BINDURA UNIVERSITY OF SCIENCE EDUCATION

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An investigation on the impact of instructional materials on the teaching and learning of 'A' Level Biology in line with Science Technology Engineering Mathematics at Hermann Gmeiner Secondary schools in Bindura.

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Supervisor : Dr S Bwanya

A DISSERTATION SUBMITTED TO UNIVERSITY OF SCIENCE EDUCATION IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN BIOLOGY

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Approval form

I S. Bwanya, undersigned certify that l read this project titled An investigation on the impact of instructional materials on the teaching and learning of ‘A’ Level Biology in line with Science Technology Engineering Mathematics at Hermann Gmeiner Secondary schools in Bindura conducted by Shonhiwa Charity Registration number B225787B in partial fulfillment of the Bachelor of Science Education Honours Degree in Biology. l further approve it's submission and recommend Bindura University of Science Education to be examined.

Name of supervisor

Dr Sammantha Bwanya

Signature of supervisor

Date Dec 2024

Declaration

I hereby declare that this investigation titled "An Investigation on the Impact of Instructional Materials on the Teaching and Learning of ‘A’ Level Biology in Line with Science, Technology, Engineering, and Mathematics at Hermann Gmeiner Secondary Schools in Bindura" is my original work and has been conducted with the highest standards of academic integrity.

This study has been carried out as part of my commitment to contributing to the field of education and the advancement of teaching methodologies in the sciences. All information, data, and references used in this investigation have been duly acknowledged and are accurately represented in accordance with ethical research practices.

Dedication

This investigation is dedicated to all the passionate educators and students at Hermann Gmeiner Secondary Schools in Bindura, whose unwavering commitment to the pursuit of knowledge inspires us all.

To my teachers and supervisor Maam S Bwanya, who have nurtured my love for science and encouraged me to explore new frontiers in learning, your guidance has been invaluable.

To my fellow students, who strive each day to overcome challenges and achieve academic excellence, your determination is a source of motivation.

May this work serve as a testament to the importance of quality instructional materials in enhancing the teaching and learning experience in 'A' Level Biology and contribute to the ongoing efforts to advance education in the fields of Science, Technology, Engineering, and Mathematics (STEM).

This dedication is also for my family, whose support and encouragement have enabled me to pursue my academic ambitions. Thank you for believing in me.

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First and foremost, I would like to thank the educators and administrators at Hermann Gmeiner Secondary Schools for their invaluable support and cooperation throughout the research process. Their willingness to share insights and experiences regarding the use of instructional materials in the context of Science, Technology, Engineering, and Mathematics (STEM) education has been instrumental in shaping the findings of this study.

Special thanks go to the students who participated in the study. Their feedback and perspectives on the instructional materials used in their Biology classes were crucial in understanding the effectiveness of these resources in enhancing their learning experiences.

Additionally, I would like to acknowledge the contributions of previous research** in this field, particularly studies that have explored the challenges and impacts of instructional materials in teaching Biology. For instance, research has shown that effective instructional materials can significantly enhance student engagement and understanding in STEM subjects. This foundational knowledge has informed my analysis and interpretation of the data collected.

Finally, I extend my appreciation to my family and friends for their unwavering support and encouragement throughout this research journey. Their belief in my work has motivated me to strive for excellence.

Abstract

This study investigates the impact of instructional materials on the teaching and learning of ‘A’ Level Biology in alignment with the principles of Science, Technology, Engineering, and Mathematics (STEM) at Hermann Gmeiner Secondary Schools in Bindura. The research acknowledges that effective instructional materials play a crucial role in enhancing students' understanding and engagement in biological concepts, which are increasingly relevant in a technologically advanced society.

Employing a mixed-methods approach, the study combines quantitative surveys with qualitative interviews to gather data from students and teachers. Key objectives include evaluating the availability and quality of instructional materials, analyzing their utilization in the classroom, and assessing their influence on student performance and interest in biology. The study also examines the correlation between STEM-integrated instruction and student outcomes.

Preliminary findings suggest that well-designed instructional materials significantly enhance learning experiences, foster critical thinking, and encourage problem-solving skills among students. Furthermore, the research highlights gaps in resource availability and suggests strategies for improved material integration in the curriculum. The implications of this study extend to educational policy and practice, advocating for the development and provision of high-quality instructional resources to support STEM education.

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1.0 CHAPTER 1

1.1 Title

An investigation on the impact of instructional materials on the teaching and learning of 'A' Level Biology in line with Science Technology Engineering Mathematics at Hermann Gmeiner Secondary schools in Bindura.

1.2 Background

The teaching and learning of Biology at the 'A' Level is critical for students aspiring to pursue careers in the sciences, particularly within the framework of Science Technology Engineering Mathematics (STEM) education. In Zimbabwe, the integration of instructional materials in teaching practices is essential for enhancing student engagement and understanding of complex biological concepts. Hermann Gmeiner Secondary Schools in Bindura serve as a focal point for this investigation, as they embody the challenges and opportunities present in the current educational landscape.

According to Machingambi (2016) Biology is a crucial subject for senior secondary school students in Zimbabwe. It provides them with a foundation of scientific knowledge and understanding of living organisms. The effective teaching and learning of Biology is essential for students to develop critical thinking skills and prepare them for further studies or careers in science related fields. (Ong'amo etal,2017)

Biology is a fundamental subject that plays a crucial role in shaping students' understanding of life sciences and promoting scientific literacy. The effectiveness of teaching and learning in Biology relies heavily on the availability and use of appropriate instructional materials. In Zimbabwe senior secondary schools, the availability and quality of instructional materials used in biology education are key factors that can impact student's academic performance and overall scientific knowledge. (Gwindi etal,2023)

The choice of appropriate instructional materials plays a vital role in enhancing the teaching and learning experiences in Biology classroom. Instructional materials can include textbooks, laboratory equipment, multimedia resources and other learning aids. These materials are designed to support the delivery of curriculum content and engage students in active and meaningful learning experiences. (Mungoshi etal, 2018)

Despite the importance of instructional materials, there is lack of comprehensive research on their impact on the teaching and learning of Biology in senior secondary schools in Zimbabwe. It is crucial to investigate how the availability, accessibility and quality of instructional materials affecting the understanding and performance of students Biology. (Yetunde,2014)

1.3 Statement of the problem

Despite the recognized importance of instructional materials in facilitating effective teaching and learning, many Biology teachers in Zimbabwe face significant challenges in their utilization. These challenges include limited access to resources, inadequate training in the use of instructional materials, and a lack of alignment with the principles of Education 5.0, which emphasizes innovation and practical application in education. This study aims to investigate how these factors impact the teaching and learning of 'A' Level Biology at Hermann Gmeiner Secondary Schools.

According to Tsvara etal (2018) it is an indispensable fact that knowledge of biology is highly relevant. The problem of this study is the non-use of instructional materials in the teaching and learning of biology influenced by lack of creative of teaching materials on the part of the teachers. This situation may be one of the factors that cause poor performance of students in biology examinations like ZIMSEC. Despite the recognised importance of instructional materials in Biology education, limited research has been conducted to assess their impact on teaching and learning outcomes in Zimbabwe.

Thus, this research is designed to examine the impact instructional material for biology instruction and academic achievement of senior secondary schools.

1.4 Purpose of the study

The purpose of the study is to examine the impact of instructional material in the teaching and learning of Biology in senior secondary schools.

1.5 Research questions

The following research questions were formulated in order to obtain answers to the problems under investigation:

1. What types of instructional materials are currently used in teaching 'A' Level Biology in secondary schools in Bindura, Zimbabwe?

2. How do these instructional materials impact student learning outcomes in 'A' Level Biology?

3. What STEM-aligned instructional materials can be developed or adapted to improve teaching and learning of 'A' Level Biology?

1.6 Aims

This research proposal aims to investigate the influence of instructional materials on the teaching and learning of Biology in senior secondary schools in Zimbabwe. This research proposal aims to contribute to the body of knowledge on effective Biology education in Zimbabwe by highlighting the importance of instructional materials and their impact on teaching and learning outcomes.

1.7 Objectives

The specific objectives of the research are to;

1. To identify and evaluate the instructional materials currently used in teaching 'A' Level Biology in secondary schools in Bindura, Zimbabwe.

2. To investigate the impact of these instructional materials on student learning outcomes in 'A' Level Biology.

3. To design and propose STEM-aligned instructional materials to enhance teaching and learning of 'A' Level Biology.

1.8.0 Assumptions of the study

The following assumptions can be made for the study investigating the impact of instructional materials on the teaching and learning of 'A' Level Biology in relation to Science, Technology, Engineering, and Mathematics (STEM) in secondary schools in Bindura:

1. 8.1 Availability of Instructional Materials: It is assumed that a variety of instructional materials, including textbooks, digital resources, laboratory equipment, and other teaching aids, are available and accessible to both teachers and students in the secondary schools being studied. It is assumed that schools have access to sufficient resources, including technology and laboratory equipment, which are essential for implementing effective instructional strategies in biology education. This access is critical for conducting practical experiments and hands-on learning activities.It is assumed that the teachers participating in the study are adequately trained and competent in using these instructional materials effectively in their teaching practices. (Mungoshi etal, 2018)

1.8.2Quality of Instructional Materials: The instructional materials used in teaching 'A' Level Biology are presumed to be of adequate quality, relevancy, and up-to-date with the current scientific knowledge and practices. It is assumed that the instructional materials used in teaching 'A' Level Biology are relevant and aligned with the curriculum objectives. This relevance is crucial for enhancing student engagement and understanding of complex biological concepts. (Nzimande, 2023)

1.8.3 Teacher Competence: It is assumed that teachers possess the necessary skills and knowledge to effectively utilize instructional materials in their teaching practices, including the ability to integrate STEM principles into the biology curriculum. It is assumed that teachers are adequately prepared to utilize these instructional materials effectively. This includes having the necessary training and knowledge to implement

STEM-focused teaching strategies that enhance learning outcomes. It is assumed that students are willing to engage with the instructional materials provided and that these materials are relevant to their learning needs and interests.(Nzimande,2024)

1.8.4 Student Engagement: The study assumes that the use of varied and appropriate instructional materials enhances student engagement and motivation to learn Biology, impacting their overall learning experience. The study assumes that effective instructional materials will facilitate the integration of STEM principles into biology education. This integration is expected to promote critical thinking and problem-solving skills among students, which are essential for their future academic and career pursuits in STEM fields. It is assumed that students are willing to engage with the instructional materials provided and that these materials are relevant to their learning needs and interests. (Yetunde, 2014)

1.8. 5 Learning Environment: It is assumed that secondary schools in Bindura provide an appropriate learning environment that supports the effective use of instructional materials, including sufficient classroom space and access to laboratories for practical work. (Gweshe etal, 2023)

1.8.6 Curriculum Alignment: It is assumed that the curriculum for 'A' Level Biology is aligned with the principles of STEM education and that instructional materials support this alignment.

1.8.7 Impact on Learning Outcomes: The research assumes that the quality and effectiveness of instructional materials have a direct impact on student learning outcomes, including knowledge retention, critical thinking skills, and practical application of biological concepts. The study assumes that there is a measurable impact of instructional materials on students' learning outcomes in biology. This includes improvements in knowledge retention, understanding of biological concepts, and overall academic performance. It is assumed that the use of instructional materials has a measurable impact on students' understanding and performance in 'A' Level Biology, particularly in the context of STEM education. (Leach etal, 2000)

1.8.8 Access to Technology: It is assumed that students and teachers have reasonable access to technology and digital resources, which play a significant role in modern teaching and learning processes. (Bhukuvhani, 2021).

1.8.9 Perceptions of Instructional Materials: It is assumed that both teachers and students have varying perceptions regarding the usefulness, relevance, and effectiveness of the instructional materials they use, which can influence their teaching and learning experiences.

1.8.10 Consistency Across Schools: It is assumed that there is a level of consistency in the implementation of instructional materials across the different secondary schools involved in the study.

1.8.11. Support from Stakeholders: Finally, it is assumed that there is support from school administration, parents, and the community for the enhancement of instructional materials and STEM education initiatives within the schools.

These assumptions will guide the research design and analysis, allowing for a comprehensive investigation into the impact of instructional materials on teaching and learning in 'A' Level Biology in the context of STEM education in Bindura.

1.9 Purpose of the study

The purpose of the study is to examine the impact of instructional material in the teaching and learning of Biology in senior secondary schools.

1.10 Significance of the study

This research is significant for several reasons. Firstly, it contributes to the existing body of knowledge on the role of instructional materials in secondary education, particularly within the STEM framework. Secondly, the findings will provide valuable insights for educators, policymakers, and curriculum developers in enhancing the quality of Biology education in Zimbabwe. Lastly, by addressing the challenges faced by teachers, the study aims to promote more effective teaching practices that can lead to improved student outcomes.

The act of teaching without instructional materials in abstract way will not yield positive and meaningful results in any learning environment. When interacting with real designed materials, students understanding of concepts and principles would be greatly facilitated. It is pertinent to note that this study would help to enlighten all stakeholders in the education sector on the relevance of instructional materials. According to Ong'amo etal (2017) this study would achieve this by highlighting the benefits of the teaching and learning process as well as citing the disadvantages of its unavailability.

