problems as learning. He believes that if students only see problems as incomprehensible and do not confront their consequences in a meaningful way, if they do not think, they will be less likely to change behavioral patterns or create new ones, or simply be open.

Learning is a social process; It is something done collectively, interact with one another; it is not a complicated concept (Dewey, 1938). For example, Vygotsky (1978) argued that communities play an important role in the process of “meaning formation.”). Therefore, all teaching and learning is a matter of sharing and discussing social knowledge.

Vygotsky (1978) stated that cognitive development occurs as a result of social interactions that lead to learning in the developmental field that children and their partners experience together.

Constructivist theory argues that knowledge can only exist in the human mind and is not necessarily based on real-world facts (Driscoll, 2000). Students will continue to try to create their own mental models from their perceptions of the real world. As students acquire new knowledge, they will continue to change their conceptual models to reflect the new information, thereby creating their own interpretations of reality (McLeod, 2024).

Inquiry based learning is an active form of learning that involves asking students questions, problems, or situations rather than relying on the teacher to teach the truth (Rooney, 2012). It encourages students to explore and understand problems, develop knowledge, and find solutions through research and projects. This approach contrasts with traditional education, which emphasizes the development of thinking and problem solving.

Inquiry-based learning is often supported by teachers who guide students in research and discovery.

The principles of inquiry-based learning can be traced back to educational explorations in the 1960s as a response to traditional teaching methods that focused

on memorization. Influenced by the learning theories of philosophers such as Piaget, Dewey, Vygotsky, and Freire, inquiry-based learning emphasizes the creation of meaning through personal experience or interaction. Constructivism plays an important role in this teaching method, where students interact with the content to create knowledge through questioning, discovery and collaboration (Dev, 2016).

The Technical Education and Content (TPACK) process provides teachers with ways to improve the use of technology in their teaching. TPACK reflects the interaction of three basic factors: content knowledge (CK), pedagogical knowledge (PK), and technical knowledge (TK). The interaction of these knowledge domains creates a specific form of knowledge within the framework of TPACK, including instructional content knowledge (TPACK).

Content knowledge: refers to teachers' understanding of the content they teach, which includes concepts, theories, evidence-based thinking and practices in a particular discipline.

Technological literacy: Includes knowledge of various digital tools, software applications, and technological resources that can enhance teaching and learning (Koehler, 2009). According to the TPACK framework, effective technology integration requires teachers to support the integration of content, instruction, and

technology by considering the characteristics and limitations of different technologies in different educational environments (Adipat, 2021). By developing a deeper understanding of how these components interact and influence each other, teachers can create engaging and meaningful learning experiences for students (Pianta et al. 2012).

Culturally Relevant Pedagogy (CRP), Dr. Gloria Ladson-Billings, who emphasizes the importance of integrating students' cultures into the educational process (Payne et al. 2013). It focuses on three main themes: academic achievement, cultural awareness, and health literacy (McAllister et al. 2000).

Components of Culturally Relevant Pedagogy:
Academic Achievement: These components emphasize the importance of developing students' academic and academic rigor (Marzano, 2014). Leader teachers set high academic expectations, mentor their students, and consider where, why, and how to teach based on their students' work history.

Cultural Competence: Cultural competence requires teachers to understand the role of culture in education, understand students' cultures, and examine their own biases and laws (Mayfield 2020). A resourceful classroom can provide students with a mirror to themselves and a window into the experiences of others.

Active learning pedagogy refers to a teaching method in which students participate in the learning process rather than receiving information from teachers. It includes a variety of strategies that require students to participate, collaborate, think critically, and apply their knowledge in the classroom. The purpose of active learning is to improve students' understanding, retention, and use of information in the classroom by engaging students in activities such as discussion, problem solving, teamwork, and exercise (Howell 2021).

Theoretical Foundation of Active Learning Pedagogy

The theoretical basis of active learning pedagogy is based on constructivist learning theory (Cattaneo 2017). Constructivism believes that people learn by creating their own knowledge through experiences and interactions with the environment (Paily, 2013). Active learning is based on this theory and encourages students to engage in activities that support higher needs, the connection between new information and existing knowledge, and the construction of conceptual models based on accurate understanding (Lombardi 2021). Additionally, active learning often involves group learning that uses social interaction to improve cognitive processes and promote collaborative problem solving (Lombardi 2021).

Evidence supporting educational pedagogy

a large body of research provides strong evidence supporting the effectiveness of educational pedagogy compared to traditional teaching methods. Meta-analyses

conducted by Freeman et al (2014) and Ruiz-Primo et al. (2011) stated that active learning is effective in increasing student performance, reducing absenteeism, and understanding disciplines, including STEM activities such as biology, chemistry, engineering, and physics. Research results consistently show that engaging in learning strategies leads to positive outcomes for students (Freeman et al. 2014).

In summary, active learning pedagogy is a student learning method that teaches participation, thinking, collaboration and use of skills in the classroom. Educational pedagogy, grounded in constructivist theory and supported by empirical research, has been proven effective in promoting deeper student understanding and enhancing learning.

2.2 LITERATURE REVIEW

GENETICS PEDAGOGY

Hmelo-Silver (2004) discusses the importance of effective teaching strategies in genetics education. The author conducted research to identify the cognitive tools that are most effective in helping students learn genetics.

The study involved 120 students who were randomly assigned to one of three instructional conditions: a control group, a cognitive tools group, and a problem-

solving group. The control group received traditional lecture-based instruction, while the cognitive tools group received instruction that incorporated cognitive tools such as diagrams, flowcharts, and concept maps. The problem-solving group received instruction that emphasized problem-solving activities.

The results of the study showed that the cognitive tools group performed significantly better than the control group on a genetics achievement test. The problem-solving group also performed well, but not as well as the cognitive tools group.

The study suggests that incorporating cognitive tools into genetics instruction can significantly improve student learning. The author suggests that cognitive tools can help students organize and integrate information, promote understanding, and support problem-solving.

The study also highlights the importance of considering the cognitive load of students when designing instructional materials. The author suggests that cognitive tools can help reduce cognitive load by providing a visual representation of information, which can help students process and understand complex information more easily.

Overall, the study provides strong evidence for the effectiveness of cognitive tools in genetics education and highlights the importance of considering the cognitive load

of students when designing instructional materials. The findings of this study have important implications for the teaching of genetics and other science subjects, and suggest that incorporating cognitive tools into instruction can significantly improve student learning.

However Hmelo-Silver did not highlight that poor or inappropriate teaching pedagogy can demoralized learners such that it can lead to dropping out of biology classes. This is as a result that the complex concepts need a suitable pedagogy for it to be understandable.

In another study by Atay (2008) on genetics pedagogy aimed to investigate the effectiveness of a problem-based learning (PBL) approach in teaching genetics to high school students. The study involved 120 students who were randomly assigned to either a PBL group or a traditional lecture-based learning (TBL) group. The PBL group was given a set of real-world problems related to genetics, such as determining the probability of a child inheriting a genetic disorder, while the TBL group received traditional lectures on genetics.

The study found that the PBL group performed significantly better than the TBL group on a test of genetics knowledge, and that the PBL group also reported higher levels of motivation and engagement. The study suggests that the PBL approach can

be an effective way to teach genetics in high school, as it allows students to apply their knowledge to real-world scenarios and develop problem-solving skills.

In addition, the study also found that the PBL group showed better retention of the material over time, suggesting that the PBL approach can have long-term benefits for student learning.

The study by Atay (2008) supports the idea that problem-based learning can be an effective way to teach genetics in high school, as it allows students to apply their knowledge to real-world scenarios and develop problem-solving skills, which can lead to better retention of the material and higher levels of motivation and engagement.

The study by Alozie (2010) investigated the impact of genetics pedagogy on student learning outcomes in introductory biology courses. The author evaluated the effectiveness of a genetics pedagogy that emphasized problem-solving, critical thinking, and active learning, compared to a traditional lecture-based approach.

The study involved 105 students who were randomly assigned to either a control group (lecture-based approach) or an experimental group (problem-solving, critical thinking, and active learning approach). The students completed a pre-test and a post-test to assess their knowledge gain, and a survey to evaluate their perceptions of the teaching methods.

The results showed that the experimental group had significantly higher knowledge gain scores compared to the control group. Additionally, the survey results indicated that the students in the experimental group perceived the problem-solving, critical thinking and active learning approach as more engaging, motivating, and effective in helping them understand genetics concepts.

The study by Alozie (2010) suggests that incorporating problem-solving, critical thinking and active learning strategies into genetics pedagogy can improve student learning outcomes in introductory biology courses. The findings support the idea that students learn genetics concepts more effectively when they are actively engaged in the learning process and are given the opportunity to apply their knowledge to real-world scenarios.

The study has some limitations, such as the small sample size and the fact that the study was conducted in a single institution. However, the findings suggest that genetics pedagogy that emphasizes problem-solving, critical thinking and active learning may be a promising approach to improving student learning outcomes in introductory biology courses. To add more from the study mentioned above the researchers did not take into consideration the use of innovative pedagogy which is characterized by the use of technology in the classroom setup.

