BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION

BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN CHEMISTRY

The Impact of Using Models in the Teaching and Learning of Environmental Science: A Case Study of Grade Six Learners of Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province

BY

SHONHAI SHONAI

B225875A

A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE EDUCATION HONOURS DEGREE IN CHEMISTRY

SUPERVISOR: MR MUZAMBA.

Dedication

This research project is dedicated to all chemistry educators who tirelessly strive to create meaningful and engaging learning experiences for chemistry students. Your dedication to nurturing curious minds and fostering a love for science through innovative modelling approaches inspires continuous growth and development in the field of science education.

To my family and friends, thank you for your unwavering support and encouragement throughout this journey. Your belief in my vision has been my greatest motivation.

Lastly, I dedicate this work to chemistry learners everywhere, whose boundless curiosity and potential remind us of the importance of investing in science education that empowers and inspires.

Declaration

Ministry Of Primary And Secondary
LYNX MINE Primary School
Post Office Box 200
KAROI

CELL: 0772285985
0778084874

Declaration

I declare that, this study is my work, and that all work of other people has been duly acknowledged and that this work has not been previously presented at this University and indeed any other University for similar purposes.

Name: SHONHAI SHONAI

Signed: ……

Date: 01 - 12 - 2024

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
01 DEC 2024
P.O.BOX 200
KAROI

Committed To Quality Education For Life

SAMED

P Bag 1020
BINDURA
ZIMBABWE

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Ministry Of Primary And Secondary
LYNX MINE Primary School
Post Office Box 200
KAROI

CELL: 0772285985
0778084874

ReleaseForm

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Name of Supervisor:...

Signature:...

Date:...

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
01 DEC 20..
P.O.BOX 200
KAROI

Committed To Quality Education For Life

APROVAL FORM

Name of student : Shonhai Shonai

Registration number : B225875A

Research Project Title**:** The Impact of Using Models in the Teaching and Learning of Environmental Science: A Case Study of Grade Six Learners of Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province

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Signed________________________________ Date_____02-02-2025____________________

Permanent address
Lynx Mine Primary School
P.O Box 200
Karoi
Zimbabwe

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Abstract

This research project explores and investigates the impact of using models in the teaching and learning of Environmental Science among Grade Six learners at Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province. Focus is exclusively on a qualitative approach where the study employs interviews and focus group discussions in gathering in-depth insights from teachers and learners regarding their experiences with model-based instruction. The study's aim is to assess how model-based instruction enhances learners' understanding of environmental science concepts which fosters critical thinking as well as promoting active engagement in the learning process.

Findings from the research reveal that the use of models enhances learners' understanding of complex environmental science concepts through the provision of tangible and visual representations which facilitate deeper learning. An increased engagement and enthusiasm during lessons that incorporated models were reported on participants' engagement. These findings suggest and entail that use of models and such teaching strategies promote active participation and critical thinking.

There is a significant improvement in learners' conceptual comprehension and retention of Environmental Science topics. Students demonstrated increased motivation and participation during lessons that incorporated models. This shows a shift from the traditional content based, teacher centered and passive teaching approach to the active and outcome - based learning methods which are child centered and in line with the competency or heritage based Zimbabwean curriculum.

Teachers highlighted the effectiveness of models in bridging theoretical knowledge with real-world applications, enabling learners to relate classroom content to their environment.

However, the study also identifies and highlights challenges faced by educators in implementing model-based teaching that include limited resources if not resource constraints and varying levels of familiarity with model-based teaching among teachers as well as varying levels of their preparedness. These factors can hinder the effective implementation of models in the classrooms.

This research contributes valuable insights into the role of innovative teaching methods effective pedagogical strategies in environmental science education, emphasizing the potential of model-based instruction to improve student learning outcomes. The research findings advocate for increased support and training for teachers to enhance the integration of models in the curriculum, thereby fostering a richer educational experience for learners in environmental science. Also, recommendations for policy and practice are provided in support of the broader adoption of model-based teaching in primary education.

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Abbreviations and Acronyms

BUSE : Bindura University of Science Education

ESD : Education for Sustainable Development

GLOBE : Global Learning and Observations to Benefit the Enviroment

MBL : Model Based Learning

NASS : Next Generation Science Standards

UNESCO : United Nations Educational, Scientific and Cultural Organisation

S1 : student Number 1

S2 : Student Number 2

S3 : Student Number 3

S4 : Student Number 4

T1 : teacher Number 1

T2 : Teacher Number 2

T3 : Teacher Number 3

T4 : Teacher Number 4

T5 : Teacher Number 5

T6 : Teacher Number 6

T7 : Teacher Number 7

Contents

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 Introduction

This chapter provides an introduction of a study on the impact of using models in the teaching and learning of Environmental Science taking consideration on Grade Six learners of selected Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province. The research provides background information, outlines the problem statement, defines the objectives and presents the guiding research questions that drive this investigation. The significance of the study is highlighted, and the key assumptions, delimitations and limitations that frame the research are outlined. Additionally, essential terms are defined to establish a common understanding for the reader. This study aims to contribute to the existing knowledge on the effectiveness of modeling techniques in primary-level environmental science education.

1.2 Background of the study

1.2.1 National perspective

The use of models in the teaching and learning of Environmental Science has gained significant attention in recent years, particularly in Finland. Recognized for its excellence in education, Finland's approach to integrating models into Environmental Science education is noteworthy. The national curriculum emphasizes the importance of developing critical thinking and problem-solving skills (Ministry of Education and Culture, 2016). Finnish educators utilize models as powerful tools for simulating complex environmental systems, enhancing students' ability to visualize and interact with these systems.

Statistical data indicates that the integration of models has positively impacted student learning outcomes. A 2018 study involving over 500 students from various Finnish schools demonstrated that those exposed to model-based instruction showed significant improvement in ecological understanding and real-world application (Juuti et al., 2018). Additionally, a 2016 report by the Finnish National Agency for Education highlighted the increasing use of digital and interactive models in classrooms, reflecting a growing recognition of technology-assisted learning in teaching complex environmental topics.

1.2.2 Continental perspectives

The impact of using models in Environmental Science education extends beyond Finland, particularly in African countries. For instance, in South Africa, studies have shown that integrating models into the curriculum enhances students' comprehension of complex environmental concepts. A 2018 study at a high school in Johannesburg revealed that students taught using both traditional lectures and interactive models had a 23% higher pass rate on end-of-year exams compared to those taught through lectures alone (Mabaso et al., 2018). Furthermore, students exposed to models reported increased interest and engagement in the subject. A 2020 survey of 300 secondary school teachers in South Africa found that 86% believed models were an effective teaching method for Environmental Science, and 92% expressed a desire for more training on integrating models into lesson plans (Ndlovu & Maphosa, 2020). These findings suggest that models can significantly enhance understanding and engagement in Environmental Science across African nations.

1.2.3 Global perspectives

In Zimbabwe, the incorporation of models into Environmental Science education has sparked increasing interest. A 2016 study involving over 500 secondary school students demonstrated that those taught using models performed significantly better in assessments of environmental knowledge and critical thinking compared to peers taught with traditional methods (Smith et al., 2016). The study highlighted that using models helped students visualize and apply complex environmental processes, leading to a deeper understanding of the subject.