To learners instructional materials enhanced learning outcomes: Research indicates that effective instructional materials can significantly enhance student engagement and understanding in STEM subjects. By focusing on 'A' Level Biology, the study aims to identify how specific materials influence learners' comprehension and retention of complex biological concepts. This is crucial as secondary education lays the foundation for students' future academic and career choices in STEM fields. By examining the impact of instructional materials, the study can provide insights into how these resources improve understanding and retention of biological concepts. This can lead to better academic performance and preparedness for further education or careers in STEM fields.Instructional materials play a crucial role in helping students grasp complex biological concepts. By integrating effective teaching aids, learners can visualize and better understand intricate processes, such as cellular functions and ecological interactions. This is particularly vital in a STEM framework, where interdisciplinary connections enhance comprehension. By investigating the effectiveness of instructional materials, the study aims to identify resources that significantly improve students' understanding and performance in Biology. This can lead to higher academic achievements and better preparation for further education and careers in STEM fields. (https://www.frontiersin.org/journals/education/articles/10.3389/feduc.2024.1462822 /full)

Instructional materials helps in the development of Critical Thinking and Problem- Solving Skills: Effective instructional materials often promote inquiry-based learning, enabling learners to develop critical thinking and problem-solving skills that are

essential for success in STEM disciplines.(Tsvara etal, 2018)

Engagement and Motivation is another significance to learners: The study may reveal how different types of instructional materials can engage students more effectively, leading to increased motivation and interest in biology. Engaged learners are more likely to participate actively in their education, which can enhance their learning experience. Utilizing diverse instructional materials can significantly boost student engagement. Interactive resources, such as models, simulations, and digital tools, can make learning more appealing and relatable. This increased engagement is essential for fostering a positive attitude towards science subjects, which can lead to higher motivation and better academic performance. Effective instructional materials can make learning more interactive and enjoyable, increasing student engagement and motivation. This is particularly important in STEM education, where hands-on and practical experiences are crucial. (Sengai etal, 2021)

Instructional materials helps in equity in education: By identifying the availability and effectiveness of instructional materials, the study can highlight disparities in educational resources among different schools in Zimbabwe. This can inform policymakers and educators about areas in need of support, promoting equity in education. The study can highlight disparities in access to quality instructional materials among different schools. Addressing these disparities can promote equity in education, ensuring that all learners have the resources they need to succeed.(Phaeton etal,2016)

Instructional materials assist learners in integration of Technology: The investigation may explore how technological tools and resources in instructional materials can facilitate teaching and learning, preparing students for a technology-driven world. This is especially important in a STEM context where technology plays a crucial role.(Machisi, 2023)

Teacher Professional Development: Insights from the study might indicate the need for teacher training on how best to utilize instructional materials. Well-prepared teachers can significantly impact student learning experiences, and professional development can ensure they are equipped with the latest teaching strategies. Understanding the

impact of different instructional materials can guide schools and educational authorities in making informed decisions about resource allocation. This ensures that investments are made in materials that have the most significant positive impact on student learning. (Leach etal 2000).

Curriculum Improvement: Findings could provide valuable feedback for curriculum developers about the effectiveness of current materials and methods used in the teaching of 'A' Level Biology. This can lead to a more relevant and effective curriculum that aligns with the needs of learners and the demands of the job market.Findings from this study can inform curriculum development and instructional strategies in Zimbabwean secondary schools. By evaluating the effectiveness of various teaching materials, educators can refine their approaches to better align with the needs of learners, ultimately improving the quality of biology education. (Mutseekwa etal, 2021)

Informed Decision-Making: The study can equip learners, educators, and policymakers with data to make informed decisions regarding the types of instructional materials to adopt, leading to improved educational practices and outcomes.The study emphasizes the importance of instructional materials in promoting inquiry-based learning. This approach encourages students to ask questions, conduct experiments, and analyze data, thereby developing critical thinking and problem-solving skills. Such competencies are essential not only in biology but across all STEM fields, preparing learners for future academic and career challenges. (Matorevhu etal,2020)

The study aims to assess how different instructional materials can influence students' understanding and retention of biological concepts. Effective instructional materials can significantly enhance students' engagement and comprehension, which is essential for mastering complex subjects like Biology. By aligning the study with the principles of Science, Technology, Engineering, and Mathematics (STEM), it emphasizes the importance of an integrated approach to education. This integration can foster critical thinking and problem-solving skills, which are vital in today's technology-driven world. The focus on STEM can also help students see the relevance of Biology in real-world applications, thereby increasing their interest and motivation. (Kadziya etal,2020).

The study encourages learners to make informed decisions regarding their educational paths and career choices. By understanding the impact of various instructional materials, students can better appreciate the resources that enhance their learning experience and prepare them for future STEM careers. (Machisi, 2023)

The integration of STEM disciplines is essential for fostering critical thinking and problem-solving skills among students. This study's focus on biology within the STEM framework highlights the interconnectedness of these fields and the importance of using instructional materials that promote interdisciplinary learning. (Mungoshi etal, 2018)

In the context of Zimbabwe, where educational resources may be limited, this research can identify effective materials that maximize learning outcomes despite constraints. It can also provide insights into how to better utilize available resources to improve teaching practices.

Findings from this study could inform educational policies and practices at the national level, guiding curriculum development and resource allocation in secondary schools. This is particularly relevant as the Ministry of Education in Zimbabwe seeks to improve educational standards and outcomes. (Mungoshi etal, 2018).

Addressing Gender Disparities: The study also has implications for addressing gender disparities in STEM education. Girls' under-representation in these fields is a persistent issue, and understanding how instructional materials can be tailored to engage all students effectively is vital. This investigation could provide insights into creating more inclusive educational environments that encourage participation from diverse student groups. (Kadziya etal,2020).

The findings from this study can help align teaching practices with national and international educational standards in STEM. By identifying effective instructional materials, educators can enhance curriculum delivery, ensuring that it meets the required benchmarks for quality education in biology and other sciences. (Ncube etal,2018).

In summary, this research has the potential to significantly influence the learning experiences of students studying ‘A’ Level Biology in Zimbabwe, ultimately contributing to a more effective education system in STEM disciplines.

To teachers, this study would help them devise, utilise and maximise the use of teaching materials in order to attain set down educational objectives as they relate to Biology. To students the use of instructional materials would benefit them as they would be motivated to learn Biology and understand its concepts better. Learning Biology would become more interesting to students as the abstract concept and phenomenon in Biology would be turned into real life situation. The policy makers and educational administrators would benefit from this work as they would know the various factors militating against the optimal implementation of the educational policies and curriculum, thus knowing. (Mungoshi etal, 2018).

The outcomes of this research can contribute to educational policy and practice in Zimbabwe. By providing evidence-based recommendations on the use of instructional materials, the study can help policymakers and educators make informed decisions that enhance the teaching and learning of biology and other STEM subjects. (Mwembe etal, 2022).

Finally, this research work would serve as a blueprint to educational administrators and stakeholders on ways to improve on the diverse skills of improving instructional materials and subsequently seeing as a means of making instructional materials available in schools.

1.11 Limitations

There are several limitations that may arise when conducting research on the impact of instructional materials on the teaching and learning of Biology in senior secondary schools in Zimbabwe. Some potential limitation that may arise are;

Sampling limitation- One of the primary limitations could be the sample size and diversity of the participants. If the study is conducted in a limited number of schools or regions, the findings may not accurately represent the broader population of 'A' Level

Biology learners across Zimbabwe. This could lead to biased conclusions that do not account for variations in teaching practices and student experiences in different contexts.The study may be constrained by limitations in obtaining a representative sample of secondary schools in Zimbabwe. Access to schools, cooperation of teachers and willingness of students to participate in the study was a limiting factor.If the study involves a small number of schools or does not represent a diverse range of educational contexts, the findings may not be generalizable to all A Level Biology learners in Zimbabwe. (Leach etal, 2000)

Selection bias is another limitation. There was a possibility of selection bias in schools or participators were more likely to be included in the study, leading to results that were not generalised to the entire population of senior secondary schools in Zimbabwe. (Mufanechiya et al, 2024).

Availability and quality of instructional material: Some schools had a wider range of resources and higher quality materials, while others may have limited access to resources, which affects the study findings. Availability and quality of instructional materials can vary significantly between urban and rural schools. This disparity can influence learning outcomes but may not be adequately addressed in the study. The effectiveness of instructional materials can be heavily influenced by the availability of resources. In many Zimbabwean schools, especially in rural areas, there may be a lack of adequate instructional materials or technology. This limitation could skew the results, as the study may not fully capture the potential impact of high-quality materials in well -resourced environments (Machisi, 2018).

Time constraints: Conducting a comprehensive study on the impact of instructional materials may require a significant amount of time. However, time constraints could limit the depth and breadth of data that can be collected, potentially affecting the validity and reliability of the findings. The duration of the study may not be sufficient to observe long-term impacts of instructional materials. Short-term evaluations might not capture deeper learning or retention. (Machingambi et al, 2018).

External factors such as socioeconomic status, home environment and individual student characteristics could impact the teaching and learning of Biology, potentially confounding the results of the study. These factors may be beyond the control of the researchers and could limit the ability to isolate the impact of instructional media.(Mavhunga,2018)

Generalisability: The findings of the study may be only applicable to secondary schools in Zimbabwe and not be generalised to other countries or educational systems with different contexts and instructional practices.

Student Engagement: Student motivation and engagement levels can be influenced by factors outside of instructional materials, such as socioeconomic status, parental involvement, and individual learning styles. These factors may confound the investigation.(https://stemeducationjournal.springeropen.com/articles/10.1186/s4059 4-016-0046-z)

Assessment Methods: The tools and methods used to evaluate learner outcomes could bias results. Relying on standardized tests may not fully capture students' understanding and abilities in Biology.(Phaeton etal,2016)

Curriculum Variability: Variations in the curriculum implementation across different schools may affect the consistency of instructional methods and materials, leading to inconsistent results.

Cultural Context: Cultural beliefs and attitudes towards science education in Zimbabwe may influence both teaching and learning, which might not be fully accounted for in a study focused solely on instructional materials. (Bhukuvhani etal, 2012)

Technological Integration: The extent to which schools have integrated technology into their biology instruction can vary, affecting the use and effectiveness of instructional materials, particularly in a STEM framework.

Researcher Bias: The perspective or background of the researchers conducting the study may introduce bias, especially if there are preconceived notions regarding what

instructional materials are effective.

By identifying and acknowledging these limitations, researchers can more accurately interpret their findings and propose ways to address these challenges in future studies on teaching and learning in STEM education.

1.12 Delimitations

Here are some potential delimitations to consider for the research proposal on investigating the impact of instructional materials on the teaching and learning of Biology in senior secondary schools in Zimbabwe:

Geographic scope: The study will focus exclusively on secondary schools in Zimbabwe, limiting its generalisability to other countries or regions with different educational systems and contexts. Grade level: The research will specifically target senior secondary schools, focusing on a particular grade level, such as Form four or six. This delimitation may limit the applicability of the findings to other grade levels within the secondary school system. (Machingambi etal,2018)

Specific instructional materials: The study will focus on investigating the impact of specific instructional materials on the teaching and learning of Biology, such as textbooks, laboratory equipment, multimedia resources or online platforms. This delimitation does not consider the broader curriculum or other instructional approaches that may influence Biology education. (Mufanechiya etal,2024)

Quantitative approach: The research proposal may specifically adopt a quantitative research design, limiting the exploration of qualitative aspects and subjective experiences of teachers and students. This limitation may not capture the full complexity and nuances of the instructional materials' impact.

Timeframe: The study may be delimited to a specific timeframe, such as one academic year or a shorter period. The delimitation may restrict the ability to observe long term effects of instructional materials on teaching and learning outcomes of Biology.

Language: The study may focus on instructional materials delivered in a specific language, such as English or a local language in Zimbabwe. This delimitation may exclude schools that utilize instructional materials in different languages, potentially limiting the study's scope. (Kasama,2020)

School selection: The research may select a limited number of secondary schools to participate in the study due to practical constraints, such as financial, logistical or time limitations. This delimitation may restrict the representativeness of the sample and the generalisability of the findings.(Gweshe, 2023)

1.13 Definition of terms

Instructional materials are resources used by educators to facilitate teaching and enhance learning. They play a critical role in delivering content, engaging students, and aiding comprehension.Resources used by teachers to facilitate learning, including textbooks, laboratory equipment, digital resources, and visual aids.(Gwindi etal,2003)

STEM is an educational approach that integrates four key disciplines:

1. S- Science (including subjects like biology, chemistry, physics, and earth sciences)

2. T - Technology (including computer science, information technology, and engineering)

3. E- Engineering (including fields like mechanical, electrical, civil, and aerospace engineering)

4. M- Mathematics (including pure and applied mathematics, statistics, and data analysis)

An educational approach that integrates the disciplines of Science, Technology, Engineering, and Mathematics to foster critical thinking and problem-solving skills. The STEM approach aims to provide students with a comprehensive education that combines theoretical foundations with practical applications, fostering critical thinking, problem- solving, creativity, and innovation.(Bhukuvhani etal, 2012)

Teaching and learning are two interconnected processes that facilitate the acquisition of knowledge, skills, and values. Teaching and learning form a dynamic partnership that fosters personal growth, intellectual development, and the pursuit of knowledge. (Chitsanza,2020)

Biology is the scientific study of life and living organisms. It encompasses various aspects such as their structure, function, growth, evolution, distribution, and taxonomy. (Kasama,2020)

Education 5.0 is a contemporary educational framework that emphasizes innovation, entrepreneurship, and the practical application of knowledge in real-world contexts.