According to Mukaratiwa (2018) explored the challenges and opportunities faced by high school teachers when teaching genetics in Zimbabwe. The study employed a qualitative research approach, and data were collected through interviews with 10 high school teachers who taught genetics. The study found that lack of resources, inadequate teacher training, and cultural beliefs were major challenges faced by teachers when teaching genetics. The study also identified opportunities for improving genetics education, such as incorporating local contexts and using multimedia resources. The study recommended that teachers should be provided with adequate training and resources to enhance their teaching of genetics, and that the curriculum should be designed to reflect the local context and cultural beliefs of students. The study is significant because it highlights the challenges faced by teachers in Zimbabwe when teaching genetics, and provides recommendations for improving genetics education in the country. This study also highlights the importance of considering local context and students' cultural beliefs when teaching genetics. This can help make genetics more relevant and interesting to students. The results of this study can be used to develop effective teaching strategies and materials for genetics education in Zimbabwe and other countries in similar contexts.

In another study conducted by Maphosa et al (2017) in this study, the authors investigated the effectiveness of a problem-solving approach in teaching genetics to high school students in Zimbabwe. The study employed a quasi-experimental

design, with 120 students randomly assigned to either a problem-solving group or a traditional teaching group. The study found that the problem-solving group performed significantly better than the traditional teaching group in terms of genetics knowledge and problem-solving skills. The study also found that the problem-solving approach was effective in promoting student engagement, motivation, and interest in genetics. The study's findings support the use of a problem-solving approach in teaching genetics to high school students in Zimbabwe. The approach can help students develop critical thinking and problem-solving skills, which are essential f or understanding genetics concepts. The study's results also suggest that the problem-solving approach can be effective in promoting student engagement and motivation, which can help to increase student achievement in genetics. The study's limitations include the use of a quasi-experimental design, which does not allow for causal inferences. Additionally, the study was conducted in a single school, which may limit the generalizability of the findings to other schools in Zimbabwe. The study provides evidence that a problem-solving approach can be an effective teaching strategy in genetics education for high school students in Zimbabwe. The approach can help students develop critical thinking and problem-solving skills, and promote student engagement and motivation. Future studies should consider using a randomized controlled design to increase the validity of the results. Research should

also examine the long-term impact of problem-solving approaches on student achievement and interest in genetics

INCLUSION OF TECHNOLOGY

Ncube (2018) examined the use of technology in teaching and learning in rural secondary schools in Zimbabwe. The study aimed to explore the experiences of teachers and students in using technology, and to identify the challenges and opportunities associated with its use. The study found that technology can improve student engagement and learning outcomes, particularly in subjects that are traditionally difficult to teach, such as math and science. However, the study also identified several challenges, including inadequate infrastructure, lack of teacher training, and limited access to technology outside of the classroom. The study recommends that the government and other stakeholders should invest in providing adequate infrastructure and training for teachers to effectively integrate technology into their teaching practices. The study also suggests that policies and strategies should be developed to address the challenges associated with technology use in rural schools, such as limited access to technology and inadequate infrastructure. Overall, this study highlights the potential of technology to improve teaching and learning in rural Zimbabwe schools, but also recognizes the need for careful planning and support to ensure effective and equitable use of technology.

The study aimed to explore the experiences of teacher s and students in using technology, and to identify the challenges and opportunities associated with its use. The study found that technology can improve student engagement and learning outcomes in genetics, particularly when interactive multimedia tools are used. However, the study also identified several challenges, including inadequate infrastructure, lack of teacher training, and limited access to technology outside of the classroom. The study recommends that the government and other stakeholders should invest in providing adequate infrastructure and training for teachers to effectively integrate technology into their teaching practices. The study also suggests that policies and strategies should be developed to address the challenges associated with technology use in rural schools, such as limited access to technology and inadequate infrastructure. Overall, the study highlights the potential of technology to improve teaching and learning in rural schools in Zimbabwe, but also acknowledges the need for careful planning and support to ensure that technology is used effectively and equitably. The study has some limitations, such as the small sample size and the focus on a single subject area. However, the study provides valuable insights into the use of technology in rural schools in Zimbabwe and highlights the need for further research and investment in this area. In conclusion, the study by Zulu (2018) provides evidence that technology can improve student engagement and learning outcomes in genetics in Zimbabwean high schools.

However, the study also highlights the need for adequate infrastructure, teacher training, and policies to support the effective use of technology in rural schools. Further research is needed to examine the use of technology in other subject areas and identify the most effective strategies to improve teaching and learning in rural schools in Zimbabwe

Annetta et al (2010) conducted a quasi-experimental study to determine how videos can be used for teaching and learning in educational environments. Participants included biology students from different classes taught by the same teacher (Chifwa 2015). The sample consisted of 131 (70 male and 61 female) high school biology students with similar abilities. Students are evaluated while meeting the teacher, Multiple Learning Applications (MLA) have been developed for high school students. MEGA (Electronic Game) is used to assess twenty-first grade students' skills in digital literacy, critical thinking, and effective communication skills (Chifwa 2015). MEGA is created in Active worlds (a 3D virtual environment). MEGA is called "Mr. Megabucks' Stolen Fortune" and takes place in a multiplayer environment. Students are asked to use their knowledge of genetics, Mendelian inheritance, blood type, and DNA fingerprinting to solve the mystery (Chifwa 2015). The background story is that a wealthy couple was struck by lightning and died tragically. The couple left inheritances to many relatives. The day everyone was there to

read the will, the heirs were stolen. The thief left blood and fingerprints at the scene. To find out whom stole the their, students must go to the laboratory and analyze the clues (Annetta et al., 2010). Students use games to stimulate and analyze genetics. Research shows that students interact more with their teachers while playing MEGA (Chifwa 2015). Excited students raised their hands to ask questions. Students can communicate with their friends and complete three tasks: creating a family tree, eliminating suspects, and identifying thieves (Chifwa 2015). Games are effective in teaching action and interaction, and because they are interactive, students can retain what they learn through games. This video game helps students understand complex and ambiguous genetic concept. White and colleagues (2007) created the Virtual Genetics Laboratory (VGL), a computer simulation of hypothetical disease genetics. This program introduces students to genetic facts related to the inheritance of selected traits (Chifwa 2015). Ask students to identify what this behavior looks like. He created genetic patterns by creating his own experimental crosses. The software then creates the resulting intersection. The results are evaluated. Since this simulation is open-ended, it supports many genetic analysis strategies (Chifwa 2015). Biology teachers use technology to support biology teaching. Various computer programs are used to enhance students' genetics learning. For example, Biology is an interactive multimedia program for the study of

genetics. In this activity, students can select or modify graphics and text and view the results according to Mendel's genetic law (Tsui et al. 2004).The concept of genetics has many concepts that students need to learn in order to understand the concept (Chifwa 2015).

Constructivist teaching methods, such as pairings, can be used to encourage discussion about genetics. May and colleagues (2013) conducted a study using biospeech. Students in an undergraduate genetics course were asked to choose a partner and the two were asked to write a dialogue based on a list of 25–30 words provided by teachers (Chifwa 2015).

Work in pairs to write and practice the speech, and then present the 5-minute speech to the class. This helps students understand the meaning of the topic rather than just memorizing it. This is because the language school relates to the knowledge that 60 students already have, the lessons are effective, and students' feedback helps students learn them (Chifwa 2015). Students find the content dull and boring. Additionally, Styer (2009) reported that learning inquiry (including the use of research materials) is a form of active learning that enables students to acquire critical thinking skills. The use of research materials also improves group learning skills and helps conduct research on students. Mendelian genetics can be taught through genetic studies.

Research articles can be used to evaluate student learning and apply genetic models to real-world situations. It is difficult for students to understand genetics because the concepts used in genetics have no use outside of the genetics course (Chifwa 2015). Learning genetics is like learning a foreign language. Many terms in genetics have different meanings for similar words but have different meanings. For example, heterozygous and homozygous; if a student does not understand one of these pairs, he will not understand the other (Woody et al. 2013).The use of metaphors helps students understand genetic concepts for example, loci and genes can be described using the habitat analogy (Chifwa 2015).

The literature reviewed in this section shows that teachers use a variety of learning methods such as case studies, discussions, assignments, projects, games and computer games that are more effective in teaching in genetics.

There are not many genetic studies in Africa (Chifwa 2015) some studies have focused only on students' understanding of genetics. One such study was conducted in South Africa; Sebitosi (2007) investigated the understanding of genetic content in rural schools in two provinces. Participants included 15 teachers enrolled in Professor Sebitosi's biology module and 100 grade 11 students taught by the participating teachers. These schools are located in rural areas (Chifwa 2015). Research tools used included surveys, interviews, pre- and posttests, and focus group discussions. The result of the research is that students do not have an understanding

of the processes and procedures involved in genetics (Chifwa 2015). Students have difficulty understanding the difference between genes and chromosomes, what is genetic and what are not, what Mendelian inheritance means, and the conflict between religion and science research (Chifwa 2015).

In South Africa, Dlamini (1999) also conducted a study to determine pre-service teachers' levels of proficiency in genetics knowledge, understanding and problem solving (Chifwa 2015).

The study was conducted on 25 students from the class of 1998. The study showed that the overall performance of the participants was higher in the test of the genetic bad genes study (Chifwa 2015). Participants performed better on 62 questions that tested cognitive decline, such as recall. Participants had difficulty understanding the meiotic process but were quite comfortable with mitotic issues. Additionally, a study by Dlamini (1999) showed that there is a positive relationship between students' knowledge and understanding of meiosis and their ability to find solutions to genetic problems (Chifwa 2015). Understanding genetics is seen as essential to solving the ongoing problem of genetics. Pre-service teachers show a lack of interpretation and expertise in the field (Chifwa 2015). This happened because some pre-service teachers wrote examples that showed multiple chromosomes instead of a single chromosome. The fact that students cannot interpret simple sentences shows that their language skills are not good. Dlamini (1999) also stated that there is not much

genetic research available in South Africa. Okoye and colleagues (2006) conducted a study in Nigeria to examine the impact of concept mapping and problem-solving strategies on the genetics of Nigerian secondary school students. A quasi-experimental pretest and posttest treatment method was adopted in this study. The sample consisted of 113 Secondary School III (SSSIII) students selected from three secondary schools in Delta State. The experimental group was taught to select genetic concepts using concept maps and problem-solving techniques, while the control group was taught to use 63 disciplinary techniques (Chifwa 2015). The experimental groups were taught by qualified teachers who had received rigorous training for the research. The results of the study showed that the genetic performance of the experimental group was better than that of the control group (Okoye et al., 2006).