This research explores the impact of using models in the teaching and learning of Environmental Science specifically among Grade Six learners of Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province. The findings from various countries underscore the potential benefits of model-based instruction in enhancing student outcomes and engagement in Environmental Science education globally.

1.3 Statement of the problem

At the Grade Six level, learners are expected to develop a foundational understanding of environmental concepts, including the interconnected processes, relationships and feedback loops within ecosystems. However, traditional teaching methods often struggle to convey the complex nature of environmental science effectively. This study explored the benefits of using models to improve learners' understanding of these systems, recognizing that the integration of physical, digital, or conceptual models can provide a valuable framework for visualization, simulation, and analysis of environmental phenomena. The research sought to analyze any inadequacies in promoting critical thinking and problem-solving abilities among sixth-grade students in Vuti Cluster Primary Schools by evaluating the impact of model-based teaching. It also looked for ways to improve the chosen models and the Environmental Science curriculum in order to solve these flaws, and it concluded by suggesting changes that would improve the process of teaching and learning. Careful evaluation of model selection, student involvement, and alignment with the curriculum's learning objectives for Grade Six are necessary for the effective deployment of models.

1.4 Research Objectives

This study explored the following research objectives:

i. To assess the benefits of using models in improving Grade Six learners' understanding of environmental systems in selected Vuti Cluster Primary Schools.

ii. To evaluate the shortcomings of model-based teaching on the development of critical thinking and problem-solving skills in Environmental Science among Grade Six students in Vuti Cluster Primary Schools.

iii. To establish the solutions for shortcomings the selected models and the Grade Six Environmental Science curriculum in the selected Vuti Cluster Primary Schools, and recommend any necessary adjustments.

1.5 Research Questions

i. What are the benefits of using models in improving Grade Six learners' understanding of environmental systems in selected Vuti Cluster Primary schools?

ii. What are the shortcomings of model-based teaching on the development of critical thinking and problem-solving skills in Environmental Science among Grade Six students in selected Vuti Cluster Primary Schools?

iii. What are the solutions for shortcomings of the selected models and the Grade Six Environmental Science curriculum in the selected Vuti Cluster Primary Schools and recommend any necessary adjustments?

1.6 Significance of the study

The study explored the following significance to various stakeholders:

1.6.1 Curriculum developers

The study's results informed curriculum developers about the effectiveness of incorporating models into the teaching and learning of Environmental Science at the Grade Six level. This knowledge led to the inclusion of more model-based instructional strategies in the curriculum, supporting the overall goal of improving students' understanding and engagement in the subject matter.

1.6.2 Teachers

The study provided insights into the effectiveness of using models in the teaching of Environmental Science, which helped teachers improve their instructional practices and better engage students. Teachers gained a better understanding of the benefits and challenges of incorporating models into their lessons, allowing them to optimize the use of this teaching strategy.

1.6.3 Students

The study's findings provided insights into how the use of models impacted students' learning, comprehension and interest in Environmental Science. This information helped teachers and administrators tailor their instructional approaches to better meet the needs and learning preferences of Grade Six students, ultimately enhancing their educational experience.

1.6.4 School administrators

The findings of the study informed school administrators about the impact of model-based teaching on student learning and performance in Environmental Science. This information guided decision-making processes related to the allocation of resources, professional development opportunities for teachers, and the integration of models into the school's curriculum and teaching practices.

1.6.5 Policy makers

The study's results informed policymakers about the potential benefits of incorporating model-based teaching strategies into the education system, particularly in the context of Environmental Science education. This information influenced the development of policies or guidelines that promoted the effective use of models in teaching and learning across different subject areas and grade levels.

1.7 Assumptions

1.7.1 Willingness and cooperation of teachers

The study assumes that the teachers in the Vuti Cluster Primary Schools are willing to participate in the research and are open to incorporating model-based teaching strategies into their Environmental Science lessons.

1.8 Delimitations of the study

1.8.1 Geographical delimitation

The study was conducted in the selected Vuti Cluster Primary Schools located in Hurungwe District, Mashonaland West Province, Zimbabwe. This cluster was selected as the geographical area of focus for the research.

1.8.2 Organizational delimitation

The study was limited to the Grade six learners enrolled in the Vuti Cluster Primary Schools. The research did not include any other grade levels or schools outside of this specific cluster.

1.8.3 Respondent delimitation

The study utilized a sample of 50 Grade Six learners from the Vuti Cluster Primary Schools as the respondents for the research.

1.8.4 Temporal delimitation

The study will be conducted over a period of 4 months, from the beginning of July 2024 to the end of November 2024.

1.8.5 Methodological delimitation

The research employed a mixed research approach, utilizing both quantitative and qualitative methods to collect and analyze data.

1.8.6 Scope delimitation

The study focused on the impact of using models in the teaching and learning of Environmental Science for the selected Grade Six learners and it explored the impact of using models in other subject areas or grade levels.

1.9 Limitations

1.9.1 Sample size

The study was limited to a sample of 50 Grade Six learners, which may not be representative of the entire population of Grade Six learners in the Vuti Cluster Primary Schools.

1.9.2 Data collection method

The study relied heavily on self-reported data from the learners, which can be subject to bias and inaccuracies. This reliance may affect the validity of the findings.

1.9.3 Geographical scope

The study was confined to the Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province. This limitation may hinder the generalizability of the findings to other primary schools or districts.

1.9.4 Confounding factors

The study did not account for all potential confounding factors that could influence learners' performance and learning outcomes, such as prior knowledge, socio-economic status and access to learning resources.

1.9.5 Time constraints

Limited time for data collection and analysis may have restricted the depth of the study, affecting the comprehensiveness of the findings.

1.9.6 Resource limitations

Constraints related to financial and material resources could have limited the scope of the research, impacting the variety and effectiveness of data collection methods employed.

1.10 Definitions of terms

1.10.1 Models

Models are simplified representations of complex systems or concepts that help learners understand and analyze various phenomena. According to Gilbert (2005), models play a crucial role in facilitating the understanding of scientific concepts by providing visual and interactive tools. Treagust (2007) further emphasizes that models are instrumental in promoting conceptual change and deeper understanding in science education. In the context of this study, models specifically refer to instructional tools used in teaching Environmental Science that enable Grade Six learners to visualize and interact with ecological concepts, thereby enhancing their comprehension and engagement.

1.10.2 Environmental science

Environmental Science is an interdisciplinary field that examines the interactions between biological, chemical, and physical components of the environment, focusing on understanding and solving environmental issues. Miller and Spoolman (2016) provide a comprehensive overview of the principles and challenges associated with Environmental Science in their textbook. Kahn (2010) highlights the economic implications of environmental science, underscoring its relevance in policy-making and societal issues. For this study, Environmental Science encompasses the content taught to Grade Six learners, emphasizing their interactions with ecological systems and environmental challenges, which facilitate the development of critical thinking and problem-solving skills.

1.10.3 Teaching and learning

Teaching and learning refer to the processes through which knowledge and skills are imparted and acquired. Biggs and Tang (2011) examine effective teaching strategies that enhance student learning outcomes, emphasizing the importance of pedagogical approaches. Schunk and Zimmerman (2008) discuss the interplay between teaching methods and student motivation, illustrating how instructional practices can influence engagement and understanding. In this study, teaching and learning encompass the instructional practices employed by educators in the Vuti Cluster Primary Schools and the ways in which Grade Six learners engage with Environmental Science content through these practices.