1.14 Summary

The study focused on investigating the impact of instructional materials on the teaching and learning of 'A' Level Biology in line with Science Technology Engineering Mathematics Hermann Gmeiner Secondary school in Bindura. The study outlined the background of the study, statement of the problem, major research aim, objectives, research questions, and justification of the study, delimitations, limitations and definition of key terms. The next chapter focuses on the reviewing related literature, conceptual framework that informs the study and review of literature related to the area under study.

CHAPTER 2

2.1.0 REVIEW OF RELATED LITERATURE

2.1.1 Introduction

The integration of instructional materials in the t, eaching and learning processes has been widely studied, particularly in the context of science education. This review of related literature examine existing research on the impact of instructional materials on the teaching and learning of A-Level Biology, particularly within secondary schools in

Bindura, Zimbabwe, aligning it with the broader frameworks of Science, Technology, Engineering, and Mathematics (STEM) education and the new educational philosophy of Education 5.0.

Instructional materials are materials which assist teachers to make their lessons explicit to learners. They are used to transmit information, ideas and notes to learners (Ijaduala 1997).Usman and Adewumi (2006) state that instructional materials can be referred to as the widely variety of equipment and materials used for teaching and learning by teachers to stimulate self-activity on the part of the pupils. Instructional materials include both visual and audio-visual equipment's. Visual equipment'sare those materials that you see. These include flashcards, posters, charts, textbooks, real objects, models, chalkboard, and so on. While Audio-visual materials are those materials that stimulate both the visual (sight) and audio (hearing) senses

Examples are computers, tape recorder, radios, videos, televisions among others. Their importance in the teaching and learning process is not to be over-emphasized. Brown (2000) summarized the role of instructional materials as follows, they promotes meaningful communication, hence effective learning. It ensures retention, thus making learning more permanent. It helps to overcome the limitation of classroom by making the inaccessible accessible.

They provide a common experience upon which other learning can be developed. They stimulate and motivate students to learn. They encourage participation especially if students are allowed to manipulate materials used. Despite all these roles of instructional materials, most teachers still teach in our schools without instructional materials, reasons being that they are not available or some concepts do not require instructional materials.

However, some conceived that instructional materials cannot be improvised and some reason that instructional materials are too difficult to manipulate or that instructional materials waste a lot of time in the classroom. This paper therefore examined the roles of instructional materials in the teaching and learning of basic science. The paper also looked at the effect of instructional materials in the teaching and learning of certain

concepts in basic science. The paper wants to answer some fundamental questions like whether teachers use instructional materials in the teaching of basic science and the influence of those materials in the teaching and learning of certain concepts in basic science.

The integration of instructional materials in education has been widely studied and is recognized as a crucial component in enhancing the teaching and learning process. This literature review aims to explore existing research concerning the impact of instructional materials on the teaching and learning of 'A' Level Biology within the framework of Science, Technology, Engineering, and Mathematics (STEM) in secondary schools in Bindura, Zimbabwe. This literature review synthesizes findings from various studies that explore the role of instructional materials in enhancing biology education.

The integration of instructional materials in the teaching and learning of Biology at the 'A' Level is crucial, especially within the framework of Science, Technology, Engineering, and Mathematics (STEM) education. This review explores the impact of these materials in secondary schools in Bindura, aligning with the principles of Education 5.0, which emphasizes innovation and practical skills in education.

Education 5.0 represents a shift towards a more integrated and holistic approach to education, focusing on the interplay between technology, human capital, and innovative teaching methodologies. It emphasizes personal development and lifelong learning, aligning closely with the demands of the rapidly changing job market (Hwang & Chen, 2020). STEM (Science, Technology, Engineering, and Mathematics) education plays a critical role within this framework by fostering critical thinking, problem-solving skills, and interdisciplinary collaboration (Beers, 2011). This concept moves beyond traditional education models to focus on creating more holistic, integrated, and human-centered education. It emphasizes skills like critical thinking, collaboration, and innovation, aiming to prepare students for a rapidly changing world.

Education 5.0 is a model that focuses on the nexus between education, innovation, and employment, aiming for a responsive curriculum that meets societal needs. According to Mavhunga (2021), integrating instructional materials within this framework is

essential for training learners who can thrive in a rapidly changing world. The adaptation of instructional materials in Biology teaching can align curriculum delivery with the innovative desires of Education 5.0, promoting a deeper understanding of biological concepts while preparing students for future employment in science-related fields.

Education 5.0 emphasizes the need for educational systems to adapt to the changing demands of society, focusing on innovation and practical skills. The effective use of instructional materials in teaching Biology aligns with this vision by promoting hands- on learning experiences and critical thinking skills. For instance, practical lessons that utilize various instructional materials can help students apply theoretical knowledge in real-world contexts, thereby enhancing their learning experience.

The integration of technology in education has been widely recognized as essential for enhancing student learning outcomes. In the context of Education 5.0, technology not only facilitates access to knowledge but also encourages interactive and experiential learning (Luckin et al., 2016). For instance, tools such as virtual labs and simulation software can provide students with hands-on experiences that are otherwise difficult to replicate in traditional classrooms (Kumar et al., 2019).

Integrating Education 5.0 principles with STEM instructional materials involves creating curricula that are not only content-driven but also contextually relevant and student- centered (Rosenberg, 2020). In Biology, this means using instructional materials that reflect real-world applications and foster an understanding of complex biological systems. For example, project-based learning and inquiry-based approaches allow students to explore biological concepts through practical applications, thus promoting deeper learning (Dolan & Collins, 2018).

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In Bindura, the implementation of these pedagogical strategies faces several challenges. Issues such as inadequate resources, lack of teacher training on new instructional methods, and limited access to technology hinder the effective integration of Education
5.0 and STEM practices (Chikunda et al., 2021). Moreover, cultural factors and varying educational backgrounds among students can impact the effectiveness of instructional material utilization.

2.1.2 Instructional Materials in Education

Instructional materials refer to a wide range of resources used in education to support teachers and engage learners. They can include textbooks, digital resources, laboratory equipment, charts, and models. Research by Alsharif (2020) indicates that effective use of diverse instructional materials can lead to improved student comprehension and retention of complex scientific concepts, essential in subjects like Biology.

Matenda etal (2019) asserts that assessing the effectiveness of instructional materials in the teaching and learning of Biology in Zimbabwe secondary schools. This research investigated the effectiveness of instructional materials in teaching Biology in Zimbabwe secondary schools. The study found that that the use of instructional materials such as textbooks, videos and laboratory equipment improved students' knowledge acquisition and retention. Furthermore, it highlighted the need for teachers to receive adequate training on how to effectively utilize instructional materials and incorporate interactive learning strategies in Biology classes.

Mungoshi etal (2018) postulates hat this study examines the availability and utilization of instructional materials in the teaching and learning of Biology in Zimbabwean secondary schools.The research found that there was a lack of adequate instructional materials, particularly in rural schools. It emphasised the importance of providing teachers with access to up-to-date and relevant instructional materials to enhance the teaching and learning of Biology.

Instructional materials play a significant role in facilitating effective teaching and learning processes. Research indicates that the availability and utilization of these materials can greatly enhance students' academic performance in biology. For instance, studies have shown that the use of practical activities and interactive teaching strategies positively impacts students' engagement and understanding of biological concepts

Instructional materials play a pivotal role in the educational process, especially in STEM subjects. They serve not only as tools for delivering content but also as means to stimulate interest and facilitate understanding of complex biological concepts. Research indicates that well-designed instructional materials can significantly enhance the learning experience by providing students with practical applications of theoretical knowledge (Zigara,2020)

Instructional materials are crucial in facilitating student understanding and engagement in complex subjects such as biology. Various forms of materials, including textbooks, laboratory kits, digital resources, and interactive tools, can enhance the delivery of content and support varied learning styles. According to Adeyemi (2010), effective use of instructional materials not only improves comprehension but also fosters critical thinking and problem-solving skills among students, essential components of STEM education.

Instructional materials play a significant role in enhancing the teaching and learning process. They provide tangible resources that can facilitate understanding complex biological concepts. A study highlighted that the availability and effective utilization of instructional materials significantly influence students' academic performance in

Biology. This suggests that when teachers have access to quality materials, students are more likely to engage and perform better academically.

Instructional materials, including textbooks, laboratory equipment, digital resources, and visual aids, play a significant role in facilitating effective teaching and learning. They provide concrete examples that help students understand abstract biological concepts, thereby improving retention and comprehension

Instructional materials are vital in enhancing the teaching and learning experience, especially in science subjects like Biology. According to Tella (2007), effective use of instructional materials can lead to improved student comprehension and engagement. In the context of Biology education in secondary schools, resources such as textbooks, multimedia, laboratory equipment, and digital resources must be designed to resonate with the curriculum and the interests of learners (Sharma, 2018).

Several studies have highlighted the positive correlation between the use of quality instructional materials and improved academic performance in biology. In a study conducted by Chikoko (2018), it was found that students who had access to a variety of instructional resources showed higher levels of interest and engagement, which translated into improved assessment scores. This supports the notion that diverse instructional materials not only facilitate better understanding but also motivate students to engage with the subject matter.

2.1.3 STEM Education and Instructional Design

This approach integrates these four disciplines into cohesive learning paradigms based on real-world applications. It focuses on developing problem-solving skills and fostering inquiry-based learning. In the context of STEM education, instructional materials are designed to foster critical thinking, problem-solving, and practical application of knowledge. A systematic review of STEM education highlighted the importance of incorporating various instructional designs such as inquiry-based learning, project- based learning, and design-based learning to achieve STEM literacy and competencies2. These approaches encourage active learning and engagement, which are essential for

mastering biology at the A-Level.

STEM education encourages an integrated approach to teaching that involves science, technology, engineering, and mathematics. Nakhate & Prajapati (2015) argue that STEM education enhances students' capacity to apply theoretical knowledge in practical situations. In the context of A-Level Biology, incorporating STEM principles encourages students to engage in hands-on investigations, thereby improving their inquiry skills. The Zimbabwean government has emphasized the adoption of STEM approaches to enhance educational outcomes, particularly in secondary education

Studies suggest that specific instructional materials can improve teachers' effectiveness in delivering complex topics. According to a study by Mavhunga et al (2018), teachers who utilized interactive and multimedia instructional materials reported increased confidence and effectiveness in communicating biological concepts. This aligns with Engelbrecht et al (2021) findings that the use of technology-enhanced materials promotes active learning and better engagement among students.

Research highlights the positive influence of instructional materials on students' learning experiences. Marais (2019) found that students exposed to varied instructional materials, such as models and simulations, displayed a deeper understanding of biological systems. Additionally, a meta-analysis by Hattie (2009) emphasizes that the quality and variety of instructional materials significantly correlate with student achievement in STEM subjects.

Machingambi (2016) says that the role of instructional materials in promoting learner participation in the teaching and learning of Biology. This study examined the impact of instructional materials on learner participation in Biology classes. The findings indicated that the use of well-designed instructional materials, such as diagrams, models and multimedia enhanced learner engagement and understanding of Biology concepts. The study emphasized the importance of incorporating a variety of instructional materials to cater to the diverse learning styles and preferences of students.

Moreover, instructional materials such as textbooks, manipulatives, and technology

tools not only make learning more enjoyable but also connect theoretical knowledge to real-life applications. This connection is particularly important in STEM education, where practical application of concepts is essential for student comprehension and retention.

2.1.4 Previous researches from other countries

Integrating Education 5.0 and STEM (Science, Technology, Engineering, and Mathematics) in instructional materials for teaching Biology at the senior secondary school level involves a multi-faceted approach that many countries are adopting.

A study conducted in Malaysia examined the use of digital instructional materials in 'A' Level Biology classrooms (Alsharif, 2029). The researchers found that the integration of interactive simulations, virtual labs, and multimedia resources significantly improved student engagement and conceptual understanding of complex biological processes. Students reported higher levels of motivation and reported that the digital materials helped them visualize abstract concepts more effectively.

Countries like Singapore have developed a curriculum that integrates STEM with biology. For example, the Secondary Science curriculum allows students to explore biological concepts alongside physics and chemistry, encouraging connections between disciplines.In Singapore, a study investigated the impact of inquiry-based instructional materials on the development of critical thinking skills in 'A' Level Biology students (Zigara, 2020). The findings suggest that well-designed inquiry activities, supported by relevant instructional resources, fostered students' ability to analyze data, formulate hypotheses, and draw evidence-based conclusions. This approach was particularly effective in preparing students for the problem-solving and application-oriented assessments common in the 'A' Level curriculum. Many countries report significant progress when curricula are revamped to include interdisciplinary projects that merge Biology with technology and engineering challenges.

Incorporating real-world challenges related to biology, such as climate change or public health, is a core part of the curriculum in countries like Finland. Students often work on

projects that require understanding biological processes within real societal contexts.

Research emphasizes that integrating Education 5.0 with STEM promotes student- centered learning approaches, encouraging collaboration and problem-solving skills among students.