Haambokoma and colleagues (2002) investigated mathematics and science teaching in secondary schools in Zambia. 64 One of the aims of this study was to identify the subjects that students have difficulty with in mathematics and science courses taught in high schools in Zambia. According to this research, teachers and department heads stated that one of the most difficult subjects to teach in biology is genetics (Chifwa 2015). Additionally, most of the teachers who participated in this study stated that they were not willing to teach genetics. Heads of Department (HODs) who responded to the survey below stated that teachers need help teaching these subjects

better. Ten years later, a study by Manda (2012) investigated the nature and causes of learning difficulties in biology among high school students in Samfia District. A descriptive descriptive research design was used. The research instruments used were an interview guide and a self-administered questionnaire (Chifwa 2015). Research shows that one of the subjects that teachers and students often have difficulty teaching and learning is genetics.

Another educational study was conducted in Zambia by Haambokoma (2007) to determine the nature and causes of learning difficulties of 12th grade students in the field of genetics. This study is a descriptive research. A survey was used to collect data from past Grade 12 students (Chifwa 2015). The research revealed that the factors that make it difficult for students to understand genetics are as follows: Teachers cannot explain it clearly, cannot teach its meaning at all, some teachers teach subjects close to the exam; students find it difficult to think about genetics, and lack of proper teaching. There is not enough time for teaching and the teachers are not good. In the same study, hybridization, calculation, genetic terminology, mutation, mitosis and meiosis, sexual order, variation and co-dominance were shown as areas where students had problems.

2.3 SUMMARY

When the literature is examined, it is clear that there are many studies on genetics education outside and in Africa that show the problems faced by genetics learners. The researcher collected data from the participants through interviews, tests, and surveys. As seen in the literature review, no research has been conducted to evaluate genetics teaching and learning in secondary schools in Zimbabwe, particularly Ndima gvt High School in Chimanimani District. This study attempts to address this important knowledge gap. This makes the current study very important. Chapter 3 details the research design; research instruments used, study participants and how the population was sampled, data collection, and data analysis document.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 INTRODUCTION

In this part an update is given on the methods used to investigate the research questions under the following sub headings; research design, research's participants, research's instruments, data collection procedures, data analysis, qualitative research methodology and summary.

3.1 RESEARCH PARADIGM

The researcher made use of the Traditional experimental design. Participants were allocated into 3 groups randomly; each group was treated to one particular pedagogy. The pedagogies were traditional method, technological method and active learning. A standardized assessment in form of a test was administered to the participants this

will help to clarify which pedagogy was the most effective in teaching and learning of genetics.

3.2 RESEARCH APPROACH

A cross-sectional design was used in this study. Mixed methods design is a mixed research method that involves collecting quantitative and qualitative data simultaneously and then analyzing them separately (Almeida, 2018). After individual analysis is performed, the results are compared or combined to arrive at overall conclusions. This design allows for the collection of rich, detailed data and provides a better understanding of the research question. It is especially useful for investigating complex questions that make use of numbers and explanations (Almeida, 2018).

3.3 RESEARCH DESIGN

Convergent concurrent design is a research design that uses multiple data collection methods and data analysis techniques simultaneously to explore questions from multiple perspectives. The first step is to clearly define the research question or

problem you want to investigate. For example, “What is the effective pedagogy in studying genetics?”

Next, is the identification of data collection methods in this case the researcher chose to use questionnaires, concept mapping, and tests. The data analysis techniques which were implemented after collecting data using different methods include descriptive data, frequency analysis for the questionnaires data and tests data. The data was analyzed using analyze data using patterns, themes, and relationships across different data sources. Interpret the results of each dataset in light of the research questions and find areas of convergence and difference between different datasets. Based on the results of different data, conclusions were drawn about the best teaching strategies for genetics education. Using multiple methods and techniques can increase the effectiveness of research results by triangulating data and providing a better understanding of the research question. More so using different methods and techniques can increase the generalizability of research findings to different contexts and populations.

Convergent concurrent designs allow researchers to identify areas of convergence or divergence between qualitative and quantitative results, allowing for greater interpretation of research results (Almeida, 2018). This approach is necessary for a deeper understanding of the efficiency of gene expression by combining qualitative and quantitative data to draw conclusions.

3.4 POPULATION AND SAMPLING

The groups used in this study were biology teachers and third and fourth year biology students at Ndima Gvt High School in Chimanimani District. Students were selected using random sampling method among 100 students. The participants were aged between 15 years to 19 years. The sample consisted of 22 boys and 38 girls. This approach gives all students an equal opportunity to participate in research. The researcher dealt with a sample of 60 students. 100 small cards were prepared, 60 of which were marked "yes" and the other 60 were marked "no". Cards are placed in an opaque box and the student chooses a card. Students who selected the "Yes" card participated in this survey. After the meeting, 60 participants were divided into 3 more groups. Again random sampling is used. A sample of 60 participants is feasible to a population of 100 due to the resources constraints, time and budget. Furthermore 60 participants is a manageable and decent number that represents the entire population assuring the sample is randomly selected.

3.5 RESEARCH INSTRUMENTS

Questionnaires, concept maps and tests are some of the research tools used in this study. . They often contain questions designed to elicit responses from participants (Bradburn et al., 2004). Although there are many ways to administer the questionnaires, including electronic and online questionnaires, the researcher chose to use open-ended and closed-ended questions as a way to gather information about

what they considered a good way to study genetics. The information collected from the questionnaires is important in determining the best genetics teaching methods that teachers can use when teaching genetics in schools. The questionnaires correlate with some external criterion such as learning outcomes or instructor ratings of teaching effectiveness. This assesses whether the questionnaire is actually measuring the theoretical construct of effective genetics pedagogy rather than some other unrelated construct validity. The questionnaires used were open ended questions. Open ended allows the participants to give information with more detail and elaborated answer beyond one word answer. The questionnaire for the participant is found on the appendix A

Test refers to the tools used to measure and evaluate research participants (Kimberlin et al., 2008). In this study, we used tests to collect classroom data to understand whether genetics teaching was effective. Take a test after completing a particular topic using a particular teaching method. These scores are used to increase the likelihood of successful gene expression. This examines whether the test items adequately cover the key content and learning objectives in genetics. Expert review is crucial to ensure the test items are representative of the genetics curriculum and skill being assessed. This also evaluates how the test scores correlate with some external criterion such as student performance on standardized tests or real world genetics related tasks. The test was made up of structured questions and essay type

of questions. The tests administered to the research participant are seen in the appendix C.

Concept map; It is the process of visually organizing and representing information (Davies, 2011). It usually involves presenting concepts in circles or boxes and showing the relationships between concepts by connecting lines connecting ideas (Novak et al. 2008). They are hierarchical in nature; more general concepts are arranged at the top, and more specific concepts are arranged below (Novak, 2012). During this research, teachers identified topics in genetics and other topics and prepared a concept map. Diagrams help put concepts or concepts together in a way that uses the same teaching method. Some of these concepts can easily be arranged in order, making it easier to understand from simple to complex. This tool helps to clarify all topics in the field of Genetics. The concepts were informed of topics found in the O level biology syllabus. The concept mapping was put in appendix D in this research. The concept mapping was given after the participants were treated to various pedagogies.

3.6 DATA COLLECTION

The law of the country stipulates that no researcher is not allowed to carry out a research without permission Education Act (1994).The researcher obtained the

permission from relevant authority that is the ministry of Primary and Secondary education.

Data collection occurred from 01/08, 2024. The set of questionnaire was in biology class, and the answers were written down immediately after the students finished their answers. This is done to prevent inappropriate behavior; that students can compare their answers, the answers will change, thus destroying the reliability of the study. The questionnaire was allocated 20 minutes to be completed the participants answered individually. Using the primary data collection method, the researcher collected questions from the students and used them for analysis.

The scores obtained from the questionnaires were recorded and included in the analysis. The test was written on 31/07/24, the appropriate testing pattern was followed to minimize negative performance so that students could report on their learning and understanding. The tests were administered to the 60 participants; the test was to be completed in 1hour 30 minutes. Each participant was given a question paper and an answering script. The invigilation was done by professionals who have experience running examination setups. A marking guide was drawn with the help of other biology teachers at Ndima Gvt High the marking of the tests was also done collaboratively this minimizes biases.

The concept mapping was given on 07/05/24; the 60 participants in their groups were given 30 cards with each card written a topic or sub topic found the Zimsec O biology syllabus. The participants were asked to identify topics related to genetics and present it in hierarchical order in form of circles or boxes. Concept mapping gives the researcher an insight into the participants understanding of genetics. Researcher prefers to collect primary data as it gives accurate results as the data collected is primary data and there is no room for bias and related data.