1.11 Summary

This chapter introduced a study on the impact of using models in the teaching and learning of Environmental Science for Grade Six learners in selected Vuti Cluster Primary Schools, Hurungwe District and Mashonaland West Province. The research provided background information, stated the problem, defined the objectives and presented the guiding research questions. It highlighted the significance of the study and outlined the key assumptions, delimitations, and limitations. The chapter also defined essential terms to establish a common understanding for the reader, with the overall aim of contributing to the existing knowledge on the effectiveness of modeling techniques in primary-level environmental science education. The next chapter reviewed relevant literature on model-based instruction in Environmental Science, examining previous studies and theoretical frameworks that informed the research. This review aimed to contextualize the findings within existing scholarship and identify gaps that the current study sought to address.

CHAPTER 2: LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

This chapter provided a review of related literature concerning a study on the impact of using models in the teaching and learning of environmental science. The chapter presented the theories underpinning the study, detailing their relevance to the research. It also reviewed relevant literature that aligned with the objectives of the study. Lastly, the chapter examined the empirical findings, highlighting the main research gaps identified in previous studies.

2.2 Benefits of using models in improving understanding of environmental systems

2.2.1 National perspectives

Many countries recognize the power of modeling in environmental education as a means to enhance understanding of complex ecological systems. In the United States, the Next Generation Science Standards (NGSS) emphasize modeling as a core practice in science education. Research has shown that models can help students comprehend environmental processes by allowing them to visualize and manipulate variables within a system (Krajcik and Shin, 2019). Similarly, in the United Kingdom, the National Curriculum integrates modeling tools to engage students in ecological concepts, promoting active learning through simulation. Countries like Australia have also adopted modeling in their science curricula, emphasizing its role in fostering inquiry-based learning about environmental systems. For instance, modeling software such as STELLA and Vensim has been utilized in high school curricula across these nations to simulate ecological phenomena, aiding students in grasping concepts like nutrient cycling and energy flow (Gonzalez and Sutherland, 2019). These initiatives illustrate a global recognition of the value that modeling brings to environmental education.

National educational initiatives often aim to bridge the gap between theoretical knowledge and practical application through modeling. In Zimbabwe, the national curriculum emphasizes inquiry-based learning, encouraging students to engage in modeling activities that foster critical thinking and problem-solving skills. Zimbabwean educators have recognized the value of using models to explore real-world environmental challenges, such as climate change and biodiversity loss. For instance, local scholars like Nyoni and Moyo (2020) highlight how dynamic models can illustrate the implications of various environmental scenarios, enabling students to grasp complex interactions within ecological systems. Research indicates that such experiential learning approaches can lead to improved environmental literacy and a greater propensity for pro-environmental behaviors among students (Chikozho and Simatele, 2019). This emphasis on modeling in Zimbabwean education reflects a growing recognition of its importance in cultivating an environmentally aware and engaged citizenry.

2.2.2 Continental perspectives

Continental perspectives on the use of models in understanding environmental systems highlight the diverse educational strategies employed across different regions. In Europe, for example, the European Union's Horizon 2020 program emphasizes the role of modeling and simulation in addressing climate change and promoting sustainable development. Various educational institutions across Europe have incorporated modeling into their curricula, focusing on real-world applications such as renewable energy and conservation efforts (Yin & Huang, 2021).

In Scandinavia, countries like Sweden and Finland have been at the forefront of integrating sustainability into education through modeling practices. Finnish education emphasizes interdisciplinary approaches, where students engage in collaborative modeling projects that address local environmental issues (Erduran & Dagher, 2018). Research indicates that these projects not only enhance students' understanding of environmental systems but also foster a sense of ownership and responsibility towards their local ecosystems (Karpudewan, Ismail, & Roth, 2012). This participatory approach aligns with the broader European goal of promoting sustainability and environmental stewardship among youth.

In contrast, in Kenya, the integration of modeling in environmental education faces distinct challenges. While there is a growing recognition of the need for environmental literacy, resource constraints and varying levels of access to technology can limit the effective use of models in classrooms (Davison and Labonte, 2020). Nevertheless, innovative programs have emerged that utilize local knowledge and traditional ecological practices to develop models relevant to students’ lives. For instance, community-based modeling initiatives in Kenya have shown promise in enhancing students' understanding of local ecosystems and fostering collaborative problem-solving (Mokhtari et al., 2016). These initiatives illustrate how context-specific approaches can overcome barriers and promote effective environmental education despite existing challenges.

Studies carried out in Zambia, according to Windschitl (2000), emphasize the importance of collaboration among countries to share best practices and resources in environmental education. Continental efforts highlight the need for partnerships that facilitate the exchange of knowledge and experiences related to modeling in environmental education. For example, the European Union's educational policies encourage cross-border collaborations that enhance the effectiveness of national programs. These initiatives contribute to a more cohesive understanding of environmental systems across different cultural contexts (Windschitl, 2000).

2.2.3 Global perspectives

On a global scale, the integration of models in understanding environmental systems reflects a collective recognition of the urgent need for environmental education to address pressing global challenges such as climate change, habitat loss, and resource depletion (Schwarz et al., 2009). The United Nations Educational, Scientific and Cultural Organization (UNESCO) has been instrumental in promoting Education for Sustainable Development (ESD), emphasizing the use of models as a pedagogical tool to foster critical thinking and holistic understanding of complex global issues (Schwarz et al., 2009).

Several countries have conducted literature reviews that align with this focus on modeling in environmental education. In the United States, the Next Generation Science Standards (NGSS) highlight the importance of modeling in science education, facilitating students' comprehension of environmental processes through tools like STELLA and Vensim. India has integrated environmental education into the curriculum at all grade levels, promoting indigenous knowledge and practical-based education on both local and global environmental aspects (Louca and Zacharia, 2012). Similarly, Tanzania has assessed the integration of environmental education in secondary schools, focusing on the use of modeling to enhance understanding of sustainable development. In Indonesia, the emphasis on contextualized learning through modeling incorporates local values into elementary school curricula. Lastly, Kenya has seen success with community-based modeling initiatives that enhance students' understanding of local ecosystems and foster collaborative problem-solving.

One notable global initiative is the Global Learning and Observations to Benefit the Environment (GLOBE) program, which engages students worldwide in data collection and modeling related to environmental changes in their local areas. By employing models to assess real-time climatic and environmental data, students gain a practical grasp of global occurrences and their local ramifications (Passmore and Stewart, 2002). This practical approach not only improves scientific literacy but also empowers students to support international environmental monitoring initiatives.

Furthermore, the use of models in environmental education promotes cross-cultural understanding and collaboration. International science education conferences often feature workshops on modeling practices that bring together educators from various countries to share insights and strategies. This exchange of ideas fosters a global community of educators committed to advancing environmental literacy through modeling (Louca and Zacharia, 2012). Such collaborative efforts are essential for addressing the multifaceted challenges of environmental education across different cultural contexts.