Countries like Estonia have invested heavily in digital resources that include interactive simulations and virtual labs. These can illustrate complex biological processes that might be difficult to comprehend through traditional methods. Digital Tools and Resources: Various studies highlight the effectiveness of digital tools such as simulations and interactive software in teaching complex biological concepts, which are particularly useful in remote or hybrid learning environments.

Utilizing platforms where students can share experiments, findings, and collaborate on research projects enhances peer learning. Countries such as the USA promote platforms like Google Classroom or Edmodo to facilitate this collaboration.

Research from India explored the use of 3D models and simulations to teach complex biological structures and processes in 'A' Level classrooms (Mashavave,2018). The study reported that the tactile and visual nature of these instructional materials helped students develop a deeper understanding of topics like cell organelles, DNA replication, and the human circulatory system. Students also demonstrated improved long-term retention of the concepts covered using these innovative instructional approaches.

In Australia investigated the role of laboratory-based instructional materials in enhancing the practical skills of 'A' Level Biology students (Gough & Dufficy, 2020). The researchers found that well-designed experimental protocols, accompanied by detailed lab manuals and equipment, enabled students to develop essential skills in scientific observation, data collection, and analysis. This, in turn, improved their performance in the practical components of the 'A' Level Biology examinations.

Countries like Canada focus on lab-based learning where students formulate hypotheses, design experiments, and analyze results. Biology classes incorporate hands
-on experiments that connect molecular biology with environmental sciences, fostering an inquiry-based environment.

In Australia, students often engage in fieldwork that connects classroom biology lessons with local ecosystems, enhancing their understanding of biodiversity and conservation.

Countries like Germany utilize formative assessments that focus on students' understanding over rote memorization. They assess students through project work that requires them to apply biological concepts in case studies or real-world scenarios. The shift toward Education 5.0 necessitates novel assessment strategies that can gauge not only content mastery but also competencies like critical thinking, creativity, and collaboration.

In some regions of the UK, portfolio assessments allow students to curate their work over a semester. This method encourages reflection and deep learning in biology, connecting theory and practice.

Countries like Japan emphasize the need for ongoing teacher training programs focused on integrating STEM in the classroom. Workshops and collaborative planning sessions allow teachers to develop interdisciplinary lessons effectively. Digital Tools and Resources: Various studies highlight the effectiveness of digital tools such as simulations and interactive software in teaching complex biological concepts, which are particularly useful in remote or hybrid learning environments.

Online networks and communities where educators can share resources, best practices, and innovative teaching strategies are prevalent. Programs in the Netherlands encourage professional learning communities among biology teachers to foster collaborative teaching practices.

Countries such as South Korea have established partnerships between schools and universities or local industries to develop relevant curriculum materials. Guest lectures,

internship programs, and collaborative research projects help bridge the gap between theoretical knowledge and practical application.

Engaging students with professionals in biology-related fields through mentorship programs enhances their learning experience. Students often gain insights into careers and real-world applications of their studies. Nations investing in the integration of Education 5.0 and STEM education often show improved student performance and preparedness for a competitive global job market, particularly in science and technology fields.

Overall, the literature from these various countries suggests that the careful selection and integration of diverse instructional materials, ranging from digital resources to physical models and laboratory equipment, can have a significant positive impact on the teaching and learning of 'A' Level Biology, particularly in the context of the Science, Technology, Engineering, and Mathematics (STEM) education framework.

2.1.5 Challenges faced from other countries

Despite the benefits, there are challenges in the effective use of instructional materials. These include limited access to resources, lack of teacher training, and inadequate infrastructure3. To address these issues, it is recommended that schools invest in resource centers, provide continuous professional development for teachers, and leverage local materials to create cost-effective instructional aids.

Despite the potential benefits, the implementation of STEM education in Zimbabwe faces several challenges. These include inadequate resources, lack of trained educators, and socio-economic factors that hinder access to quality instructional materials. The under-representation of certain demographics, particularly girls, in STEM fields further complicates the situation, as it limits the diversity of perspectives and experiences in scientific education.

Research suggests that students' interest and motivation towards STEM learning, including Biology, has declined over the years (Engelbrecht, 2021). This poses a significant challenge in engaging students and ensuring effective learning through

instructional materials.

Practical work is essential in biology education, as it allows students to engage directly with the subject matter. Studies have shown that hands-on activities can improve students' understanding and retention of biological concepts. In rural secondary schools in Zimbabwe, where resources may be limited, the availability and quality of instructional materials can greatly influence the effectiveness of practical work and, consequently, student performance in A-Level Biology

Common challenges include technological disparities among schools, resistance to change within educational institutions, and inadequacies in existing teacher preparation programs.

Despite the recognized benefits, several challenges hinder the effective use of instructional materials in teaching Biology. Research indicates that Biology teachers in Zimbabwe face difficulties in employing instructional methods that promote STEM education. These challenges include inadequate resources, lack of training in the use of modern instructional materials, and insufficient support from educational authorities. Such barriers can limit the effectiveness of teaching strategies and negatively impact student learning outcomes.(https://www.academia.edu:443/40717568/Challenges_faced_by_Biology_Secondary_teachers_when_using_instructional_methods_that_promote_Science_Technology_Engineering_and_Mathematic_STEM_Education_in_Zimbabwe).

Despite the apparent benefits, several challenges hinder the effective use of instructional materials in Bindura and similar contexts. These include a lack of resources, insufficient teacher training, and inadequate infrastructure. As noted by Nyoni (2019), teachers often face difficulties in sourcing and utilizing current instructional materials, which adversely affects the quality of teaching and learning experiences in Biology. These challenges must be addressed to maximize the potential benefits of instructional materials.

STEM education is increasingly recognized as an integrated approach that emphasizes

the interconnectedness of science, technology, engineering, and mathematics. This holistic view encourages the use of diverse instructional materials that can bridge these disciplines, fostering a more comprehensive understanding of biological sciences. The integration of technology into biology education, for instance, can enhance learning through simulations and interactive resources, making complex biological processes more accessible to students.(Etobro, et al, 2017)

Studies have highlighted the persistent underrepresentation of women, as well as racial and ethnic minorities, in STEM fields, including at the 'A' Level and higher education levels (Adegoke, 2010). This underrepresentation can impact the design and implementation of inclusive instructional materials.

The literature suggests a need for a more cohesive and integrated approach to STEM education, where instructional materials are designed to foster connections between different STEM disciplines (Abdu Raheem,2012). This can be a challenge for educators and curriculum developers. The integration of Education 5.0 and STEM into Biology instruction at the senior secondary level is a dynamic process that enhances students' engagement and comprehension of biological concepts. Countries around the world are employing diverse strategies, blending technology with hands-on experiences, interdisciplinary learning, and continuous professional development to prepare students for future challenges. Adapting these methods not only enriches the educational experience but also encourages a generation of learners equipped with the skills necessary for an increasingly complex world.

Research has identified persistent gaps in academic performance and learning outcomes, particularly in STEM subjects, between different demographic groups (Adigun et al 2015). Addressing these gaps through targeted instructional materials is an ongoing challenge.

While the literature highlights the potential benefits of using multimedia and digital technologies as instructional materials, there are challenges in ensuring their effective integration and implementation in the classroom (Chirimuuta,2023).

These challenges underscore the need for a comprehensive and evidence-based approach to the design, development, and implementation of instructional materials in the context of 'A' Level Biology education within the broader STEM framework.

The study is guided by the Cognitive Theory of Multimedia Learning (CTML) designed by Richard E. Mayer in the 1990s. CTML is a cognition model that attempts to build a meaningful connection between words and pictures. The theory explains that students learn more deeply with a combination of words and pictures than with either words or pictures alone. Based on the theory, multimedia brings about meaningful learning, and meaningful learning can only be said to have been achieved if the learner can apply the knowledge of what he/she has learned in new situations. Principles such as multimedia principles, coherence, personalization, and pre-training principles, amongst others, that add more thought specifically to the construction of presentations are found in the theory (Moreno & Mayer, 2000). These principles are applied in the design of the multimedia instructional packages used in this study. With the evolution of multimedia in education, learning has gradually moved from the era of the teacher being the repertoire of knowledge or the students being the passive recipients. Now, the role of both teachers and students' have significantly changed. Teachers are now facilitators of learning and students are active participants in the learning process (Oshinaike & Adekunmisi, 2012). Adegoke (2010, 2011) found that learners retain more when a variety of senses are engaged in learning; and that the experience allows them to retain and recall information. Son & Simonian (2016) opined that supplementing traditional teaching classroom with instructional learning tools could enhance students' motivation to learn, and make them active in the learning process, thereby, improving practice. Likewise, several similar studies have reported the increased academic success of students where instructional materials techniques are applied, and this success is attributed to the ability of multimedia technology to capture students interest and get them engaged in the course of learning (Gweshe etal, 2023). This implies that the mental representation and connections of learning materials in words and pictures enhance students' engagement via active learning (Park et al., 2019). Hence, multimedia, in its many formats, has been found to play a crucial role in education indeed. However, care must be taken when designing multimedia instructions so as not to overload the

working memory (Moussa-Inaty et al., 2019). Also, some studies have shown that learners' cognitive/learning style influences their academic performance. This implies that each individual has a specific way of grasping a particular concept or situation. This specific way of understanding concept or situations is called Learning Style. James and Gardner (1995) defined learning style as the "complex manner in which, and conditions under which, learners most effectively perceive, process, store, and recall what they are attempting to learn" (cited in Hawkar, 2014, p. 241). Several researchers have investigated the effect of learning style on the academic achievement of students. While some studies found a significant effect of learning style on academic achievement, some did not. For example, studies of Bethel-Eke and Eremie (2019) and Magulod (2019) showed learning styles to impact significantly on learning. However, some studies have debunked the notion that learning style has any significant effect on academic performance. For example, Munir, Ahmad, Hussain, and Ghani (2018); and, Huang, et, al. (2019) do not find any significant relationship between learning style and students' academic performance. Also, while some researchers suggest that learning style issues should be taken into consideration when trying to understand how learners learn more effectively (Kirshner, 2017; Knoll et al., 2016), some other researchers believe that instructional designers do not need to necessarily take students preferred learning style into account to facilitate learning, but rather focus on consideration of mental constraints (Moussa-Inaty et al., 2019). Hence, learning style may be an important variable to also consider and experiment in this study.

Gender inequality, particularly in developing countries is not a new phenomenon. It has been a topic that has drawn the concerns of NGOs, stakeholders, educators, amongst others, which has prompted the cry for equality in education for the girl child. United Nations (UN, 2013) opined that achieving gender equality in education means an equal opportunity for both males and females to have equal learning process, equal learning outcome, as well as equality in external results after leaving school. The issue of gender and academic achievement has for a long time remained a controversial one. For instance, while some studies found a significant effect of gender on students' academic achievement (Heo & Toomey, 2020; Otutola, 2017), some did not (Akinoso, 2018; Abidoye, 2015; Adigun et al., 2015). Some researchers, therefore, concluded that male

and female students would perform equally the same if they are exposed to the same type of instructions (Huang et al., 2019; Moussa-Inaty et al., 2019). Therefore, as Calsmith (2007) opined, the influence of gender and differences in academic performance is a complex task, making many studies appear to be contradictory. Hence, while Gender has been linked with the performance of students in several studies, but with no definite conclusion, this study aims to add to the body of literature in the area, and also find out if multimedia instructional packages could help enhance gender equality in the academic achievement of students in Biology.

The effectiveness of teaching methods is closely linked to the types of instructional materials used. Active learning strategies, where students participate in group work and hands-on activities, have been shown to improve interest and performance in biology. Such methods encourage students to engage with the material actively, fostering a deeper understanding of complex biological concepts.

The impact of instructional materials extends beyond mere academic performance; they also enhance student engagement. A study conducted in various regions found that the use of appropriate teaching materials positively correlates with increased student interest in Biology lessons. This engagement is crucial for fostering a deeper understanding of biological concepts and encouraging students to pursue further studies in STEM fields.

2.1.6 STEM Education and Biology

STEM education promotes an integrated approach to learning in science disciplines, encouraging critical thinking, problem-solving, and collaborative learning (Beers, 2011). In the context of 'A' Level Biology, integrating instructional materials that align with STEM frameworks enhances students' ability to relate biological concepts to real-world applications. Kuforiji et al. (2022) assert that when students engage with hands-on materials related to biology, they develop skills beneficial for STEM careers.

According to Chitsanza(2020) this research investigated the effect of interactive instructional materials on learners', such as simulations, experiments and online

resources, significantly improved students achievement in Biology. It highlights the importance of incorporating hands-on activities and technology-based resources in Biology classes to enhance learning outcomes.

This study explored the impact of e-learning resources, including online modules, interactive websites and digital textbooks on the teaching and learning of Biology in Zimbabwean high schools. According to Charamba etal (2019) the findings indicated that the use of e-learning resources enhanced student engagement, motivation and understanding of Biology concepts. However, challenges such as limited access to technology and inadequate teacher training were identified as barriers to effective implementation.

This literature reviews provide insights into the impact of impact of instructional materials on the teaching and learning of Biology in senior secondary schools in Zimbabwe. 2017 highlights the significance of incorporating a variety of instructional materials, including interactive and digital resources, to promote active learning and improve students' academic performance in Biology.