3.7 DATA ANALYSIS

Qualitative content analysis was used to analyze the collected data. Hsieh and Shannon (2005: 1278) define the term qualitatively as: “A study that interprets data content through the process of classification to code and identify themes or patterns.” It is defined as follows; According to Chifwa (2015), qualitative content analysis is the process of establishing systematic and transparent data for analysis, determining analysis units, creating categories and coding schemes, testing the coding process of question samples, coding, measuring coding consistency and drawing conclusions from coded data (Weber, 1990; Kumar, 1999; Creswell, 2003). The researcher made a preliminary coding framework guided by the research question and themes. These

codes included the participants' prior knowledge to genetics which was obtained from the concept mapping, effective genetics pedagogy which the data was supplied from the questionnaires and the tests given to participants, a coding for learning aids was also used derived from the questionnaires lastly the code for participation of participants during teaching and learning sessions. The codes were arranged in hierarchical order for better presentation effective genetics pedagogy.

3.8 QUALITATIVE RESEARCH METHODOLOGY

Finished questionnaires were scrutinized thoroughly using content analysis. That means an open ended question from one questionnaire was picked and the answers to that question were jotted down. If the participant gave more than one answer, the answers were highlighted separately. Another questionnaire was selected and the same procedure was carried out, the researcher wrote the answer given for the same question on the sheet for that question. This procedure was repeated carefully until all the questionnaires were exhausted. Then responses to each one of the question were thoroughly observed to see whether they are in common or different. Responses that were in common in meaning were bunched under one group or theme. These groups or categories constituted the units of analysis; codes were given to each group.

When it comes to tests, scoring guidelines have been established. The scoring table is designed to provide the correct score and size to ensure the competition is efficient and effective. The report card is forwarded to other biology teachers at the school to check the answers. To ensure trustworthy of the findings in this research, the investigator used the data triangulation method. This is cemented by the use of multiple methods to collect data which include tests, questionnaires and concepts mapping on topic of exploring the effective genetics pedagogy in rural schools.

3.9 ETHICAL CONSIDERATION

The researcher takes into consideration inclusivity and accessibility such that genetics education is accessible to student of all backgrounds, ability and learning styles. The researcher avoided teaching methods that marginalized other groups. The researcher respected privacy and consent of participants this means that the gathered information was only used in the academic arena only and nothing else.

3.10 SUMMARY

In this investigation, the researcher adopted the convergent parallel design as the research design. Also in this chapter much emphasis was given on the research instrument which includes questionnaires, tests' and concept mapping as a way of collecting data from participants in this research. The research participants were O

level learners at Ndima Gvt High school in 2024. These participants were sampled from a population used random sampling method. The data collected is analyzed using qualitative content analysis. The next chapter will focus on presentation on the data obtained by the research instruments and it will be analyzed giving a discursive platform of the findings.

CHAPTER 4

PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.0 INTRODUCTION

This section consists of the response rate looking closely on response by the participants as how they returned the research instruments and the number of instruments returned. Also in this section is the demographic data on the composition of the research participants. The findings of quantitative and qualitative data in this study will be discussed in detail this section.

4.1 RESPONSE RATE AND DEMOGRAPHIC DATA

The researcher gave the participants 60 questionnaires to answer and when they finished 60 completed answered questionnaires were returned. On the test again 60

question papers were issued and the participants managed to answer the questions on answer scripts and 60 answer scripts were obtained after the session. This marks a 100% response rate from the participants. This was achieved because the researcher was time conscious as soon as the participants answered the questionnaires all the responses were collected and all submitted. For the test and concept mapping dates were given and the researcher kept reminding the dates until activities were done and all participants were presence and a 100% turn up was achieved during this study. The research participants were comprised of both boys and girls undertaking their O level studies at Ndima gvt high. The participants were aged between 15-19 years. The participants come from average income communities the community depends of farming and selling of bananas pineapples and other horticultural activities. The general performance of the participants was below standard with the candidates that set for Zimsec 2023 examination had 33% pass rate. The facilitors were biology teacher with diploma in education as their highest qualifications.

4.2 QAUNTITATIVE RESULTS

In this section the outcomes of this research are highlighted according to research questions. The researcher was curious to know why learners are not interested in biology.

1.3.1 What factors contribute to students dropping out of biology classes?

The responses given to this question the data was collected on the reason why learners were not doing biology at the school.

Table 1; Reasons for dropping

Reason	**Frequency**	**%**
Inappropriate genetics biology pedagogy	**40**	**66.6**
Lack of money to register biology	**15**	**25**
School drop out	**5**	**8.3**
Total	**60**	

As eluded by table 1, the majority of the participants highlighted that the major factor which led learners to drop out of biology class was inappropriate pedagogies in teaching genetics which have 66.6%. Then other learners are unfortunate that their parents cannot afford to register biology due to financial constraints and this consists of 25%. Lastly some learners could not finish their course due to various reasons forcing them to drop out of school.

1.3.2 What are the specific concepts in genetics that learners struggle with the most?

The data shown in table 2 was gathered from the research participants on the concept which they deemed challenging and problematic to learn.

Table 2: Topics in biology

Concept	**frequency**
Biodiversity	2
Micro-biology and biotechnology	7
Genetics	35
Enzymes	2
Cells and cellular activities	5
Plant science	2
Safety careers in biology	-
Animal science	4
Chemicals of life	3
Ecosystems	-
Health and diseases	-
Total	60

The data in table 2 shows that genetics is deemed difficult and troublesome concept to learn as far as the participants are concerned. Genetics has a whooping 35 participants out of 60 that voted it as difficult. The investigator was keen to identify the most difficult concept in biology and how it is taught at the school that means effective genetics pedagogy should implemented for learning to take place.

1.3.3 Which genetics pedagogies are currently used at Ndima Gvt High School?

Participants were given an opportunity to highlight the kind of strategies which the teachers were currently using in their lesson when teaching genetics. In most cases teachers used the traditional pedagogy in delivering their lesson where the facilitator does most of activities and learners remain passive during the sessions.

Table 3: Pedagogy currently used

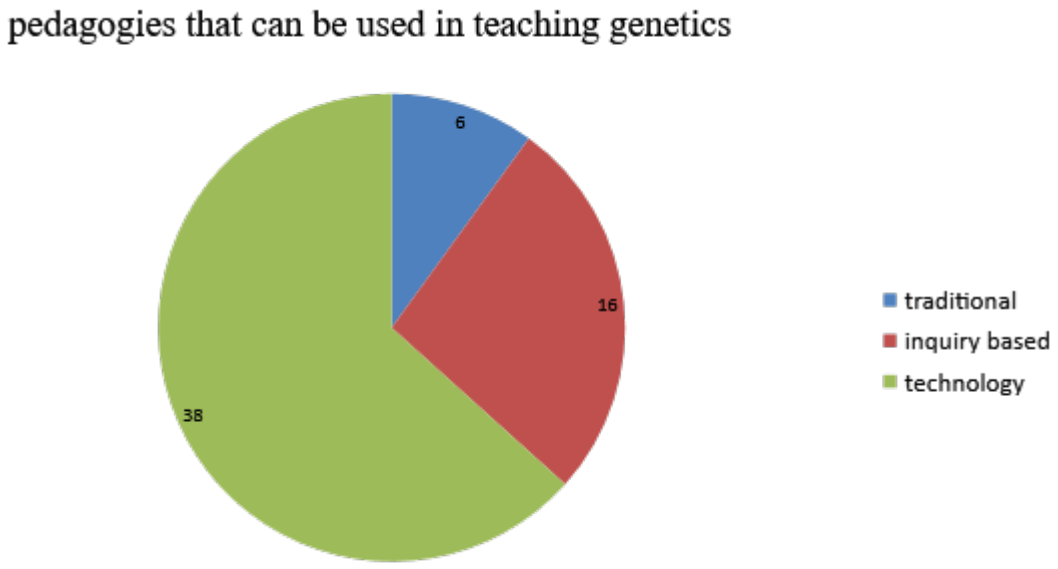
Pedagogy	**Frequency**
Traditional pedagogy,	45
Inquiry-based pedagogies	10
Innovative pedagogies	5
Total	60

Traditional pedagogy is the most common popular pedagogy being used by educators when delivering content in biology lessons. This pedagogy is most characterized by lecturing method where the teacher does all of the activities during the lesson.

1.3.4 What are the characteristic of alternative teaching pedagogy could improve student understanding and engagement with genetics at Ndima Gvt High School?

The table below shows different types of pedagogy and the participants answered on which pedagogy can be the most alternative pedagogy in genetics. Besides the teacher centered approach there are other approaches which can be used during teaching and learning.

Fig 4.0 Pedagogies that can be used in teaching genetics



As illustrated in fig 4.0 most participants opted for technology pedagogies which include the use of computers projectors videos, video games, simulations etc as an alternative teaching pedagogy in genetics. With this era of technological advancement learners are not to be left behind as technology fascinates them learning becomes enjoyable and understandable.

1.3.5 What resources are available to support genetics instruction at Ndima Gvt High School, and are they used effectively? In this section the researcher wanted to identify the utilization of available resources at the school.

Table 4; Available resources

Available Resources	Used in lessons
textbooks	Yes
models	No
Technological computers etc	No

From the responses compiled by the researcher from the questionnaires it show that textbooks are the only source of resources used at Ndima gvt high during learning biology particularly in genetics. Models and technological devices are underutilised as teacher mainly focuses on text books only.

Test marks (in class test)

The data below was obtained from the test which the participants wrote this was after each group was taught using single particular pedagogy. The researcher was interested in gathering data on which pedagogy was most effective for learners to understand concepts in Genetics. The following data show the percentage pass rate of each group.