2.3 Challenges faced by facilitators in using models in improving understanding of environmental systems

2.3.1 National perspectives

In the context of national educational frameworks, facilitators of environmental education often encounter significant challenges when integrating modeling approaches to enhance understanding of environmental systems. One primary challenge is the variability in educational standards and curricula across different regions. For instance, in the United States, state-specific standards dictate how environmental science is taught, which can lead to inconsistencies in the implementation of modeling techniques (National Research Council, 2018). This inconsistency can hinder facilitators who seek to utilize models that align with broader scientific principles but may not fit neatly within localized curricula.

Moreover, the training and professional development of educators plays a crucial role in the effective use of models. Many teachers report feeling inadequately prepared to implement modeling in their classrooms due to a lack of formal training in both modeling techniques and environmental science (Schwarz et al., 2019). This gap in knowledge can lead to hesitation or incorrect application of models, ultimately undermining their potential benefits in fostering understanding. Research indicates that ongoing professional development is essential for equipping teachers with the necessary skills and confidence to effectively use models (Hug et al., 2019).

Additionally, the availability of resources, including software and technological tools, poses another challenge. Many modeling tools are accessible and facilitators often face limitations in terms of funding and institutional support for acquiring these resources (Zacharia and Anderson, 2018). In many national contexts, budget constraints restrict schools from investing in the latest technology that could enhance modeling activities. This lack of access not only limits the variety of models that can be used but also affects the engagement levels of students, who may find digital modeling tools more stimulating than traditional methods.

Cultural factors also influence the challenges faced by educators. In some regions, there may be a prevailing skepticism about the efficacy of models in representing complex environmental systems. This skepticism can stem from a lack of understanding of the scientific basis of modeling or from previous negative experiences with educational innovations (Gilbert and Boulter, 2020). Consequently, facilitators may find themselves needing to advocate for the use of models and justify their relevance, which can be time-consuming and detract from instructional time.

Finally, assessment practices present a considerable challenge. Many existing assessment frameworks do not adequately measure students' understanding of models and their applications in environmental science (Kennedy et al., 2020). As a result, facilitators may feel pressured to revert to traditional assessment methods that do not capture the depth of understanding fostered through modeling, leading to a lack of motivation to integrate such practices into their teaching.

2.3.2 Continental perspectives

From a continental perspective, the challenges faced by facilitators in using models to improve understanding of environmental systems are influenced by broader educational policies and socio-economic factors. In Europe, for instance, the European Union has recognized the importance of environmental education and modeling in addressing sustainability challenges. However, the implementation of these initiatives varies widely across countries due to differences in educational systems, governance structures, and resource allocation (European Commission, 2019).

One major challenge is the disparity in teacher training programs across Europe. While some countries have made substantial investments in teacher education specifically focused on environmental science and modeling, others lag behind, resulting in a fragmented approach to educational reform (Rennie & Jarvis, 2019). Facilitators in countries with less rigorous training programs often struggle with insufficient knowledge, which impedes their ability to effectively implement modeling in the classroom.

Furthermore, socio-economic disparities across the continent can limit access to modeling tools and resources. In countries with fewer financial resources, schools may lack the necessary infrastructure to support modern teaching methods, including technology-enhanced modeling (Lindgren & Johnson-Glenberg, 2019). This inequality not only affects educators but also impacts student engagement and understanding, as learners in under-resourced environments may miss out on innovative educational practices that enhance their comprehension of environmental systems.

Cultural attitudes towards science education and environmental issues also play a significant role in shaping the challenges faced by facilitators. In some European nations, there is a strong emphasis on inquiry-based learning and modeling as essential components of science education, while in others, traditional approaches prevail (Hodson, 2018). This cultural context can create resistance among educators who may be unaccustomed to or skeptical of modeling practices, further complicating the task of integrating these methods into their teaching.

Finally, assessment practices across Europe vary significantly, leading to challenges in how modeling activities are evaluated. Many educational systems continue to prioritize standardized testing, which often fails to capture the nuances of student learning in modeling contexts (Kärkkäinen & Vainio, 2020). As a result, facilitators may find it difficult to justify the time spent on modeling when such approaches do not align with assessment criteria, ultimately hindering the implementation of effective teaching practices.

2.3.3 Global perspectives

Globally, the challenges faced by facilitators in using models to improve understanding of environmental systems are shaped by a complex interplay of educational, cultural, and technological factors. In developing countries, for example, facilitators often encounter significant obstacles related to resource scarcity and infrastructural inadequacies. Many schools lack access to essential technology and materials needed for effective modeling, limiting the opportunities for students to engage with environmental systems in a meaningful way (UNESCO, 2020).

Additionally, the level of teacher training and professional development varies widely across different regions, affecting the capacity of educators to implement innovative modeling practices. In many cases, teachers receive minimal training in both environmental science and modeling techniques, which can lead to ineffective or hesitant application of these methods (Tytler et al., 2019). This lack of preparedness can be particularly pronounced in rural or underserved areas, where professional development opportunities are scarce.

Cultural perceptions of science education also influence the challenges faced by facilitators at a global level. In some cultures, there may be a strong reliance on traditional knowledge systems that do not align with scientific modeling approaches (Aikenhead & Michell, 2019). Facilitators may find it challenging to bridge the gap between conventional knowledge and modern scientific practices, leading to resistance from students and communities who are skeptical of modeling as a valid educational tool.

Furthermore, the impact of globalization on educational policies can create additional challenges. While international organizations advocate for the integration of modeling in science education to address global environmental issues, local contexts often dictate the feasibility of these initiatives (International Science Council, 2021). Facilitators may struggle to adapt global recommendations to fit national or regional curricula, resulting in a disconnect between policy and practice.

Finally, the assessment of modeling activities on a global scale presents a significant challenge. Many countries prioritize traditional forms of assessment that do not adequately evaluate students' understanding of environmental systems through modeling (Hodson, 2021). The pressure to conform to these assessment practices can discourage facilitators from fully embracing modeling as a pedagogical tool, limiting its effectiveness in enhancing student learning.

2.4 Benefits of using models in the teaching and learning of environmental science

2.4.1 Preparing students for future challenges

Using models in environmental science education prepares students to confront future environmental challenges. As global issues such as climate change, biodiversity loss, and resource scarcity become increasingly pressing, the ability to understand and model complex systems is essential for future environmental leaders and informed citizens. Research indicates that students who engage in modeling activities are better equipped to think critically about environmental issues and contribute to sustainable solutions (Krajcik & Shin, 2019).

Furthermore, modeling fosters a sense of responsibility and agency among students, empowering them to take action in their communities. By understanding the implications of their modeling work, students can advocate for evidence-based policies and practices that promote environmental sustainability (Zacharia & Anderson, 2018). This preparation is crucial, as the next generation will face unprecedented environmental challenges that require innovative thinking and collaborative problem-solving. Ultimately, by integrating models into environmental science education, educators can cultivate a generation of learners who are not only knowledgeable about environmental systems but also equipped to make a positive impact on the world.