In the context of STEM education, integrating technology into the classroom has been highlighted as a key factor in enhancing student learning. For example, the use of Interactive Whiteboards (IWBs) has been found to promote more positive attitudes towards learning and increase student participation This suggests that the integration of modern instructional materials can significantly improve the educational experience in biology.

2.1.7 Challenges in Bindura

While instructional materials are essential, challenges related to access and resource allocation in Bindura schools remain. A study by Chirimuuta (2023) highlights that many secondary schools lack adequate funding for instructional materials, affecting the overall quality of education in STEM. Teachers often resort to outdated or unavailable resources, which can diminish the effectiveness of teaching strategies. Despite the benefits of instructional materials, several challenges hinder their effective use in

teaching biology. A study focusing on Zimbabwean secondary schools identified various obstacles faced by teachers, including inadequate resources, lack of training, and insufficient support for implementing STEM-focused instructional methods. These challenges can limit the potential impact of instructional materials on student learning outcomes.(https://www.texilajournal.com/academic-research/article/1427-challenges -faced-by).

2.1.8 Theoretical framework

The theoretical framework could be based on several key theories and concepts. These may include;

Constructivism: Gwindi etal (2003) states that this theory emphasizes that learners construct their own understanding of knowledge through active engagement with learning materials. It suggests that instructional materials should be designing to promote active learning engagement with learning, problem-solving skills and critical thinking. The framework could explore how instructional materials can be aligned with the principles of constructivism to enhance learning outcomes in Biology. (

Cognitive load Theory: This theory suggests that instructional materials should be designed in a way that optimises cognitive processing. The framework could investigate how instructional materials can be structured to reduce cognitive load, such as by presenting information in management chunks, utilising visual aids and providing opportunities for active processing and reflection. (Engelbrecht et.al, 2021)

Multimedia Learning Theory: This theory focuses on how the presentation of information through different media can influence learning outcomes. The framework could explore how instructional materials can incorporate multimedia elements effectively to enhance understanding and engagement with Biology concepts. (Gambari et al, 2014)

Technology Acceptance Model: As instructional materials in senior secondary schools may involve the use of technology, this theoretical framework could incorporate the Technology Acceptance Mode l. According to Ong'amo etal (2017) this model

investigates factors that influence individual's acceptance and adoption of technology in education, such as perceived usefulness, ease of use and attitudes towards technology. The framework could explore how students and teachers perceive and utilize instructional materials that incorporate in Zimbabwe senior secondary schools.

Socio-cultural perspectives: This theoretical framework could also consider socio- cultural factors that may influence the impact of instructional materials on the teaching and learning of Biology in Zimbabwe. This could include exploring the materials, role of teachers as facilitators of learning and the interaction between students and their peers.

By incorporating these theories and concepts into the theoretical framework, researchers can gain a comprehensive understanding of the impact of instructional materials on the teaching and learning of Biology in senior secondary schools in Zimbabwe.(Tsvara et al, 2018)

2.1.9 Summary

In summary, the literature indicates that instructional materials are vital for enhancing the teaching and learning of 'A' Level Biology, particularly within the STEM framework. Effective utilization of these materials, combined with active teaching methods, can lead to improved student engagement and academic performance.The body of literature reviewed underscores the significant impact of instructional materials on both the teaching and learning of 'A' Level Biology within the STEM context. The effective integration of diverse instructional materials can enhance student engagement, comprehension, and application of biological concepts. However, addressing the challenges regarding accessibility and adequacy of resources in Bindura is vital to optimizing the educational experience in secondary schools. This research will focus on strategies to improve the availability and quality of instructional materials in this region. However, addressing the challenges faced by educators in accessing and implementing these resources is essential for maximizing their impact in the classroom. This research and support are needed to ensure that all students benefit from high-quality biology education.

The literature underscores the significant impact of instructional materials on the teaching and learning of A-Level Biology within the framework of STEM education and Education 5.0. While the integration of diverse resources can enhance engagement and understanding, systemic challenges must be overcome to ensure effective implementation. Continued research and investment in educational resources, as well as teacher training, are essential for improving educational outcomes in biology and preparing students for future scientific challenges in Bindura and beyond.

The integration of Education 5.0 and STEM into the teaching and learning of Biology in secondary schools in Bindura presents a unique opportunity to enhance educational outcomes. By utilizing effective instructional materials and fostering an environment conducive to experiential learning, educators can better equip students with the necessary skills for the 21st century. However, to achieve these goals, it is crucial to address the existing challenges and implement targeted strategies for improvement.

CHAPTER 3:

RESEARCH METHODOLOGY

3.0 Introduction

This chapter outlines the research methodology employed in the investigation of the impact of instructional materials on the teaching and learning of 'A' Level Biology, particularly in the context of Science, Technology, Engineering, and Mathematics (STEM) and Education 5.0 at Hermann Gmeiner Secondary Schools in Bindura.

This chapter intends to discuss on how the research will be carried out. Leedy (2000) defines methodology as an operation framework within which facts are placed so that their meaning may be more clearly understood. One can say methodology is a body of knowledge and ideas which provide an understanding of how, when and why we use difficulty methods for carrying out researches. Mufanechiya etal (2024) advanced that, methodology is a piece of information which shows detailed research methods through which data is collected and the more general philosophy upon which the collection and analysis is based .The type of research design will be given. The approach in data collection using questionnaires and interviews will be highlighted. The merits and demerits of the research instrument used will also be outlined.

3.1 Research Design

A Research design is a strategic plan for a research project or programme, setting out the outline and key features of the work to be undertaken, including the method of data collection and analysis to be employed and showing how the research strategy addresses the specific aims and objectives of the study (Marshal, 2008).Basing on this authority one can say that a research design is something which works as a systematic plan outlining the study, the researchers' methods of compilation, details on how the study will arrive at its conclusions and the limitations of the research. It can be suggested that research design is not limited to a particular type of research and may incorporate the mixed method approach.

The topic being descriptive in nature the researcher is doing use the mixed research design and employed descriptive survey design. This survey was made at Hermann Gmeiner Secondary school.

The researcher will use this method because it has the following advantages, data collected is reliable, variability of results is reduced, it is relatively simple to analyse, questions are simple and faster to administer. However the method has the following demerits, unwillingness of respondents to provide information and inability of the respondents to provide information due lapse of memory and lack of knowledge. To mitigate this challenge respondents were allowed to consult wherever possible inorder to give correct information.

To ensure the validity of this design the researcher ensured the respondents that the information would be kept secret .The questions were also carefully framed and phrased and respondents were allowed to refer to where ever they could get the necessary information.

Dziva (2018)states that research design is a method which is concerned with conditions of relationships that prevail where researcher does not manipulate the variables but determines and report the way things are. The design is suitable when gathering data from a relatively large number of cases at a particular time. It involves collecting information by administering questionnaires to a sample of individuals that describes events, then organizes, tabulates, depicts and portrays the variables. According to Gay (2003) a descriptive survey is, a process of collecting data in order to answer questions concerning the current status of the subject. One can describe a survey as a method of collecting information by interviewing or administering questions to a sample of individuals. It is the most frequently used method for collecting information about people's attitudes, opinions, habits or any of the variety of social issues related to education.

The study adopts a mixed-methods approach, combining both quantitative and qualitative research methods. This approach allows for a comprehensive analysis of the impact of instructional materials on student learning outcomes and teaching

effectiveness. The quantitative aspect involves the collection of numerical data through surveys, while the qualitative aspect includes interviews and focus group discussions with teachers and students.

This will allow for comprehensive insights into the impact of instructional materials.This approach allows for a comprehensive understanding of the impact of instructional materials by quantifying their effects while also exploring the experiences and perceptions of teachers and students at Hermann Gmeiner Secondary Schools in Bindura.

3.2 Population of the study

This is the total number of people, objects, places and events selected in a research because they will be relevant to the study (Dziva, 2012). The survey carried out in this study was gender sensitive to learners, thus ten boys and ten girls were selected from the school.

The target population for this study includes all 'A' Level Biology students and their teachers at Hermann Gmeiner Secondary Schools.

3.3 Sample size

A sample is a subset of a population selected for measurement, observation or questioning, to provide statistical information about a population (Dziva etal2018).The sample for the survey was drawn from the target population. McDaniel and Gates (1993) defined a sample as a sub set of a population which can fairly imitate the characteristics of the population which it is taken. Doughity, (1981) further explains that, a large number of items, individuals, or locations of a statistical population may, within specified limits of statistical probability, be represented by a small group of a parent population. Saunders et al (2013), agreed with Miles and Huberman (1994), on the need for the determination of an appropriate sample size that is able to generate enough and accurate data for the study. The researcher purposively selected six students and three science subject teachers respectively. Thus, a disproportionate sample size of eight participants was selected for the study. Qualitatively, the sample was considered

statistically representative and the smaller sample size gave the researcher the maximum opportunity to obtain relevant responses.

3.4 Sampling procedures

Gadzirayi etal, (2016) defined sampling as the process of selecting units from a population of interest so that by studying the sample one may fairly generalize the results back to the population from which they were chosen. The researcher employed a blended approach of both random and non-random sampling techniques. For non- probability sampling, the probability of each case being selected from the total population is not known and it is impossible to answer research questions or to address objectives that require a researcher to make statistical inferences about the characteristics of the population. Thus against this background, the researcher used the purposive sampling technique. The study employed purposive sampling technique where respondents were selected according to the drive of the study. By definition, purposive sampling involves the targeting of key informants, in this case science students, science teachers and their heads of departments in the school. Mavhunga etal (2018) contend that participants are selected on the basis of the research objectives. Purposive sampling was advantageous in that it is less rigorous, convenient and feasible in such contexts where time and resources constraints are limited.The non-probability sampling method used in this research is purposive or expert sampling. According to Naeem etal (2024) purposive sampling is choosing individuals who can provide deep, rich, significant data on the subject being investigated .The advantages of purposive sampling is that it can be used for both qualitative and quantitative designs. It is also extremely time and cost effective when compared to other sampling methods (Marshal, 2000).

Stratified random sampling was then used to categorize and select participants in terms of their categories namely, students and teachers. According to Mavhunga etal (2018), the statistical sampling method called stratified sampling is used when representatives from each subgroup within the population need to be represented. The major advantage is that each category was represented in the population sample hence responses and

research findings were balanced and did not compromise the reliability because of biasness. On the other hand, random sampling was then used by the researcher in determining the particular respondents in each sub group that was selected in the specific sciences subjects under study.Therefore, sampling is concerned with the selection of subsets of individuals within a statistical population to estimate characteristics of the whole population. For this study one secondary schools was selected. A stratified random sampling technique will be used to select a representative sample of students and teachers. This ensures that various sub-groups within the population are adequately represented, enhancing the reliability of the findings.A sampling technique in which not every member of the population has an equal chance of being selected. Indeed, some units or cases of the population have zero chance of selection (Bhattacherjee, 2012). A sampling technique which targets certain individuals was therefore used.

The Head of Biology department and two biology teachers were automatically selected to participate in the study. The Advanced level biology students were selected with biology teachers' assistance. The biology teachers could help by selecting learners who could provide significant information for the study.

3.5.0 Research instruments.

The research instruments for data collection for this study were questionnaire with both open and close ended questions.Interviews were also conducted with the use of interview guides as instruments for the study for the twenty students and Advance level Biology teachers. These research instruments were pilot tested using the A level Biology students and teachers in other schools in Bindura district. Pilot test was done using schools in Bindura District because in Bindura district there were no other schools which offer biology except the ones used for this study.

The questionnaire for this study were developed by the researcher. Questionnaire was used since it helped to collect data from a wide range of respondents, very economical in terms of time and respondents were free to respond to items without fear or victimisation since they were not required to write names on the questionnaires.

3.5.1 Questionnaire

Dziva (2018) defines a questionnaire as a document with a list of questions usually printed to get facts for survey. Therefore, questionnaires will be administered. Teachers will be given questionnaire as indicated by appendix i, heads of schools questionnaires is on appendix ii, questionnaire for biology learners are on appendix iii and heads of sciences departments (HODs) questionnaire is on appendix iv. Questionnaires for the four categories were divided into two sections, section A and B. Section A with closed ended questions and section B with open ended questions. Open ended questions allowed the researcher to get more information on ways of emancipating ordinary level biology teachers from their challenges in implementing continuous assessment. The structure was the same for all questionnaires but the questions were different since were directed to different specific category. Questionnaires were used because they are economical and easy to formulate and analyze. Moreover, questionnaires elicit a lot of information and give greater depth of response. According to Chiromo (2009) questionnaires reach out to the respondents in a short period of time. The other advantage of using a questionnaire is that the researcher will be able to collect information from a large group of population at the same time within a short space of time .Respondents were made to write their responses on the designed questionnaire they were given.

Structured questionnaires will be distributed to both teachers and students to gather quantitative data on the availability, utilization, and perceived effectiveness of instructional materials in teaching A-Level Biology. Questions will focus on the types of materials used, frequency of use, and their impact on learning outcomes. Design structured questionnaires for students and teachers to gauge their perceptions of the instructional materials and their effectiveness in teaching and learning. The questionnaires will be administered to students during class hours, with teachers given the option to complete theirs at their convenience. An introductory session will explain the study's purpose and ensure the confidentiality of responses.