Table 5; Test results%

Pedagogy	**% pass rate**
Traditional pedagogy	45
Inquiry-based pedagogies	55
Technological pedagogies	85

Fig 4.1 Test results%

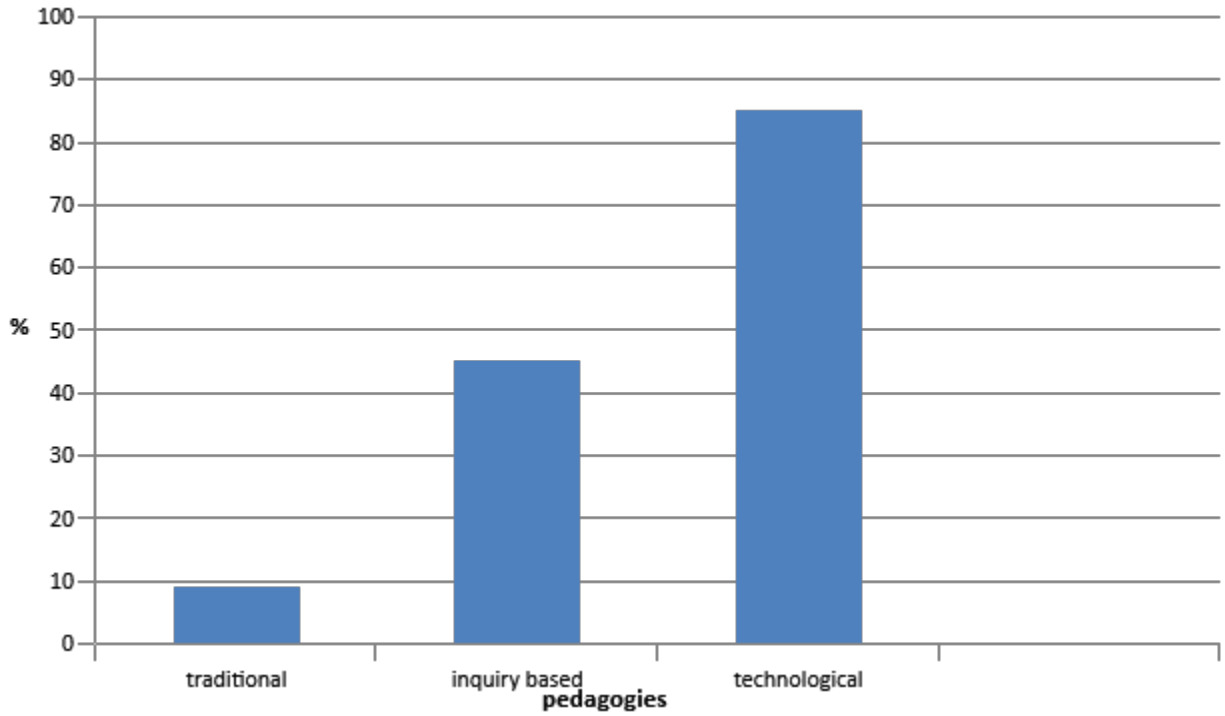


Table 6 Tests marks

pedagogy	Tests marks actual out of 20																			
traditional	12	10	10	5	9	7	11	11	4	10	11	07	5	9	3	6	9	10	7	10
Inquiry	9	9	15	3	10	7	11	13	9	6	10	11	12	10	13	10	13	5	7	9
technology	12	14	10	15	9	18	16	9	16	14	13	9	13	15	14	17	15	15	13	15

The mean for traditional pedagogy is 8.6

The mean for inquiry based pedagogy is 9.6

The mean for technological pedagogy is 13.6

To further clarify that technological pedagogy is the most effective genetics pedagogy the researcher used the z- score as it used to observe the performance of individuals

The standard deviation for traditional pedagogy is 2.6

The standard deviation for inquiry based pedagogy is 2.9

The standard deviation for technological pedagogy is 2.57

Z score = score – mean /standard deviation

For traditional pedagogy 166-86/2.6 =60.5

For inquiry based pedagogy 192-9.6/2.9=62.9

For technological pedagogy 240-13.6/2.57=88.1

The larger the Z score the better the performance hence technological pedagogy is the most effective genetics pedagogy as it has a larger value than the other pedagogies.

To further clarify that technological pedagogy was the most effective when teaching genetics the researcher used ANOVA to compare the pedagogies which the participants were treated to.

Null and alternative hypothesis

The null hypothesis is that there is no significant difference between the mean of 3 genetics pedagogy

H_0: $\mu_1 = \mu_2 = \mu_3$.

The alternative hypothesis, H_1, is that at least one of the 3 genetics pedagogy is different from the other.

H1: $\mu_1 = \mu_2 \neq \mu_3$.

Significance level

The test is performed at 5% significance level or at $\alpha = 0.05$.

Total sum of squares (SS_{TOT})

The following summary statistics are important for calculation of the SS_{TOT}:

$\sum x_1 = 8.6, \quad \sum x_2 = 9.6, \quad \sum x_3 = 13.6,$

$\sum x_{TOT} = \sum 8.6 + \sum 9.6 + \sum 13.6 = 31.8$

$\sum x_1^2 = 73, 96 \qquad \sum x_2^2 = 92, 16 \qquad \sum x_3^2 = 190.44,$

$\sum x^2_{TOT} = \sum 73.96 + \sum 92.16 + \sum 190.44 = 356.56$

$n_1 = 20, \qquad n_2 = 20 \qquad n_3 = 20,$

N = $n_1 + n_2 + n_3 = 20 + 20 + 20 = 60$.

$SSTOT = \sum x^2_{TOT} - (\sum x_{TOT}^2 / N) = 356.56 - (31.8^2 / 20) = 306$

Sum of squares between (SS_{BET})

$SS_{BET} = \sum [(\sum x_i)^2 / n_i] - (\sum x_{TOT}^2 / N) = [(8.6^2 / 20) + (9.6^2 / 20) + (13.6^2 / 20)] - (31.8^2 / 60) = 0.65$

Sum of squares within (SS_W)

$SS_W = \sum SS_i$, where $SS_i = \sum x_i^2 - [(\sum x_i)^2 / n_i]$.

$SS_1 = 73.96 - (8.6^2 / 20) = 70, 26$

$SS_2 = 92.16 - (9.6^2 / 20) = 87.56.$

$SS_3 = 190.44 - (13.6^2 / 20) = 180.94.$

$SS_W = 70.26 + 87.56 + 180.94 = 338.76.$

Mean squares between (MS_{BET})

$MS_{BET} = SS_{BET} / df_{BET} = SS_{BET} / (k - 1) = 0.65 / (3 - 1) = 0.31.$

Mean squares within (MS_W)

$MS_W = SS_W / df_W = SS_W / (N - k) = 338 / (60 - 3) = 5.93.$

***F*-statistic**

$F = MS_{BET} / MS_W = 0.31 / 5.93 = 0.05$

The critical value

The critical value, $F_{0.05}$, using degrees of freedom for the numerator, $df_{BET} = k - 1 = 3 - 1 = 2$, and degrees of freedom for the denominator, $df_W = N - k = 60 - 3 = 57$

Given:

Degrees of freedom for the numerator, df BET = k – 1 = 3 – 1 = 2

Degrees of freedom for the denominator, df W = N – k = 60 – 3 = 57

To find the critical value F0.05, we need to refer to the F-distribution table with degrees of freedom df1 = 2 and df2 = 57 at a significance level of α = 0.05.

From the F-distribution table or using statistical software, we can determine that the critical value for F0.05 with df1 = 2 and df2 = 57 is approximately **3.15**.

Therefore, the critical value F0.05 for the given degrees of freedom is **3.15**.

A low p value indicates that there is enough evidence to reject the null hypothesis and conclude that there are significant differences between the group means.

The participants which innovative pedagogies were used managed to surpass other pedagogies as 17 participants passed the test and 85% was obtained. Inquiry-based pedagogy followed with 55% and lastly traditional pedagogies with 45%.

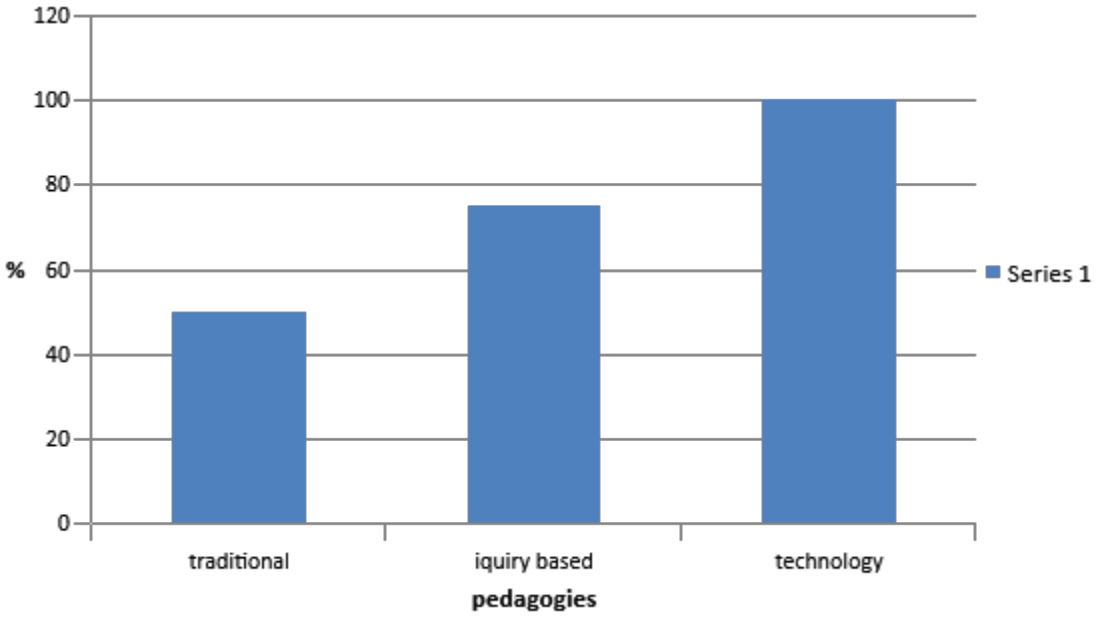
Concept mapping

The researcher in a bid to show that the participants had fully understood the concepts of genetics, concept mapping was given to individuals in their respective pedagogy groups.