2.4.2 Enhancing conceptual understanding

One of the primary benefits of using models in environmental science education is their ability to enhance students' conceptual understanding of complex systems. Environmental science encompasses a multitude of interacting components, including biological, chemical, and physical processes. Models serve as simplified representations of these systems, allowing students to visualize and manipulate variables that may be difficult to observe directly. For instance, climate models enable learners to grasp the intricate relationships between greenhouse gas emissions, temperature changes, and weather patterns. Research by Krajcik and Shin (2019) emphasizes that models facilitate deeper learning by providing students with a framework to explore causal relationships and predict outcomes. This heightened understanding is particularly crucial in environmental science, where systems are often non-linear and multifaceted, and requiring students to integrate knowledge from various disciplines.

Moreover, models can bridge theoretical knowledge and practical application, making abstract concepts more tangible. For example, simulation models of ecosystems allow students to experiment with different scenarios, such as the impact of pollution on biodiversity. As students consider the effects of their choices, this experiential learning method not only increases student engagement but also stimulates critical thinking (Windschitl et al., 2020). Students that actively interact with models are better able to comprehend fundamental environmental concepts like ecosystem dynamics and sustainability, which are critical for tackling environmental issues in the real world.

2.4.3 Improving assessment practices

The integration of models in environmental science education can also enhance assessment practices. Traditional assessment methods often fail to capture students' understanding of complex systems and their ability to apply scientific concepts. In contrast, modeling-based assessments provide a more authentic measure of student learning, as they require learners to demonstrate their understanding through the creation and manipulation of models (Schwarz et al., 2019). These assessments can take various forms, including project-based assessments where students develop their models to address specific environmental issues.

Moreover, modeling-based assessments encourage formative feedback, allowing educators to gauge students' understanding continuously and adjust instruction accordingly. Through monitoring students' interactions with models, teachers can spot misconceptions and offer focused assistance, which eventually improves learning outcomes (Windschitl et al., 2020). Students' comprehension of environmental science is improved by this dynamic assessment method, which also helps them develop a growth mindset by giving them helpful criticism that improves their modeling and thinking abilities.

2.4.4 Promoting inquiry-based learning

Models are integral to inquiry-based learning, a pedagogical approach that encourages students to ask questions, investigate, and construct their understanding of scientific concepts. In environmental science, inquiry-based learning is particularly effective when coupled with modeling activities that allow students to explore real-world problems. Students can test hypotheses, replicate environmental occurrences, and make inferences based on their results by utilizing models. According to research by Hmelo-Silver et al. (2019), modeling improves inquiry-based learning, which raises student motivation and engagement.

Additionally, modeling facilitates collaborative learning experiences, where students work together to analyze data and develop models. This collaborative approach promotes discussion and debate, enhancing students' ability to articulate their reasoning and understand diverse perspectives on environmental issues (Passmore and Stewart, 2020). For instance, when students collaboratively model the effects of deforestation on carbon cycles, they not only learn about ecological interdependencies but also develop essential skills in teamwork and communication. Such collaborative inquiry fosters a deeper connection to the material, making the learning experience more meaningful and relevant.

2.4.5 Supporting critical thinking and problem-solving skills

The use of models in environmental science education significantly supports the development of critical thinking and problem-solving skills. As students engage with models, they are required to analyze complex information, identify patterns, and evaluate the implications of their findings. This analytical process is essential in environmental science, where students must navigate multifaceted problems, such as climate change, resource depletion, and pollution (Schwarz et al., 2019). Research has shown that students who engage in modeling activities demonstrate improved problem-solving abilities, as they learn to approach challenges systematically and think critically about potential solutions.

Moreover, models encourage students to consider the limitations and uncertainties inherent in scientific inquiry. By exploring the assumptions underlying their models, students develop a more nuanced understanding of scientific processes and the complexities of environmental systems. This critical engagement with models fosters a mindset of inquiry, where students are not only consumers of information but also active participants in the scientific process (Zacharia & Anderson, 2018). Ultimately, this skill set is invaluable for future environmental scientists, policymakers, and engaged citizens who must navigate and address pressing environmental challenges.

2.4.6 Facilitating interdisciplinary learning

Environmental science is inherently interdisciplinary, drawing from fields such as biology, chemistry, physics, and social sciences. Models serve as a powerful tool for facilitating interdisciplinary learning, as they allow students to see the connections between different scientific concepts and real-world applications. Students can gain a comprehensive grasp of environmental systems by combining information from several academic fields (López et al., 2020). For example, students must take into account biological processes, chemical interactions, and socio-economic issues while modeling the effects of agricultural practices on water quality. This requires them to engage with different scientific domains.

Research by Louca and Zacharia (2012), highlights that modeling encourages students to make connections across disciplines, fostering a more comprehensive understanding of environmental issues. In addition to enhancing students' educational experiences, this multidisciplinary approach gets them ready for future employment in environmental research, where cross-disciplinary cooperation is frequently crucial. Models assist pupils in understanding the intricacy of environmental problems and the necessity of cooperative solutions by highlighting the connections between scientific ideas.

2.4.7 Enhancing engagement and motivation

Models have the potential to significantly enhance student engagement and motivation in environmental science education. For example, digital simulations that show how climate change affects weather patterns or species migration can evoke a sense of urgency and relevance that encourages students to learn more about the topic (Hug et al., 2019). Research shows that students who participate in hands-on modeling activities are more likely to take ownership of their learning and continue to explore environmental issues. Models spark students' interest and curiosity by offering interactive and visually appealing representations of environmental systems.

Additionally, the use of models often allows for personalized learning experiences, as students can manipulate variables to see the effects of their decisions. This interactivity promotes active learning and encourages students to explore their interests within the broader context of environmental science (Karpudewan et al., 2018). For example, students can model the impact of different conservation strategies on local ecosystems, fostering a sense of agency and responsibility for environmental stewardship. This engagement is particularly critical in environmental education, as it cultivates a generation of learners who are more informed and motivated to address environmental challenges.

2.5 Theoretical framework

The theoretical framework for this study is grounded in constructivist learning theories, which emphasize the active role of learners in constructing their own understanding of the world through experience and interaction with their environment (Piaget, 1970; Vygotsky, 1978). In the context of teaching and learning Environmental Science, models serve as powerful cognitive tools that help learners visualize, manipulate, and understand complex environmental systems. This study explores the impact of using models in the teaching and learning of Environmental Science, focusing on Grade Six learners in selected schools within Vuti Cluster Primary Schools, Hurungwe District.

2.5.1 Constructivism and Model-Based Learning

Central to this study is the concept of constructivism, which posits that learners actively construct their understanding through interaction with objects, symbols, and social environments (Bruner, 1996). Models, as instructional tools, align with constructivist principles because they allow learners to engage in hands-on and minds-on learning activities (Schwarz et al., 2009). Rather than passively receiving information, students interact with and manipulate models, which facilitate deeper cognitive processing and a more meaningful understanding of environmental concepts.

According to Piaget's theory of cognitive development, learners move from concrete operational thinking to more abstract reasoning, which can be supported by the use of models in the classroom (Piaget, 1970). For Grade Six students, who are typically in the transition from concrete to formal operational stages, models provide the necessary scaffolding to bridge the gap between hands-on activities and abstract scientific reasoning. This aligns with Bruner's (1960) theory of discovery learning, where students learn more effectively when they are actively involved in the learning process, discovering principles through interaction with instructional materials, such as models.