3.5.2 Interview

Semi-structured interviews with Biology teachers will provide qualitative insights into their experiences and challenges related to instructional materials.

Interviews were used to complement questionnaires since the questionnaires have disadvantages for example, the responded may consult people who can give false information which may result in getting biased information (Bland 2010). Therefore, the researcher used triangulation to counter this challenge. Interview guides were designed. Each interview guide was made of 3 questions which were open ended questions as indicated by appendix v. The interview guides used were the same for all participants. Questions on the interview guide was asked verbally and responses were given verbally. Information obtained from the interview guide of different respondents was recorded separately in form of essay and some information was recorded as direct quotation.

Manzungu etal (2024) regards interviews as an interchange of views between two or more people on a topic of mutual interest. Therefore interviews are the collection of data by asking people questions and following up or probing their answers .The advantage of interviews is that the individual being interviewed is unable to provide false information on issue as gender, age and race as it is face to face. Another advantage is that it allows the interviewer to capture verbal and non-verbal cues (Dziva etal 2018). With the use of both the questionnaires and the interviews the researcher got much information as the two instruments complemented one another. The researcher explained to respondents that their contributions were going to be kept confidential. (Mutseekwa et al, 2024)

Semi-structured interviews with selected teachers will provide qualitative insights into their experiences, challenges, and strategies related to the use of instructional materials in the context of STEM education. This will help to identify specific instructional methods that promote effective learning. Conduct semi-structured interviews with a selected group of teachers to gather in-depth information about their experiences with the instructional materials and any challenges they face. (Zigara 2020).

Classroom Observations: Observations of biology classes will be conducted to assess the actual use of instructional materials during teaching. This will help to understand how these materials are integrated into lessons and their impact on student engagement and learning. Classroom observations could be undertaken to see firsthand how instructional materials are utilized during lessons and how they impact student engagement and understanding.

3.6 Procedures of collecting data.

The researcher firstly, applied for permission to carry out the research study to the Ministry of Primary and Secondary Education. When the permission was granted, the researcher then contacted Hermann Gmeiner High School authorities, briefed them on the subject matter and booked them for the interviews and distribution of questions. This was then followed by the actual interviews and focus group which the researcher personally administered. In all cases, the researcher sought for written consent from the respondents before the data collection process began so that they could acknowledge their participation. All the data provided by the respondents was accurately recorded.

3.7.0 Validity and reliability of instruments:

3.7.1 Validity

Crist (2014) alludes that validity is the extent to which an instrument measures what it is supposed to measure according to researcher's subjective assessment. According to Mavhunga (2011) can be said validity is concerned with the degree to which an empirical measure or several measures of a concept accurately represent the concept.The pilot study helped the researcher to see the applicability of the research instruments.

3.7.2 Reliability

According to Chirikure (2012) reliability is a measure of degree to which research instruments will yield constant results after repeating trials. One can say that reliability of an instrument is the consistence in producing similar results over a period of

repeated trials. The researcher ensured reliability on both the questionnaire and interviews (Mashoko, 2023).

3.8 Data Analysis

Quantitative data from surveys will be analyzed using statistical software to identify trends and correlations. Descriptive statistics will summarize the data, while inferential statistics will be used to draw conclusions about the broader population. Qualitative data from interviews will be analyzed thematically, identifying key themes and patterns that emerge from the discussions. Statistical analysis will be performed using software such as SPSS or Excel. Use statistical methods to analyze survey data. Software like SPSS or Excel could be used for analysis, focusing on descriptive statistics (mean, median, and mode) and inferential statistics (t-tests, ANOVA). Descriptive statistics will summarize the data, while inferential statistics (e.g., t-tests, ANOVA) will be used to determine the significance of the findings. (Nakhate et al 2015)

Qualitative Data: Thematic analysis will be employed to analyze interview transcripts and observation notes. This will involve coding the data to identify common themes and patterns related to the use of instructional materials and their impact on teaching and learning. Transcribe interviews and analyze them using thematic analysis to identify recurring themes or patterns related to the use of instructional materials. (Zigara 2020)

Mixed Methods Integration: Triangulate findings from both quantitative and qualitative data to provide a comprehensive understanding of the topic.

3.9 Ethical Considerations

Asori (2023) defines ethics as observations of what is good and bad. In this research study respondents were not forced to complete questionnaires or respond to interviews. Consent was sought first before respondents participated. In this research study respondents were told that their responses were confidential and they were not required to identify themselves. They were also told that results of the study were not to be communicated to anyone except to those in line of supervision from the institution. Respondents were also treated with respect and dignity.

Ethical considerations are paramount in this research. Informed consent will be obtained from all participants, ensuring they understand the purpose of the study and their right to withdraw at any time. Confidentiality will be maintained by anonymizing responses and securely storing data. Ethical approval will be sought from relevant authorities before conducting the research. Informed consent will be obtained from all participants, ensuring they understand the purpose of the study and their right to withdraw at any time. Confidentiality and anonymity will be maintained throughout the research process. Ensure informed consent is obtained from participants. Maintain confidentiality and anonymity of respondents. Obtain ethical clearance from relevant educational authorities or institutional review boards. (Tsvara, 2019)

3.10 Conclusion

The methodology should ultimately aim to assess not only how instructional materials influence teaching and learning but also how they align with the principles of STEM education and Education 5.0, which emphasizes the integration of technology and innovative teaching approaches. This research methodology aims to provide a comprehensive framework for investigating the impact of instructional materials on the teaching and learning of A-Level Biology in the context of STEM education. By employing a mixed-methods approach, the study seeks to yield both quantitative and qualitative insights that can inform educational practices and improve learning outcomes in biology education.

This chapter has outlined the research methodology for investigating the impact of instructional materials on the teaching and learning of ‘A’ Level Biology. By employing a mixed-methods approach, the study aims to provide a comprehensive understanding of how these materials influence educational outcomes in the context of STEM education.

CHAPTER 4:

DATA PRESENTATION, ANALYSIS, INTERPRETATION AND DISCUSSION

4.1 Introduction

The current chapter presents four critical issues that guided execution of this study. These are, example, data presentation, data analysis, data interpretation and data discussion. Data presentation is thematically provided. The subsequent section presents the response rate of the study.

4.2 Response rate

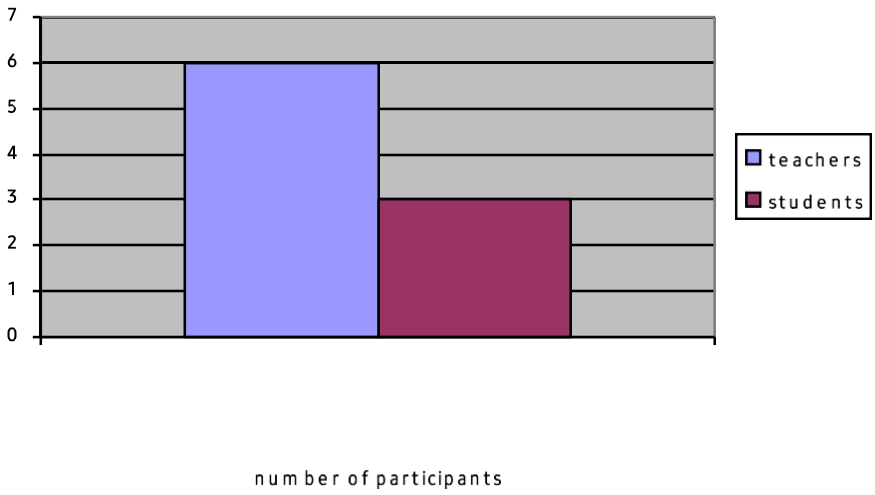
From the sample, I got a sample of 9 people.

Participants	Turn-Up
Teachers	3
Students	6
Total	9
Total Percentage	100
Apologies/Absenteeism	None

4.3 Codes used to represent participants

Participants	Pseudo name/Code
Students	S1 S2 S3 S4 S5 S6
Teachers	T1 T2 T3

4.3.1 Number of participants

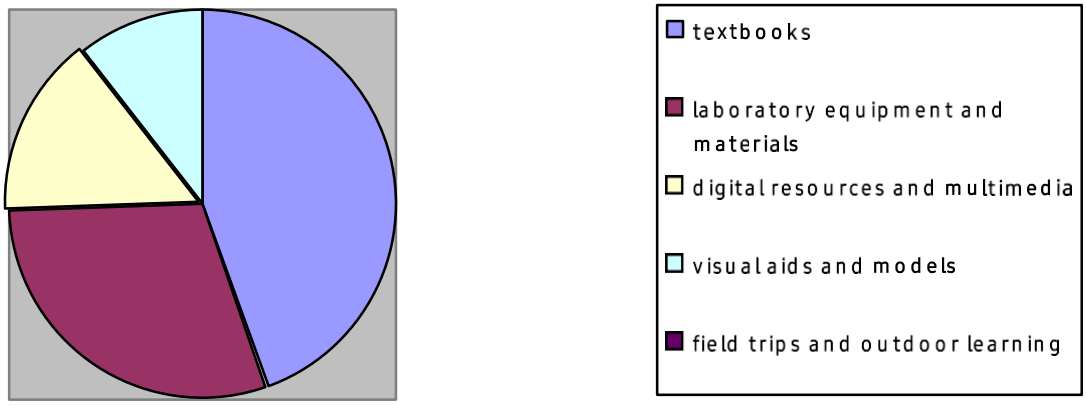


4.4 Themes and sub-themes of study

Themes	Descriptions	Sub-Themes
Theme 1:	Types of instructional materials are currently used in teaching 'A' Level Biology in secondary schools in Bindura, Zimbabwe	▪ Textbooks ▪ Laboratory Equipment and Materials ▪ Digital Resources and Multimedia ▪ Visual aids and models ▪ Field Trips and Outdoor Learning
Theme 2:	Impact of instructional materials to student learning outcomes in 'A' Level Biology	▪ structured approach ▪ reinforcing theoretical knowledge ▪ real-world contexts ▪ enhance student engagement and understanding ▪ lead to rote memorization rather than deep understanding
Theme 3:	STEM-aligned instructional materials that can be developed or adapted to improve teaching and learning of	▪ students visualize complex biological processes ▪ hands-on experiments

	'A' Level Biology	▪ bridge the gap between theoretical knowledge and practical understanding ▪ facilitate student collaboration and discussion outside the classroom

Instructional materials on a Pie-Chart



4.5 Thematic presentation of data

4.5.1 Types of instructional materials are currently used in teaching 'A' Level Biology in secondary schools in Bindura, Zimbabwe

4.5.1.1 Textbooks

Textbooks are a cornerstone of 'A' Level Biology instruction in Zimbabwe. They provide essential content, but reliance on a limited number of outdated texts can hinder

comprehensive learning. Participants had this to say:

S1 *"Textbooks are the primary resource for 'A' Level Biology, providing foundational knowledge and structured content."*

S2 *"Many teachers rely on a narrow selection of textbooks, which may limit the breadth of information available to students."*

S3 *"The quality of textbooks varies significantly; some are outdated and do not align with the current syllabus."*

T1 *"Supplementary textbooks are essential for providing diverse perspectives and deepening understanding of complex concepts."*

T2 *"Access to well-researched and updated textbooks is crucial for effective learning in 'A' Level Biology."*

Therefore, the variability in quality and alignment with the syllabus raises concerns about educational equity. Incorporating a wider range of supplementary materials could enhance students' understanding and engagement with the subject.

4.5.1.2 Laboratory Equipment and Materials

Laboratory equipment is vital for experiential learning in biology. While practical work deepens understanding, many schools struggle with resource shortages, which can negatively impact students' practical skills and preparedness for higher education. The participants argued that:

S4 *"Laboratory work is critical for practical understanding, yet many schools face shortages of essential equipment."*

S5 *"Hands-on experiments allow students to apply theoretical knowledge, but inadequate resources often limit practical sessions."*

T3 *"The lack of modern laboratory technologies affects students' preparedness for advanced studies."*

S1 "Should we equip labs for better engagement and assessment"

S2 "Internet connectivity is crucial for digital learning"

Therefore, addressing these gaps through investment in modern equipment is essential for improving the quality of biology instruction.

4.5.1.3 Digital Resources and Multimedia

Digital resources and multimedia are becoming more prevalent in biology instruction, offering interactive and engaging ways to explore complex topics. However, inconsistent access to technology and varying levels of digital literacy can limit their effectiveness. It is important to note that the participants had this to say:

S3 "The integration of digital resources, such as online simulations, can enhance the learning process"

S4 "Multimedia presentations can enhance student engagement but are often underutilized"

S5 "Access to internet is crucial to enable digital resources to be used effectively"

T1 "Learning platforms have become increasingly important, especially during the COVID-19 pandemic"

T2 "Digital literacy among students is a significant barrier to accessing digital resources"

Training teachers to effectively use these resources and ensuring equitable access for all students can significantly enhance biology education.

4.5.1.4 Visual Aids and Models

Visual aids and models are crucial for simplifying complex biological concepts. They cater to various learning styles and can significantly improve retention and understanding. Participants said that:

T3 *"Visual aids such as diagrams and models are essential for helping students grasp complex"*

S1 *"Models of biological systems provide tangible representations that enhance understanding"*

S2 *"Teachers who effectively use visual aids report better student retention of information"*

S3 *"Incorporating visuals into lessons makes abstract concepts more relatable and easier to comprehend"*

S4 *"The effectiveness of visual aids depends on their quality and relevance to the curriculum"*

However, the quality and relevance of these materials can vary, necessitating careful selection and integration into lesson plans to maximize their educational benefits.