Table 7; Concept mapping

Pedagogy	Frequency of participants Who completed concept mapping correct	%
Traditional	10	50%
Inquiry-based	15	75%
Technology	100	100%

Fig 4.2 Concept mapping



From the data presented in table 5and in fig 4.1 participants of technological pedagogy managed to out-class other groups as they managed to link topics which are related to genetics in the O level syllabus. All the members of this managed to do the task correctly. Inquiry based group followed with 75% and lastly, traditional pedagogy with 50%.

4.3 QUALITATIVE RESULTS

One participant when asked on what methods were used by teachers when teaching genetics wrote that

"Teachers in most lessons narrate and dictates everything no activities like group work or discussion just notes writing. It has become monotonous in every lesson

and some learners had developed disinterest in studying genetics to the extent of dropping out of biology classes".

This highlights that educators are not using proper pedagogy when teaching their learners.

Another research participant when responding to what type of activities they would want during learning genetics suggested that

"Carrying out experimental activities would help them to understand some of the concepts".

However some of the facilitors argued that

"*Having experimental activities in genetics is not that possible in most scenarios as in observing F1 generation in monohybrid it will take time like months".*

When forward teachers asked on the possible way highlighted that

"The use of technology in teaching and learning can be helpful to illustrate some of the concept which cannot be done practically like observing a gene. Teachers can use videos through projectors showing a chromosome and position of genes".

Participants agreed to that when asked what materials they need when learning genetics

"Learners need computers projectors tablets and Wi-Fi in their learning where teachers can make use of videos, games soft copies of textbooks and online assignments".

This shows that with these technological advancements learners should not be left behind. They found technological devices fascinating hence educators can take the opportunity and include it in learning.

4.4 DISSCUSSION

The response from the participants on the concept which they considered problematic and challenging genetics was voted as the most difficult topic in the O level syllabus. Genetics can be a difficult topic for many students, which often makes them feel discouraged or uninterested in biology classes. There are many reasons why genetics is difficult for students.

Genetics involves the study of complex biological processes and concepts such as DNA replication, transcription, translation, and gene regulation. These courses can be difficult to understand, especially for students without a strong foundation in biology.

Genetics has its own vocabulary that can be overwhelming for students unfamiliar with scientific terminology. Words like genome, gene, allele, dominant, and recessive can be confusing, and it can take time for students to learn how to use them

correctly. During research the teacher confirmed that learners were dropping out of biology classes due to the way which topics in biology are being taught this makes the concepts harder and difficult to understand.

Genetics deals with abstract concepts such as expression of traits and inheritance of genetic information. These concepts can be difficult to visualize, especially for students who are more accustomed to concrete, tangible objects.

Genetics is a theoretical subject, so it can be difficult for students to understand how the concepts they learn apply to real-world situations. This can make it difficult for students to understand the importance of genetics and be motivated to learn.

To address these issues and help students succeed in genetics, educators can make use of the most effective genetics pedagogy for learning to take place. Teachers can take several steps:

Provide clear explanations and examples. Teachers can help students understand complex genetics concepts by providing clear, concise explanations and examples. Using visual aids such as diagrams or illustrations can also help students visualize abstract concepts.

Analogies and metaphors can help students understand complex genetics concepts by comparing them to more familiar concepts. For example, comparing DNA replication to a photocopier can help students understand the process more easily.

Emphasize the importance of genetics. Teachers can help students see the relevance of genetics by emphasizing the importance of genes in real-world situations. For example, they can explain how genetics is used in medicine, agriculture, and forensics.

Provide hands-on learning opportunities. Hands-on learning experiences can help students understand genetics concepts more effectively. Teachers can give students the opportunity to see genetics in action by performing experiments, using simulations, and analyzing data.

Encourage collaboration. Collaborative learning can help students succeed in the field of genetics. Teachers can encourage students to work in groups to solve problems, discuss concepts, and share their understanding of the material.

Provide support and resources. Teachers can provide additional support and resources to students struggling with genetics issues. This may include additional support sessions, training, and online resources that provide additional explanations and practice problems. By taking these steps, teachers can help students overcome the challenges of genetics and become more engaged and motivated in biology class. However teachers indicated that lack of advanced material like Wi-Fi computers and infrastructure at the school making it difficult to provide effective pedagogies in genetics.

From the results in table 4, technological pedagogy was the most effective genetics pedagogy as the 85% was highest. Technological pedagogy involves using technology to enhance teaching and learning. This becomes the most effective pedagogy because it is a learner centered approach with the following benefits that includes: Personalized learning, technology enables students to learn at their own pace and style. This can be helpful for students who need extra time or support to understand concepts, as well as advanced students who need more challenging material. When Zulu (2018) carried out his investigation also find out that if learners are exposed to technological pedagogies learners are mostly like to perform better and they understand concepts easily. This is similar to the results which obtained in this study were learners treated to technological methods did well than traditional and inquiry based learning methods.

Technology provides access to a wide range of educational resources, including online courses, videos, educational apps, and e-books. This gives students the opportunity to explore topics in depth and provide independent learning opportunities.

Technology can make learning more fun and interactive, increasing student motivation and engagement. For example, multimedia presentations, simulations, and games can help students understand complex concepts in a more engaging way.

Collaboration and communication technology allows students to collaborate and communicate with each other and their teachers in new and innovative ways. This can help develop teamwork and communication skills and promote a sense of community and collaboration in the classroom.

Flexibility and convenience technology makes learning flexible and convenient, which can be especially helpful for students who have busy schedules or live in remote locations. Online courses and materials are available anytime, anywhere with an Internet connection.

In concept mapping participants were effective methodology was used did exceptionally well as they understood the concepts indicating that learning indeed took place.

4.5 SUMMARY

This chapter reflected on the findings of this research. From the data gathered it showed that technological pedagogy is the most suitable and effective pedagogy as the participants which were treated to technology managed to have a better pass rate

of 85% beating traditional pedagogy with 45% and inquiry based with 55%.The researcher also made use of descriptive statistics by including the mean and z score to illustrate that technological pedagogy is the best. To cement this concept mapping indicated that participants from technological pedagogy had better understanding of genetics as they attained a 100% in relating topics under genetics. In qualitative analysis participants advocated for the inclusion of technological devices and other related activities during lessons. The next chapter will preview the summary of the whole chapter, conclusions to the study and recommendations needed to implement technological pedagogy.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

5.0 INTRODUCTION

The use of technology in learning set up in rural areas will ensure that learners are included in this dynamic technological era. They will be familiar with devices, have updated information, and they learn new aspects in unique way helping them to achieve their goals from their marginalized areas.

This section tries to wrap it up this research highlighting major concerns of the research. The recommendations corning this research will also be given under the section of recommendations.

5.1SUMMARY OF THE STUDY

The researcher found it necessary to conduct this research due to the fact that learners at Ndima gvt High school were not interested in doing biology .This resulted in most of them dropping out of biology classes. The sole purpose of this research was to explore the most effective genetics pedagogy in rural school with the major focus on Ndima Gvt High in Chimanimani District. The effective pedagogy will motivate the learners to study and further their genetics knowledge.

The research questions used are as follows

1.3.1 What factors contribute to students dropping out of biology classes?

1.3.2 What are the specific concepts in genetics that learners struggle with the most?

1.3.3 Which genetics pedagogies are currently used at Ndima Gvt High School?

1.3.4 What are the characteristic of alternative teaching pedagogy could improve student understanding and engagement with genetics at Ndima Gvt High School? (Traditional pedagogy, Inquiry-based pedagogies and Innovative pedagogies

1.3.5 What resources are available to support genetics instruction at Ndima Gvt High School, and are they used effectively?

The research question guided the researcher to construct the questionnaires which were related to the study at hand.

A similar research was carried out which focused on the teaching of genetics in Zambia in Kitwe district. However this research wants to give which is the most effective genetics pedagogy that makes the concept of genetics easy to understand

and prevent learners from dropping out biology classes. This study took into consideration inclusion of technology as genetics pedagogy.

Hmelo-Silver (2004) discusses the importance of effective teaching strategies in genetics education. The author conducted research to identify the cognitive tools that are most effective in helping students learn genetics.

In another study by Atay (2008) on genetics pedagogy aimed to investigate the effectiveness of a problem-based learning (PBL) approach in teaching genetics to high school students. This study only focused on problem based learning only it did not explore other pedagogies which can be useful in genetics education.

Furthermore Ncube (2018) examined the use of technology in teaching and learning in rural secondary schools in Zimbabwe. The study aimed to explore the experiences of teachers and students in using technology, and to identify the challenges and opportunities associated with its use. Though this study was not carried out in the field of biology it was a fore runner in highlighting technology as a suitable pedagogy in learning.