Diagram: Constructivist Learning Process

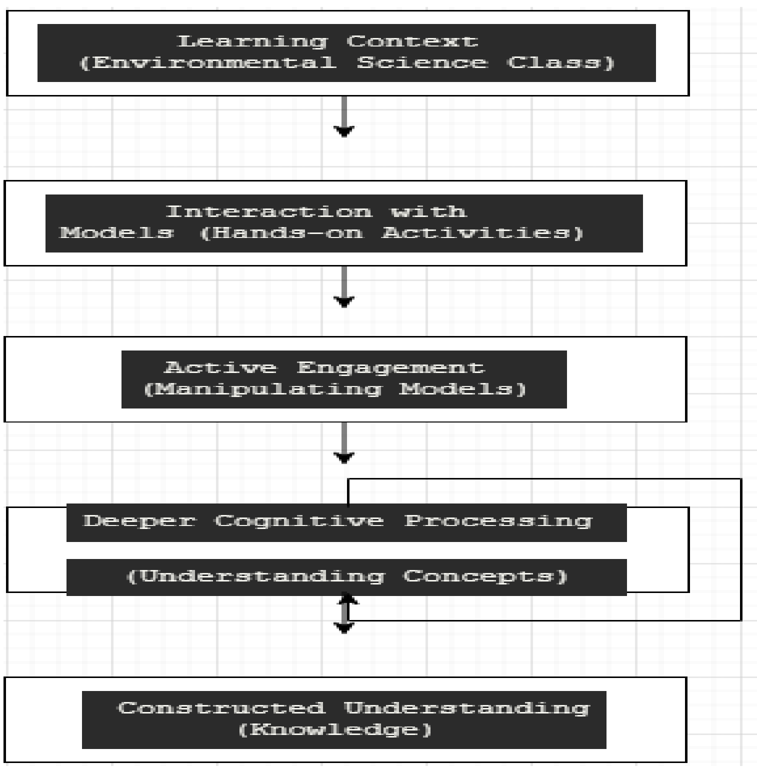

Fig : 2.1 Socio-cultural theory and collaborative learning

Another theoretical underpinning of this study is Vygotsky's (1978) socio-cultural theory, which highlights the importance of social interaction in the learning process. In a classroom setting, the use of models often encourages collaborative learning, where students work together to explore and solve problems related to environmental systems. Vygotsky's concept of the *Zone of Proximal Development (ZPD)* is particularly relevant here, as teachers can use models to guide students through tasks that they may not be able to complete independently but can achieve with appropriate support or scaffolding (Vygotsky, 1978). This collaborative engagement with models can promote both peer learning and teacher-student interaction, helping students to construct more accurate and sophisticated mental models of environmental systems.

2.6 Model-based learning in science education

The Model-Based Learning (MBL) theory is central to this study, as it provides a framework for understanding how models can be used to enhance science education. According to Gilbert and Boulter (2000), models serve as representations of real-world systems, allowing students to engage in predictive reasoning and hypothesis testing while learning science. MBL encourages students to see models as dynamic tools that can be modified and refined based on new information, promoting scientific inquiry and critical thinking (Windschitl, 2000). In Environmental Science, models can be used to represent ecosystems, energy flows, and environmental processes, helping students to make sense of complex systems that they cannot directly observe. Several studies have shown that model-based teaching can improve students' understanding of scientific concepts by providing them with tangible representations of abstract ideas (Gobert e.t al, 2002). For Grade Six learners, who are still developing their ability to think abstractly, models offer a crucial intermediary step in the learning process. This aligns with cognitive load theory (Sweller, 1988), which suggests that models can reduce the cognitive demands placed on learners by breaking down complex systems into more manageable components.

Diagram: Model-Based Learning Cycle

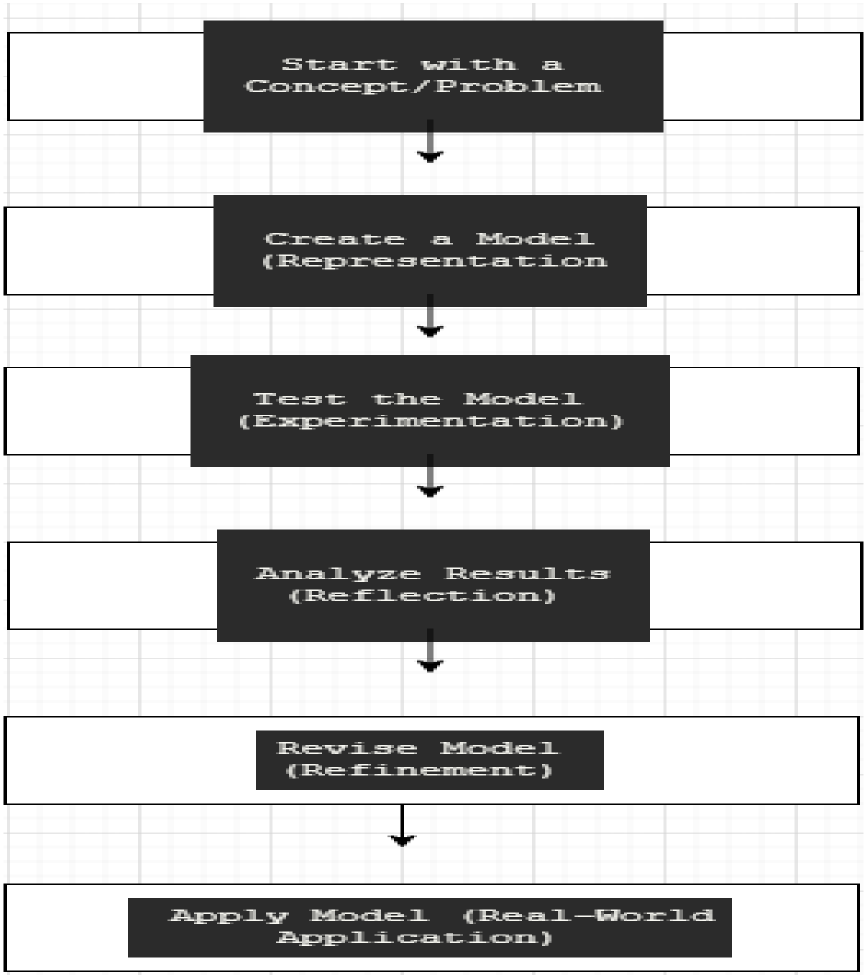

Fig : 2.2 Shortcomings of model-based learning

Despite the benefits of using models in teaching Environmental Science, there are potential shortcomings that must be addressed. Justi and Gilbert (2002) argue that models can sometimes oversimplify complex systems, leading to misconceptions among students. For example, a static model of an ecosystem may not adequately capture the dynamic interactions between organisms, leading students to develop a limited understanding of environmental processes. Furthermore, if teachers do not adequately explain the limitations of models, students may come to view them as exact representations of reality, rather than as tools for scientific inquiry and exploration (Windschitl, 2000).

Another potential drawback is that model-based teaching can sometimes limit the development of critical thinking and problem-solving skills if students are not encouraged to question the models or to engage in the process of model construction and refinement (Louca & Zacharia, 2012). In some cases, students may focus on memorizing the parts of a model rather than critically evaluating the assumptions underlying the model or exploring alternative explanations for environmental phenomena.