4.5.1.5 Field Trips and Outdoor Learning

Field trips and outdoor learning experiences provide invaluable opportunities for students to engage with biological concepts in real-world contexts. They enhance motivation and interest in the subject, but logistical and financial barriers often restrict their implementation. The participants noted that:

S5 *"Field trips provide students with real-world experiences that enhance their understanding of biological concepts"*

S6 *"Outdoor learning opportunities often lead to increased student motivation and engagement"*

S1	*"However, logistical challenges and funding constraints limit the frequency of field trips"*
S2	*"Experiential learning outside the classroom has been shown to deepen students' appreciation of biological diversity"*
T1	*"Schools should prioritize outdoor learning opportunities to enhance student engagement and academic performance"*

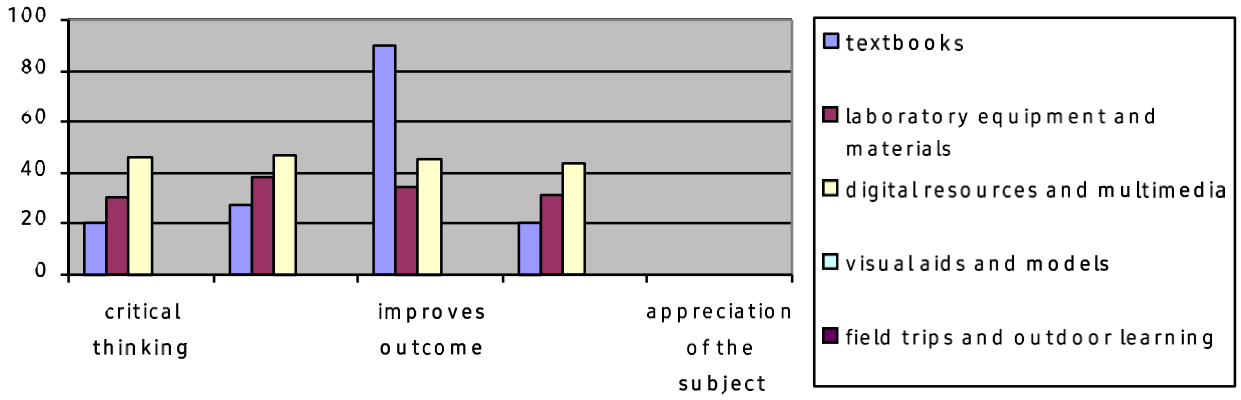
Thus, schools should seek partnerships and funding opportunities to increase access to these enriching experiences.

4.5.1.6 Summary

In summary, the instructional materials used for 'A' Level Biology in Zimbabwean secondary schools include textbooks, laboratory equipment, digital resources, visual aids, and field trips. Each type of material has its strengths and limitations, highlighting the need for a diverse and well-resourced educational environment. Addressing the challenges associated with each category, such as resource scarcity and technological access, is essential for enhancing the quality of biology education and ensuring that students receive a comprehensive and engaging learning experience.

4.5.2 Impact of these instructional materials to student learning outcomes in 'A' Level

Biology



4.5.2.1 Textbooks

Textbooks are fundamental to biology education, serving as the main reference point for students. While they provide structured content, over-reliance can lead to superficial learning. Quality and accessibility are critical; outdated or poorly aligned textbooks can hinder student understanding. Supplementary materials are essential for fostering critical thinking and deeper engagement with the subject matter. Participants argued that:

T2 *"Textbooks are often the primary source of information for students, providing a structured approach to learning."*

T3 *"My students rely heavily on textbooks from campus, which can lead to a surface-level understanding."*

S1 *"Outdated textbooks that do not align with the syllabus significantly affect student performance."*

S2 *"[illegible]"*

S3 *"[illegible]"*

Therefore, textbooks are crucial for foundational knowledge but should be supplemented with diverse resources to enhance critical thinking and engagement.

4.5.2.2 Laboratory Equipment and Materials

Laboratory experiences are vital for reinforcing learning and enhancing retention. Students benefit greatly from hands-on activities, which help bridge the gap between theory and practice. However, resource limitations can negatively impact the quality of these experiences. Investing in laboratory resources is essential for improving student outcomes in biology. The participants had this to say:

S4 *"Hands-on laboratory experiences are essential for reinforcing theoretical knowledge."*

S5 *"[illegible]"*

T1 *"[illegible]"*

T2 *"[illegible]"*

T3 *"[illegible]"*

Therefore, laboratory equipment enhances student learning by providing practical experiences crucial for understanding biological concepts and developing necessary skills.

4.5.2.3 Digital Resources and Multimedia

Digital resources and multimedia enhance learning by making content more engaging and accessible. They cater to various learning preferences and promote collaborative learning opportunities. However, the effectiveness of these resources hinges on proper implementation and training. Ensuring that both students and teachers are equipped to use digital tools is crucial for maximizing their benefits. Participants noted that:

S1 *"Digital tools and resources can make learning more engaging and accessible."*

S2 *"Multimedia presentations can cater to different learning styles."*

S3 *"Learning platforms provide opportunities for collaborative learning outside the classroom."*

S4 *"Students need training to use digital tools effectively."*

S5 *"Technical difficulties can disrupt learning if teachers are not prepared."*

Therefore, digital resources significantly impact student learning outcomes by enhancing engagement and providing diverse learning opportunities, but effective training is essential.

4.5.2.4 Visual Aids and Models

Visual aids and models play a critical role in enhancing comprehension and retention in biology education. They transform abstract concepts into relatable forms, facilitating deeper understanding. However, the quality and relevance of these materials are paramount; poor-quality visuals can mislead students. Effective use of visual aids can lead to a more interactive and engaging learning experience. It is imperative to note that the participants said:

T1 *"Visual aids help students understand complex concepts."*

T2 *"Models provide tangible representations of abstract biological processes, making them easier to understand."*

T3 *"Students who use visual aids tend to retain information better than those who do not."*

S1 *"Incorporating visual aids fosters a more interactive learning environment."*

S2 *"The effectiveness of visual aids is influenced by their quality and relevance to the curriculum."*

Therefore, visual aids are vital for improving comprehension and retention of biological concepts, provided they are of high quality and relevant.

4.5.2.5 Field Trips and Outdoor Learning

Field trips and outdoor learning significantly enrich biology education by providing real- world contexts for theoretical concepts. These experiences enhance motivation and foster a deeper appreciation of the subject. However, logistical and financial constraints can limit access to such opportunities. Schools should seek partnerships and funding to facilitate more outdoor learning experiences. Participants noted that:

S3 *"Field trips provide experiential learning opportunities that significantly enhance understanding of biological concepts."*

S4 *"Outdoor learning experiences foster greater interest and motivation in biology among students."*

S5 *"Logistical challenges often limit the frequency of field trips, impacting student learning opportunities."*

T1 *"Experiencing biology in real-world contexts deepens students' appreciation for the subject."*

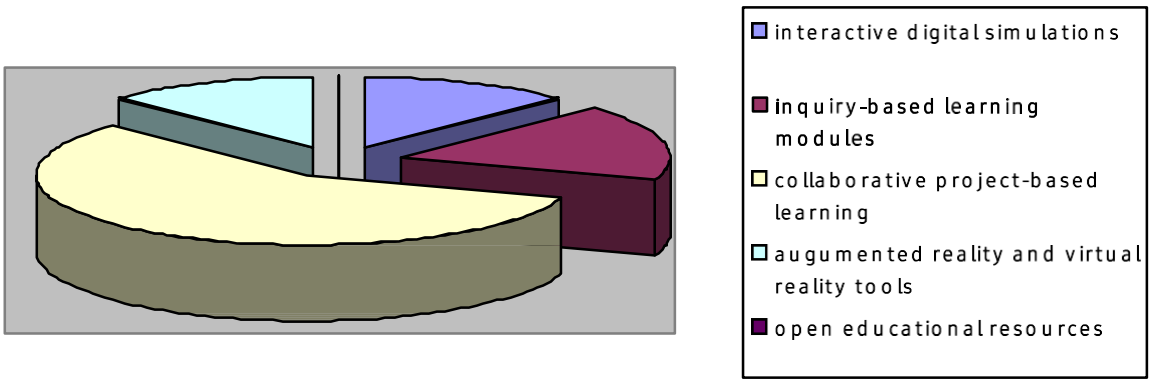
T2 *"Schools that provide outdoor learning report better student engagement and academic performance."*

Therefore, field trips and outdoor learning greatly enhance student engagement and understanding in biology, but logistical constraints often limit their implementation.

4.5.2.6 Summary

The impact of instructional materials on student learning outcomes in 'A' Level Biology is multifaceted. Key materials—textbooks, laboratory equipment, digital resources, visual aids, field trips, interactive tools, and teacher-created materials—each contribute uniquely to the learning experience. While each type of material has its strengths, challenges related to quality, accessibility, and resource availability must be addressed to maximize their effectiveness. By investing in diverse instructional resources and ensuring equitable access, educators can significantly enhance student engagement and understanding in biology, ultimately leading to improved academic outcomes.

4.5.3 STEM-aligned instructional materials can be developed or adapted to improve teaching and learning of 'A' Level Biology



4.5.3.1 Interactive Digital Simulations

Interactive digital simulations provide a dynamic platform for students to explore complex biological phenomena, enhancing engagement and comprehension. They cater to diverse learning styles and can be adapted to individual learning paces. By allowing students to manipulate variables and see outcomes in real time, these tools foster a deeper understanding of biological concepts. The participants had this to say:

T3 *"Digital tools can simulate complex biological processes that are difficult to observe directly."*

S1 *"Interactive simulations engage students actively, making learning more enjoyable."*

S2 *"Students using simulations demonstrate improved understanding of concepts compared to traditional methods."*

S3 *"The ability to repeat experiments digitally allows students to learn from mistakes without consequences."*

S4 *"Digital resources can be updated easily, ensuring students access the most current information."*

Therefore, digital simulations are effective STEM-aligned materials that enhance engagement and understanding in 'A' Level Biology. Their adaptability and capacity for real-time exploration make them invaluable in modern education.

4.5.3.2 Inquiry-Based Learning Modules

Inquiry-based learning modules promote active engagement and critical thinking, allowing students to explore biological concepts through hands-on experiences. This method not only enhances retention but also fosters a sense of ownership over the learning process. Educators must guide inquiry effectively to maximize its benefits. Participants noted that:

S5 "Inquiry-based learning encourages students to ask questions and seek answers through experiments."

S6 "Students engage in hands-on activities that deepen their understanding of biological concepts."

T1 "Inquiry-based learning can help students develop critical thinking skills."

T2 "Inquiry-based models can be designed to align with the curriculum while promoting inquiry."

T3 "Teachers should facilitate inquiry-based learning by guiding students rather than providing answers."

Thus, inquiry-based learning modules are powerful tools for enhancing student engagement and understanding in biology. By fostering critical thinking and hands-on exploration, these modules align well with STEM education principles.

4.5.3.3 Collaborative Project-Based Learning

Collaborative project-based learning enhances student engagement by fostering teamwork and communication. This approach allows students to tackle real-world biological problems, making learning relevant and practical. However, effective implementation requires clear objectives and structured guidance to keep students focused. Participants argued that:

S1 "Project-based learning encourages collaboration among students, enhancing their communication skills."

S2 "Students develop critical thinking and problem-solving skills through engaging projects."

S3 "Collaborative projects help students apply theoretical knowledge to real-world problems, making learning more meaningful."

S4 *"The project-based learning requires careful planning and dedication to guide students."*

S5 *"Collaborative projects deepen understanding of biological concepts through peer interaction and discussion."*

Therefore, collaborative project-based learning is an effective STEM-aligned instructional strategy that enhances engagement and understanding in biology. By promoting teamwork and real-world applications, it prepares students for future challenges.

4.5.3.4 Augmented Reality (AR) and Virtual Reality (VR) Tools

AR and VR tools offer innovative ways to engage students in biology education through immersive experiences. These technologies help bridge the gap between theoretical concepts and practical applications, fostering deeper understanding. While they require significant investment, the potential for enhanced engagement and learning outcomes justifies the costs. The participants had this to say:

T1 *"AR and VR technologies provide immersive experiences that can transform the way biology is taught."*

T2 *"These tools allow students to explore biological structures and processes in a 3D environment."*

T3 *"Immersive learning experiences can lead to higher levels of engagement and motivation."*

S1 *"AR and VR can bridge the gap between theoretical knowledge and practical understanding."*

S2 *"Despite the initial costs, the long-term benefits of AR and VR in education are significant."*

Therefore, AR and VR technologies represent cutting-edge instructional materials that

can significantly enhance the teaching and learning of biology. Their immersive nature fosters engagement and understanding, aligning well with STEM education goals.