60 participants were involved in this study comprised of O level boys and girls at Ndima gvt high school who were selected randomly. The researcher used open ended questionnaires in gathering data, the tests used had structured and free response questions on genetics and concept mapping was characterized by the topics

which are in the O level biology syllabus and participants identified topics related to genetics, were used as research instruments in collecting the much needed data.

From the analyzed data from this research highlighted that most learners at Ndima gvt high school are dropping out of biology classes the reason being teachers are not using pedagogies that makes lessons interesting as the learners remains docile and passive during the lessons. Learners are not actively participating as the traditional pedagogy are used in teaching of genetics, pupils need to be involved for learning to take place. A test was given to the learners after each group was treated to specific pedagogy; the outcome indicated that the group which innovative pedagogy that includes the use of computers, projectors, vides and the use of internet managed to perform best than other pedagogies. 17 out of 20 participants managed to past the test which was prepared as a research instrument, 85% was achieved. This indicates that innovative pedagogy is the most effective pedagogy that can be used in teaching of genetics at Ndima gvt high. Inquiry-based pedagogy had 55 %, only 11 out of 20 managed to pass the test. Lastly the participants treated to traditional pedagogy only 9 out of 20 participants managed to pass bringing the percentage to 45%. Technological surpasses other pedagogies as it had 85% making it the most effective pedagogy which teachers can use in teaching genetics. In concept mapping Traditional pedagogy had 50%, Inquiry based pedagogy had 75% and Technological

pedagogy had 100% this illustrated that learners treated to technological pedagogy had a better understanding of genetics and identified topics related to genetics.

The literature on genetics pedagogy has grown significantly in recent years as educators and researchers have recognized the importance of effective teaching and learning of genetics. From the literature related to this research it is crystal clear that the pedagogy which involves the participation of the learners, learners perform better.

5.2 CONCLUSION

1.3.1 What factors contribute to students dropping out of biology classes?

From the findings of the study it showed that pupils dropping out of classes due to poor genetics pedagogies. Students may drop out of biology classes due to inadequate genetics instruction for the following reasons:

Lack of relevance

If genetics is taught in a way that is not relevant to students' lives or interests, students may lose interest in the subject.

Excessive emphasis on memorization

Traditional genetics education often focuses on memorizing terms and concepts rather than developing critical thinking and problem-solving skills. This can leave students feeling overwhelmed and demotivated.

Lack of context

Genetics is often taught in isolation, with no connection to other biological concepts or practical applications. This can make it difficult for students to understand the meaning and importance of genetics in the broader context of biology and everyday life.

Inappropriate visual aids

Genetics involves complex concepts that are difficult to visualize. Inappropriate or inappropriate visuals, such as confusing diagrams or inaccurate pictures, can make students more confused and difficult to understand.

There is a lack of diversity and inclusion

Traditional genetics pedagogy cannot adequately address the diverse backgrounds, experiences, and learning styles of students. This can lead to a lack of participation and a sense of belonging among students who feel their individuality and views are not respected.

Excessive use of lectures

Lecture-based classes maybe less effective way to teach genetics because they do not allow for active participation and practice. Students may lose interest and become disengaged from the subject.

Lack of technology integration

Incorporating technologies such as interactive modeling can increase student engagement and understanding of genetics. Lack of technology integration can result in students feeling disengaged and bored.

By addressing these factors, educators can create more engaging and effective genetics teaching methods that promote student interest and understanding of the topic. This may help reduce the likelihood that students will drop out of biology classes due to inadequate genetics.

1.3.2 What are the specific concepts in biology that learners struggle with the most?

Students may struggle with genetics for a variety of reason. Possible reasons include

Lack of prior knowledge

Genetics is a complex and abstract subject that requires a solid foundation in biology, chemistry and mathematics. Students who lack a clear understanding of these core subjects may have difficulty understanding the concepts and principles of genetics

Difficulties with terminology

Genetics uses unique terminology that can be difficult for students to understand. Students may have difficulty understanding the meaning of genetics terms such as allele, gene, chromosome, and genome.

Conceptual difficulties

Genetics includes many abstract concepts such as Mendelian principles of inheritance, gene expression and genetic variation. Students may have difficulty understanding these concepts especially if they are not presented clearly and concisely

Lack of motivation

Genetics can be a complex and difficult subject and it can be difficult for learners for students to stay motivated and interested. Student who lacks motivation may find it difficult to focus and pay attention to a topic. By understanding why students struggle with genetic issues educators can develop effective strategies to address these issues and help students achieve academic success.

1.3.3 Which genetics pedagogies are currently used at Ndima Gvt High School?

From the findings of this study the data collected in chapter 4 showed that traditional pedagogy is the most commonly used pedagogy in biology. The traditional is often

associated with teacher-centered approaches has a number of shortcomings. These include;

Lack of student's participation

Traditional pedagogy often relies on lectures, memorization, and standardized assessment which can result in lack in a lack of student engagement and motivation.

Limited opportunities for critical thinking

Traditional pedagogy often emphasizes rote learning and memorization rather critical thinking and problem solving skills. This can limit students' ability to think creativity and apply knowledge to real world situations.

1.3.4 What are the characteristic of alternative teaching pedagogy could improve student understanding and engagement with genetics at Ndima Gvt High School?

Technology pedagogy in genetics refers to the use of technology to enhance teaching and learning in the field of genetics. This can include a variety of tools and techniques such as online resources multimedia presentations and interactive simulations.

Accessibility

Technology can make learning genetics more accessible to a wider of students particularly those who may not have access to traditional educational resources.

Online resources such as virtual labs and video lectures can be accessed from anywhere with an internet connection making it easier for students to learn at their own pace and on their own schedule.

Interactive

Technology can facilitate interactive learning that engages students and helps them for better understanding complex genetic concepts.

Advanced visualization

This technology can be used to create detailed visualization of genetic concepts such as 3D models of D.N.A. This allows students to better understanding the structure and function of these molecules and more easily visualize complex processes and interactions.

Collaboration

Technology can facilitate collaboration amongst students and between students and teacher. For example online discussion forums and collaboration tools can allow students to work together on projects and share ideas and insights.

Gamification

Technology can be used to gamify the learning process making learning more fun and enjoyable for pupils. For example online games and simulation can be used to

teach genetic concepts and virtual rewards and incentives can be used to motivate learners learn.

Access to up to date information

There are several theories that support the use of technological pedagogy in biology teaching:

Constructivism:

Constructivist theory emphasizes the active role of learners in constructing their own understanding through exploration, experimentation, and interaction with digital tools and simulations.

Technology can provide interactive, hands-on learning experiences that align with constructivist principles, enabling students to actively engage with biological concepts.

Cognitive Load Theory:

Cognitive Load Theory suggests that effective instruction should consider the limitations of working memory and minimize extraneous cognitive load.

Technological tools, such as multimedia presentations, animations, and virtual laboratories, can help reduce cognitive load by presenting information in a more organized and engaging manner.

Multimedia Learning Theory:

Multimedia Learning Theory, developed by Richard Mayer, suggests that learners can better understand and retain information when it is presented using both visual and verbal modes.

Integrating technology, such as interactive visualizations, simulations, and multimedia resources, can facilitate this dual-coding approach and enhance biology learning.

Technology can provide students with access to the latest information and resources in the field of genetics. This will enable students to stay up to date with the latest developments and advancements in the field as well as gain a better understanding of practical application of genetics in the fields as medicine and agriculture.

5.3 RECOMMENDATIONS

Teachers in most rural schools are regarded as the only resource this means that they should improvise in most cases as they teach their lessons. Teachers should make sure that they use technology in delivering their lesson in biology especially genetics. As the resources are scarce teachers can make use of their mobile phone, laptops in trying to integrate technology in their classes. More so teachers can arrange trips to other nearby town school which have advanced technological such that their learner can see how captivating it is using technology in studying biology

With the advancement in the technological world that is ever dynamic learners get fascinated with technological gadgets it is wiser to make use of technology in learning this include online assignments, virtual lessons, games, pictures, zoom or even google class. Teachers can create watssapp groups were discussion can be carried out most learners have smart phones these days and they can be made useful. When learners participate there is high chances that they grasp concepts easily and learning take place.

As for the school heads, deputy heads, heads of departments they should supervise their teachers and ensure that teachers are using proper teaching strategies which makes complex concepts simple. The school administration can facilitate income generating projects like piggery and poultry the profits obtained can be channelled to buying technological gadgets like projectors and computers which can be used during lesson delivering. Schools in rural set ups face challenges of network connectivity arrangements can be made with service providers such they can install Wi-Fi at the school for zero deposit and the school will pay in instalments.

The school developing committee and the community at large should provide the school with enough resources; these resources include technological gadgets like computers, projectors and internet connectivity. These can be obtained from well-wishers, non-governmental organisation like Plan international and even the government as can also donate the technological gadgets in schools. With these

resources available teachers can make use of technological pedagogy in classroom as indicated in this study it is one of most effective genetics pedagogy.

From the findings of this study technological pedagogies proved to be the most effective pedagogy in teaching and learning of genetics. So it is of paramount importance to have gadgets needed for technological learning to be available in schools such that learners are captivated in learning their subjects especially biology.

5.3.1 RECOMMENDATION FOR FUTURE RESEARCH

For future studies of this kind in exploring genetics pedagogies, researchers should consider taking into account a wider coverage area like comparing the pedagogies in different location rural schools and urban schools it cannot be limited to one school or one district.