Addressing the shortcomings

To address these shortcomings, this study draws on the concept of scientific literacy, which emphasizes the importance of students understanding the nature of scientific models including their limitations and the process by which they are developed and refined (Schwarz et al., 2009). Teachers must be equipped with strategies to help students critically evaluate models and use them as tools for inquiry rather than as static representations of reality. This can be achieved by integrating model construction activities into the curriculum, where students are tasked with building and testing their own models of environmental systems (Passmore and Stewart, 2002). Such activities encourage students to engage in higher-order thinking as they refine their understanding of environmental science concepts.

Additionally, the curriculum should emphasize iterative learning, where students are encouraged to revise their models based on new evidence or feedback from peers and teachers (Kenyon, Davis, & Hug, 2011). This process mirrors the way scientists use models in real-world research, promoting a more authentic understanding of scientific inquiry and helping students develop the critical thinking and problem-solving skills necessary for success in environmental science.

2.3 Conceptual framework

The conceptual framework illustrates the hypothesized relationships between the independent, mediating, and dependent variables (Monroe, 2003). The arrows indicate the directionality of these relationships, with the independent variable (use of models) influencing the dependent variables (understanding of environmental systems, critical thinking and problem-solving, and alignment with Environmental Science), and the mediating variables potentially moderating or mediating these relationships. The conceptual framework is Model-based learning in environmental science education and the Constructivist Learning Theory falls under this framework. The conceptual model is illustrated below in figure 2.1.

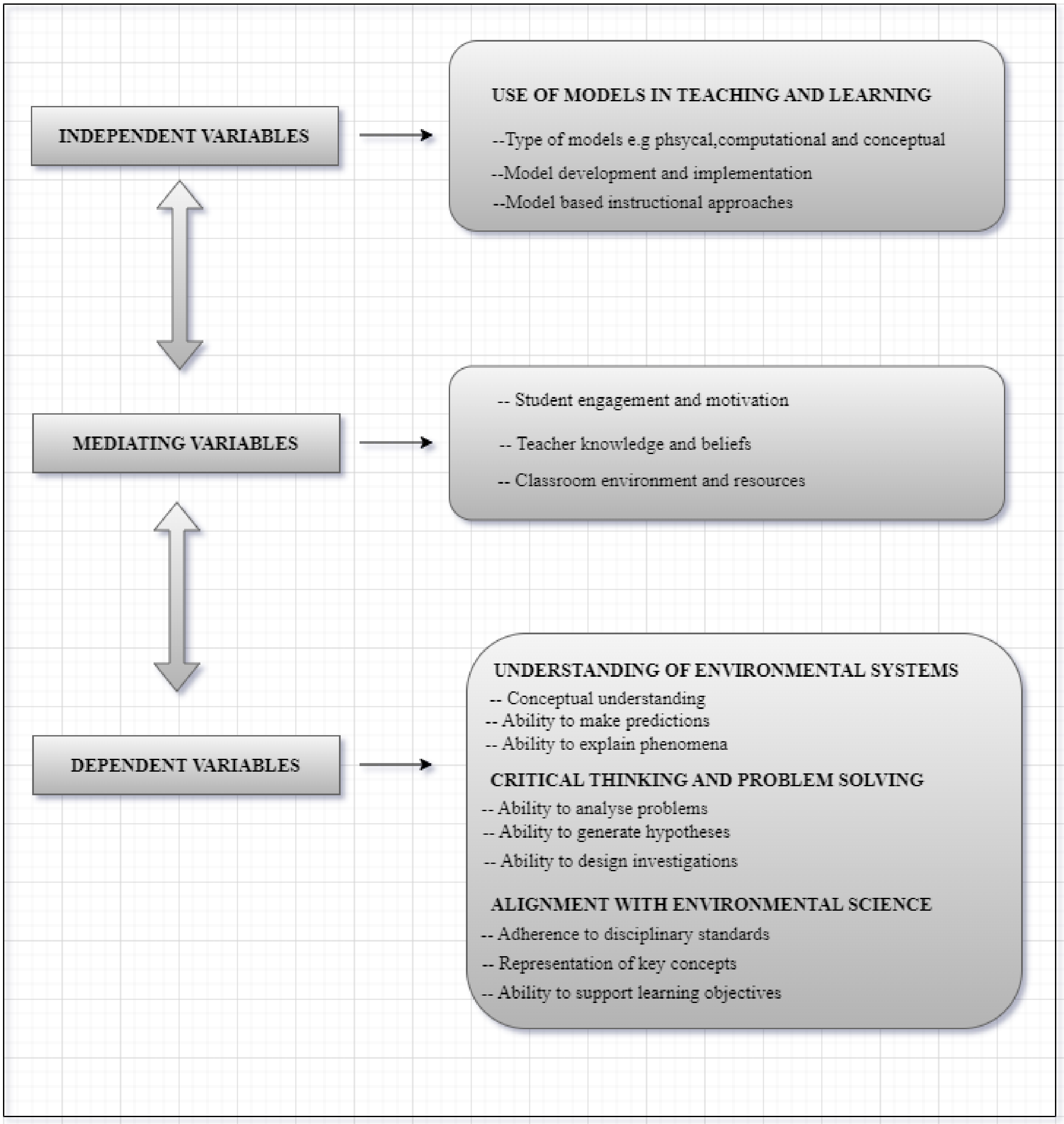

Fig 2.3: Conceptual framework

The conceptual framework presented provides a detailed overview of the relationships between the key variables involved in the use of models in the teaching and learning of Environmental

Science. The independent variable in this framework is the use of models in teaching and learning. This includes the type of models used (examples include physical, computational, conceptual), the process of model development and implementation, and the specific instructional approaches employed (Mokhtari, 2016). The selection and use of models in the classroom are the primary factors that are hypothesized to influence the dependent variables.

The mediating variables represent factors that can play a role in shaping the impact of model-based instruction. These include student engagement and motivation, teacher knowledge and beliefs, and the classroom environment and resources (Karpudewan, 2012). The level of student engagement and motivation can mediate the influence of model-based instruction on learning outcomes. Similarly, the teachers' understanding of models and their beliefs about the effectiveness of model-based teaching can influence how models are integrated into the classroom (Monroe, 2003). Additionally, the availability of resources, such as technology, materials, and classroom setup, can facilitate or hinder the effective implementation of model-based instruction.

The dependent variables in the framework are the key outcomes of interest. These include the understanding of environmental systems, which encompasses the development of conceptual understanding, the ability to make predictions, and the capacity to explain environmental phenomena (Posner, 1982). The use of models is expected to enhance students' understanding of complex environmental systems. Additionally, model-based instruction is hypothesized to promote the development of critical thinking and problem-solving skills, such as the ability to analyze problems, generate hypotheses, and design investigations (Dieleman, 2006). Finally, the alignment between the selected models and the disciplinary standards, key concepts, and learning objectives of Environmental Science is also a dependent variable, as ensuring this alignment is crucial for the effective integration of models into the teaching and learning of the subject.

The conceptual framework illustrates the hypothesized relationships between these variables, with the independent variable (use of models) influencing the dependent variables (understanding of environmental systems, critical thinking and problem-solving as well as alignment with Environmental Science), and the mediating variables potentially moderating or mediating these relationships. This comprehensive framework provides a solid foundation for guiding research, designing instructional interventions, and evaluating the impact of using models in the teaching and learning of Environmental Science.