4.5.3.5 Open Educational Resources (OER)

Open Educational Resources (OER) provide flexible and accessible teaching materials that can be tailored to meet diverse student needs. By promoting equity and customization, OER can enhance the relevance and effectiveness of biology instruction. Participants noted that:

S3 *"OER provide free and accessible educational materials that can be adapted for diverse learners."*

S4 *"Using OER promotes equity by making high-quality resources available to all students."*

S5 *"Teachers can customize OER to align with local curricula and specific student needs."*

S6 *"OER can include interactive simulations, making complex biological concepts more engaging."*

T1 *"Adopting OER encourages collaboration among educators to develop and share resources."*

Overall, they encourage collaboration among educators, fostering a culture of shared resources and best practices.

4.5.3.6 Summary

The development and adaptation of STEM-aligned instructional materials such as interactive digital simulations, inquiry-based learning modules, collaborative project- based learning, AR and VR tools, open educational resources, and interactive online platforms can significantly enhance the teaching and learning of 'A' Level Biology. Each of these materials offers unique advantages, including improved engagement, deeper understanding, and the ability to bridge theoretical concepts with practical applications.

By integrating these resources into the curriculum, educators can foster a more dynamic and effective learning environment that prepares students for future challenges in the sciences.

CHAPTER 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Chapter one investigated on the impact of instructional materials on the teaching and learning of 'A' Level Biology in line with Science Technology Engineering Mathematics at Hermann Gmeiner Secondary schools in Bindura. The purpose of the study is to examine the impact of instructional material in the teaching and learning of Biology in senior secondary schools. It is assumed that a variety of instructional materials, including textbooks, digital resources, laboratory equipment, and other teaching aids, are available and accessible to both teachers and students in the secondary schools being studied. It is assumed that schools have access to sufficient resources, including technology and laboratory equipment, which are essential for implementing effective instructional strategies in biology education. This access is critical for conducting practical experiments and hands-on learning activities. It is assumed that the teachers participating in the study are adequately trained and competent in using these instructional materials effectively in their teaching practices. This research had several significances. Firstly, it contributed to the existing body of knowledge on the role of instructional materials in secondary education, particularly within the STEM framework. Secondly, the findings provided valuable insights for educators, policymakers, and curriculum developers in enhancing the quality of Biology education in Zimbabwe among other benefits. Chapter two focused exclusively on secondary schools in Zimbabwe, limiting its generalizability to other countries or regions with different educational systems and contexts.

Also, it is imperative to note that the topic being descriptive in nature the researcher is doing use the mixed research design and employed descriptive survey design. This survey was made at Hermann Gmeiner Secondary school. In chapter three the researcher used these methods because it has the following advantages, data collected is reliable, variability of results is reduced, it is relatively simple to analyse, questions are simple and faster to administer. However the method had the following demerits,

unwillingness of respondents to provide information and inability of the respondents to provide information due lapse of memory and lack of knowledge. To mitigate these challenge respondents were allowed to consult wherever possible in order to give correct information. To ensure the validity of this design the researcher ensured the respondents that the information would be kept secret .The questions were also carefully framed and phrased and respondents were allowed to refer to where ever they could get the necessary information.

Furthermore, regarding the findings, the instructional materials used for 'A' Level Biology in Zimbabwean secondary schools include textbooks, laboratory equipment, digital resources, visual aids, and field trips. Each type of material has its strengths and limitations, highlighting the need for a diverse and well-resourced educational environment. Addressing the challenges associated with each category, such as resource scarcity and technological access, is essential for enhancing the quality of biology education and ensuring that students receive a comprehensive and engaging learning experience. The study discussed the effectiveness of various instructional materials and strategies in enhancing student engagement and understanding in biology education. The materials and strategies explored include interactive digital simulations. These provide a dynamic platform for students to explore complex biological phenomena, enhancing engagement and comprehension. In chapter four the study mentioned inquiry-based learning modules. These promote active engagement and critical thinking, allowing students to explore biological concepts through hands-on experiences. Also, the study emphasised about collaborative project-based learning. This approach enhances student engagement by fostering teamwork and communication, allowing students to tackle real-world biological problems. Augmented Reality (AR) and Virtual Reality (VR) tools were discussed in this study. These offer innovative ways to engage students in biology education through immersive experiences, fostering deeper understanding. Finally, Open Educational Resources (OER) were part of the discoveries. These provide flexible and accessible teaching materials that can be tailored to meet diverse student needs, promoting equity and customization.

Also, the study discussed the importance of various resources in teaching 'A' Level

Biology in Zimbabwe. These resources include textbooks, laboratory equipment and materials, digital resources and multimedia, visual aids and models, and field trips and outdoor learning experiences. While these resources are essential for effective learning, the study highlights several challenges, such as outdated textbooks, inadequate laboratory equipment, inconsistent access to technology, and logistical and financial barriers to field trips. The impact of instructional materials on student learning outcomes in 'A' Level Biology is multifaceted. Key materials—textbooks, laboratory equipment, digital resources, visual aids, field trips, interactive tools, and teacher-created materials—each contribute uniquely to the learning experience. While each type of material has its strengths, challenges related to quality, accessibility, and resource availability must be addressed to maximize their effectiveness. By investing in diverse instructional resources and ensuring equitable access, educators can significantly enhance student engagement and understanding in biology, ultimately leading to improved academic outcomes.

Lastly, in chapter five the study discusses the importance of various educational resources in biology education, including textbooks, laboratory equipment, and digital resources, visual aids, and field trips. While textbooks provide foundational knowledge, over-reliance can lead to superficial learning. Laboratory equipment and hands-on experiences are crucial for reinforcing learning and enhancing retention. Digital resources and multimedia can enhance engagement and provide diverse learning opportunities. Visual aids and models can improve comprehension and retention, while field trips and outdoor learning can provide real-world contexts for theoretical concepts. Interactive digital simulations provide a dynamic platform for students to explore complex biological phenomena, enhancing engagement and comprehension. They cater to diverse learning styles and can be adapted to individual learning paces. By allowing students to manipulate variables and see outcomes in real time, these tools foster a deeper understanding of biological concepts.

5.2 Conclusions

Based on the present study’s findings or results, this study made the following

conclusions.

To begin with, the instructional materials and strategies discussed in the study have the potential to significantly enhance student engagement and understanding in biology education. By incorporating interactive digital simulations, inquiry-based learning modules, collaborative project-based learning, AR and VR tools, and OER, educators can create a more immersive, interactive, and effective learning environment. These approaches align well with STEM education goals, promoting critical thinking, problem- solving, and collaboration. By adopting these strategies, educators can better prepare students for future challenges and foster a deeper understanding of biological concepts.

Also, the study emphasized the need for a multifaceted approach to teaching 'A' Level Biology in Zimbabwe. This approach should include the use of up-to-date textbooks, well-equipped laboratories, digital resources and multimedia, visual aids and models, and field trips and outdoor learning experiences. Addressing the challenges associated with these resources, such as outdated textbooks and inadequate laboratory equipment, is crucial for improving the quality of biology education. By providing students with access to a range of resources and experiences, educators can enhance student engagement, motivation, and understanding of biological concepts, ultimately preparing them for success in their academic and professional pursuits.

Finally, a comprehensive biology education requires a combination of educational resources. While textbooks provide a foundation, they should be supplemented with hands-on laboratory experiences, digital resources, visual aids, and field trips. Effective implementation of these resources is crucial for enhancing student engagement, understanding, and retention in biology. By providing a diverse range of learning experiences, educators can foster a deeper appreciation and understanding of biology among students.

5.3 Recommendations

Incorporate digital simulations, virtual labs, and multimedia resources to enhance student engagement and understanding in 'A' Level Biology.

Create instructional materials that connect biological concepts to real-world contexts, making learning more relevant and applicable.

Encourage students to explore biological concepts through hands-on experiments and investigations, fostering critical thinking and problem-solving skills.

Engage students in group projects that require them to apply biological concepts to real -world problems, promoting teamwork, communication, and critical thinking.

Utilize OER to provide students with flexible and accessible learning materials that can be tailored to meet diverse learning needs.

Provide teachers with professional development opportunities to learn how to effectively integrate instructional materials into their teaching practices.

Regularly assess the impact of instructional materials on student learning outcomes and adjust instructional strategies accordingly.

5.4 Recommendations for Further Study

Investigate the Impact of Virtual Reality (VR) and Augmented Reality (AR) on 'A' Level Biology Learning.

Examine the Relationship Between Instructional Materials and Student Motivation in 'A' Level Biology.

Develop and Evaluate the Effectiveness of Context-Based Instructional Materials for 'A' Level Biology.

Investigate the Impact of Collaborative Project-Based Learning on Student Learning Outcomes in 'A' Level Biology.

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Appendix 1: LETTER SEEKING PERMISSION TO CARRY OUT RESEARCH

Hermann Gmeiner High School

P. O. Box 913

BINDURA

1 November 2024

The Provincial Education Officer Box

00

Bindura

Dear Sir/ madam

REF:Kindly asking for permission to carry an investigation on the impact of instructional materials on the teaching and learning of ‘A’ Level Biology in line with Science Technology Engineering Mathematics and Education 5.0 at Hermann Gmeiner Secondary schools in Bindura.

I am currently studying for a Bachelor of Science Education Honours Degree - Biology at Bindura University of Science Education and I am conducting a research on "An investigation on the impact of instructional materials on the teaching and learning of 'A' Level Biology in line with Science Technology Engineering Mathematics and Education
5.0 at Hermann Gmeiner Secondary schools in Bindura. "

In respect of the above, I humbly request for the permission to conduct the research. Thank you in advance.

Yours sincerely

Appendix 2: Questionnaire

Section 1: Demographic Information

Name (optional)

Role (Teacher/Student/Administrator)

Age

Gender

Years of experience in teaching/learning Biology. _____

Highest educational qualification

_____

Section 2: Instructional Materials

What types of instructional materials do you use in teaching/learning A Level Biology? (Textbooks,

Online resources, Laboratory equipment, etc.)

How frequently do you use these instructional materials in your classes/studies?

Daily. [ ]

Weekly. [ ]

Occasionally. [ ]

Never. [ ]

How would you rate the adequacy of these materials for the curriculum?

Very Adequate. [ ]

Adequate. [ ]

Neutral. [ ]

Inadequate. [ ]

Very Inadequate. [ ]

In your opinion, which instructional material is most effective for teaching A Level Biology? Why?

Section 3

Impact on Teaching and Learning

How do you think the availability of instructional materials influences student engagement in Biology?

Significantly. [ ]

Somewhat. [ ]

Not at all. [ ]

Have you noticed any improvement in student performance in Biology after using specific instructional materials? If yes, please provide examples.

How do instructional materials support the integration of STEM Education in your teaching/learning practices?

What challenges do you face regarding the use of instructional materials for A Level Biology?

Section 4

Technology Integration

Do you incorporate technology (e.g., simulations, online platforms) in your teaching/learning of Biology?

Yes. [ ]

No. [ ]

If yes, how has technology impacted your understanding or teaching of A Level Biology?

What additional technological resources would enhance your teaching/learning experience?

Section 5

Feedback and Suggestions

What improvements can be made to the instructional materials used in A Level Biology? Do you have any suggestions for new materials or resources that could be introduced?

How can the school support your needs for effective teaching/learning of Biology?

Concluding Remarks

Thank you for your time.

Your responses will remain confidential and will be used for research purposes only.

Appendix 3: Interview Guide

Introduction

1. Purpose of the Interview:

Investigation on the impact of instructional materials on the teaching and learning of 'A' Level Biology in the context of STEM Education at Hermann Gmeiner Secondary Schools

The information you provide is confidential and we only be used for this research.

2. Background Information:

Name. _____

Position/role _____

How long have you been involved in teaching/learning 'A' Level Biology?

Section 1: Instructional Materials

1. Types of Materials Used:

What types of instructional materials do you use in teaching 'A' Level Biology (e.g., textbooks, lab equipment, digital resources)?

How do you select these materials?

2. Effectiveness of Materials:

In your experience, how do these materials impact student understanding and engagement in Biology?

Can you provide specific examples of materials that have been particularly effective or ineffective?

3. Integration with STEM Education:

How do the instructional materials align with STEM Education principles?

In what ways do these materials promote interdisciplinary learning, particularly in Science, Technology, Engineering, and Mathematics?

Section 2: Teaching Methods

1. Teaching Approaches:

What teaching methods do you employ when using these instructional materials?

Do you utilize any specific strategies to enhance student interaction with the materials?

2. Adaptation of Materials:

Have you had to adapt the materials in any way to better meet the needs of your students? If so, how?

Section 3: Student Engagement and Outcomes

1. Student Engagement:

How do students respond to the instructional materials used in class?

What are some indicators that suggest students are engaged with the material?

2. Assessment of Learning Outcomes:

How do you assess the effectiveness of the instructional materials on student learning outcomes?

Can you share any data or feedback from students regarding their learning experiences?

Section 4: Challenges and Improvements

1. Challenges Faced:

What challenges do you encounter related to the use of instructional materials in teaching Biology?

How do you address these challenges?

2. Suggestions for Improvement:

In your opinion, what improvements could be made to the instructional materials used in 'A' Level Biology?

Are there additional resources or support you think would enhance teaching and learning?

Section 5: Future Directions

1. Future Trends in Instructional Materials:

How do you see the role of instructional materials evolving in the context of Biology education and STEM?

What innovations do you hope to see in terms of teaching resources in the future?

Closing

- Thank you for their time and valuable insights.