A replica of this research can be perfected if the participants are slow learners especially in schools which stream their pupils. By increasing the number of the research participants will also be great improvement to the research fraternity.

More so future researcher can compare combined pedagogies (inquiry based and traditional and problem solving) against technological pedagogy. This will make things interesting as new facts can be obtained.

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APPENDICES

APPENDIX A

QUESTIONNAIRE FOR LEARNERS

This questionnaire was prepared by Taguma Fungai Willard reg # B225419B currently studying for HBScEdBz degree at Bindura University of Science Education. The purpose of this questionnaire is to collect data on exploring effective genetic pedagogy in rural school particularly at Ndima Gvt High.

The information provided in this questionnaire remains confidential and will be only used for academic purposes only. If you want to remain anonymous do not answer section A

Answer all questions by giving responses in the spaces provided. There are no wrong or right responses. This questionnaire takes 30minutes to complete

SECTION A

NAME ----------

SURNAME----------

GENDER ----------

CLASS ----------

AGE ----------

SECTION B

1) In your opinion what is the reason for learners dropping the subject of biology at your school

---

2) Which topic do you find challenging and difficult to understand in Biology?

---

3) What teaching methods, learning activities, assessment strategies are used in genetics lesson at Ndima Gvt High School?

---

4) What resources do the teachers use when teaching genetics?

5) Do you prefer to work independently or in groups?

6) What alternative teaching pedagogy could improve student understanding and engagement with genetics at Ndima Gvt High School?

7) What resources are available to support genetics instruction at Ndima Gvt High School, and are they used effectively?

8) What teaching strategies do you find most effective learning genetics?

9) How do you think technology can be used to enhance genetics education?

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10) What digital resources or tools do you find most effective for genetics education?

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11) What types of activities do you think are most useful for learning genetics?

APPENDIX B

QUESTIONNAIRE FOR TEACHERS

This questionnaire was prepared by Taguma Fungai Willard reg # B225419B currently studying for HBScEdBz degree at Bindura University of Science Education. The purpose of this questionnaire is to collect data on exploring effective genetic pedagogy in rural school particularly at Ndima Gvt High.

The information provided in this questionnaire remains confidential and will be only used for academic purposes only. If you want to remain anonymous do not answer section A

Answer all questions by giving responses in the spaces provided. There are no wrong or right responses. This questionnaire takes 10 minutes to complete

SECTION A

NAME ----------

SURNAME----------

GENDER ----------

PROFESIONAL QUALIFICATION----------

SECTION B

Answer all questions

1. Which qualification do you have in education?

---

2. How many have you been teaching Biology?

---

3. In your own opinion what causes learners to drop-out biology classes?

---

4. What are the most effective ways to teach genetics concepts?

---

5. What challenges do teachers and learners face when teaching and learning genetics respectively?

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6. How can teachers use technology such as virtual lab and online resources?

APPENDIX C

TEST FOR LEARNERS

GENETICS QUESTION

Time *1h*

Instructions

Answer all questions on spaces provided

1) Define the following genetics terms

a) Genetics _____ (1)

b) Allele _____ (1)

c) Genotype_____(1)

2)

Phenotype	Genotype
Grey wings	Bb
Black wings	Bb, BB

i) State the term used to describe the nature of the genotype

BB_____

Bb_____(1)

ii) A black winged moth was crossed with a grey winged moth. In the offspring produced, some had black wings and others grey wings, Use a genetic diagram to explain the cross (4)

3) Describe the causes of the Down’s syndrome

_____

_____

_____(3)

4) Describe the production of recombinant DNA

_____

_____

_____

_____

_____

_____

_____(3)

7a) Define evolution (1)

_____

_____

b) Discuss natural selection as a mechanism of evolution (2)

_____

_____

_____

8a) Identify factors affecting variation (1)

_____

_____

b) Distinguish between continuous and discontinuous variation (2)

_____

_____

_____

_____

APPENDIX D

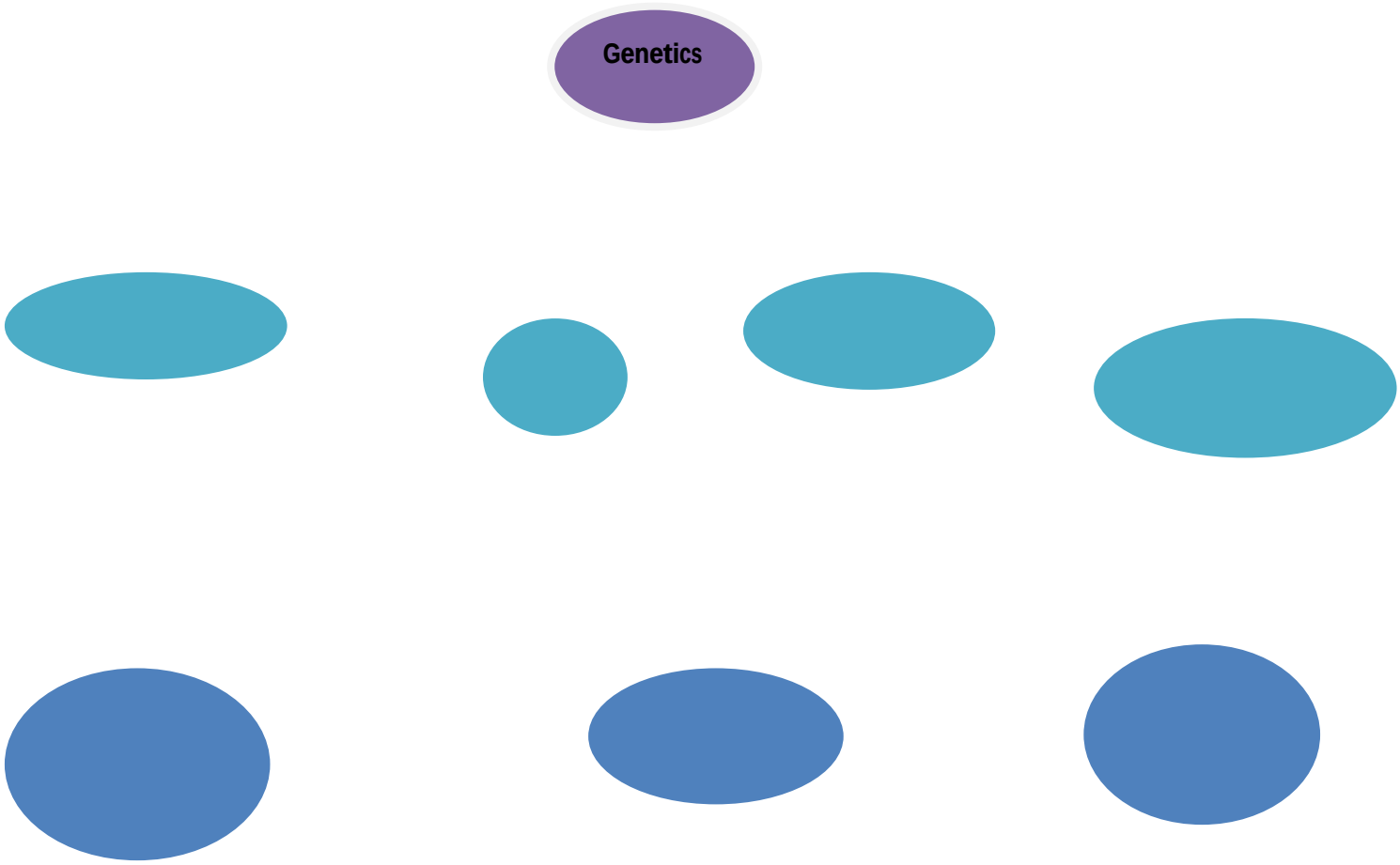
CONCEPT MAPPING

This task was prepared by Taguma Fungai Willard reg # B225419B currently studying for HBScEdBz degree at Bindura University of Science Education. The purpose of this research instrument is to collect data on exploring effective genetic pedagogy in rural school particularly at Ndima Gvt High.

The information provided remains confidential and will be only used for academic purposes only.

Question

1. You are given various concepts in O level biology syllabus. Identify the topics which are related to Genetics and write it in the circles below.


Genetics

APPENDIX E

CHIMANIMANI DISTRICT EDUCATION
POBOX 80
CHIMANIMANI

DEAR SIR/MADAM

RE: APPLICATION FOR PERMISSION TO CONTACT A RESEARCH PROJECT IN YOUR INSTITUTIONS.

The above subject refers a request for your permission to carry out my research in your institutions. I am a teacher at Ndima Govt High School and I am currently furthering my education with Bindura University of Science Education under the Teacher Capacity Development Block Program (TCD) with Student Registration Number B225419B. The research project is a requirement which should be submitted in partial fulfilment of the HBScEdBz degree program. The research title being: THE EXPLORING EFFECTIVE GENETICS PEDAGOGY IN RURAL SCHOOLS; AN ANALYSIS OF NDIMA GVT HIGH See attachment copy below

Your cooperation and assistance is greatly appreciated

Thank you
TAGUMA FUNGAI WILLARD
EC Number: 0997775 M

DISTRICT SCHOOLS INSPECTOR
MINISTRY OF PRIMARY & SECONDARY EDUCATION
16 MAY 2024
P O. BOX 80, CHIMANIMANI
ZIMBABWE
PHONE: 027 2052512 / 2901

THE HEADMASTER
NDIMA GOVT HIGH SCHOOL
20 MAY 2024
P. BAG 2069, CHIMANIMANI
ZIMBABWE