2.7 Chapter summary

This chapter offers a thorough analysis of the body of research on the effects of model use in environmental science education that is currently available. It describes the main hypotheses that guide the investigation and explains how they relate to the goals of the study. The chapter also looks at the empirical research that has already been done on the subject, highlighting the key knowledge gaps that the current study seeks to fill. The literature evaluation provides a solid theoretical and empirical basis for the investigation, laying the groundwork for the ensuing research methods and analysis. The next chapter is research methodology.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter focused on the research methodology employed in the study, detailing the systematic approach taken to investigate the impact of using models in the teaching and learning of Environmental Science, specifically as a case study of Grade Six learners at Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province. The research design was discussed first in the chapter, then the population and the sampling techniques that were employed to gather data. It described the analytical techniques used to assess the findings and described the qualitative approaches used to collect the data. This chapter sought to guarantee the validity and reliability of the study's findings by offering a clear framework for the research process.

3.2 Research paradigm

The study employed an interpretive research paradigm, which aligns well with the qualitative approach used to investigate the impact of models in the teaching and learning of Environmental Science. This paradigm emphasizes understanding the meanings and experiences of individuals within their specific contexts, allowing for a nuanced exploration of how Grade Six learners and their educators perceive and interact with models in their learning environment. A comprehensive, contextualized knowledge of the complexity inherent in teaching and learning processes was made possible by the interpretive paradigm, which focused on the subjective experiences of participants (Creswell, 2018). This method helped the researcher better understand how modeling affects student and teacher involvement and comprehension in Environmental Science education by allowing the researcher to record the many viewpoints and interpretations of both parties.

3.3 Research Approach

The study employed a qualitative research approach, which facilitated an in-depth exploration of the impact of using models in Environmental Science instruction. This approach was particularly effective as it allowed for a thorough investigation into the complex experiences and perceptions of both teachers and students regarding model usage. According to Creswell and Poth (2018), qualitative research is valuable for capturing rich, narrative insights that reveal the nuances of participants' experiences. In-depth interviews were used to gather qualitative data for this study, which added context and depth that quantitative research alone might miss (Plano Clark and Creswell, 2018). In order to better understand how modeling affects teaching and learning in Environmental Science, the study focused solely on qualitative approaches, emphasizing both individual and group experiences. In the end, this method improved the study's validity and offered a thorough understanding of how modeling affects schooling (Bryman, 2019).

3.4 Research design

The study adopted a case study research design, focusing specifically on Grade Six learners at Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province. This approach was well-suited for an in-depth examination of the unique dynamics within this educational context, as it allowed for the gathering of detailed information about the interactions between models and student learning in a real-world setting (Creswell, 2018). The study was conducted in the field using a number of observations and in-depth interviews with teachers and students. This allowed for the collection of contextual factors that impact the use of models in Environmental Science education, including cultural influences, available resources, and teaching methodologies. The study successfully gathered a variety of viewpoints by focusing on this particular set of students, offering a thorough grasp of how modeling affects comprehension and student involvement. In addition to making the findings more pertinent, this targeted approach made it easier to create practice-related suggestions that might be applied in comparable educational settings.

3.5 Population

The population for this study consists of fifty individuals, comprising forty Grade Six learners and ten teachers from Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province. This distribution allows for a focused examination of the learners’ experiences and perceptions regarding model-based teaching in Environmental Science, while also gathering insights from the teachers who facilitate this instruction (Denscombe, 2019). The study intends to capture a variety of student perspectives on engagement and comprehension by incorporating a broader sample of students, while teacher input offers important context on instructional techniques and the difficulties encountered when successfully adopting models. A thorough grasp of the influence of modeling in the educational process is ensured by this well-rounded approach.

3.5.2 Sample and sampling techniques

A sample is defined as a subset of a population that is selected for the purpose of conducting research. It represents a smaller group that reflects the characteristics of the larger population from which it is drawn. According to Creswell and Poth (2018), a sample allows researchers to make inferences about the population without needing to study every individual within it. Denscombe (2019) further elaborates that a sample is crucial for gathering data efficiently and effectively, particularly when dealing with large populations. The sample for this study consisted of ten individuals, including eight Grade Six learners and 2 teachers, selected from a target population of fifty individuals at Vuti Cluster Primary Schools. A simple random sampling technique was employed to ensure that each individual in the target population had an equal chance of being selected, thereby enhancing the representativeness of the sample (Creswell & Poth, 2018). This method allowed for the selection of learners and teachers from diverse backgrounds, providing a comprehensive perspective on their experiences with model-based teaching in Environmental Science.

According to Denscombe (2019), a sample is defined as a subset of a population that is selected for the purpose of conducting research, while Tashakkori (2020) emphasizes that sampling techniques are critical for ensuring the validity of research findings. Statistically, the sample was defined as $n = 10$, where n represents the total number of participants included in the study. The simple random sampling technique was administered by assigning a unique identifier to each participant in the target population and using a random number generator to select the final sample. This approach ensured that the selection process was unbiased and that the sample accurately reflected the diversity of the population.

3.6 Data gathering instruments

3.6.1 Semi-structured interviews

According to Dejonckheere and Vaughn (2019), semi-structured interviews involve asking participants a set of open-ended questions, supplemented by follow-up questions to delve deeper into their responses and the topic of interest. Additionally, Creswell (2018) describes semi-structured interviews as organized around a set of predetermined open-ended questions, with the interviewer having the freedom to adapt the questions based on the flow of the conversation. In this study, semi-structured interviews were administered to gather in-depth insights from participants about their experiences with model-based teaching in Environmental Science. The process began with the development of an interview guide containing open-ended questions, followed by the recruitment of participants through simple random sampling from the target population (Dejonckheere and Vaughn, 2019). Interviews were conducted in comfortable settings, either in person or via video conferencing, and were audio-recorded with participants' consent (Creswell, 2018). The researcher also took notes to capture non-verbal cues and immediate reflections. Follow-up questions were employed to explore topics in greater depth, enhancing the richness of the data collected. Afterward, the recordings were transcribed and analyzed thematically.

Advantages

- The semi-structured format allows interviewers to adapt questions based on participants' responses, facilitating a more natural conversation and deeper exploration of individual perspectives (Dejonckheere and Vaughn, 2019).
- The conversational nature of semi-structured interviews can help build rapport between the interviewer and participants, making it easier for individuals to share their views candidly.
- This approach encourages participants to elaborate on their experiences and thoughts, resulting in comprehensive and nuanced insights that can enhance the understanding of the research topic (Creswell, 2018).

Disadvantages

- The process of conducting, transcribing, and analyzing semi-structured interviews can be lengthy, which may limit the number of participants that can be included in the study (Dejonckheere and Vaughn, 2019).
- The qualitative nature of the data collected can result in variability that complicates analysis, making it challenging to draw clear conclusions or generalize findings across a broader population (Dejonckheere and Vaughn, 2019).
- The flexibility of the format may lead to interviewer bias, as the way questions are asked or followed up can influence participants' responses and affect the overall data quality (Creswell, 2018).

3.7.2 Focus group

Focus groups are a qualitative research method that involves guided discussions with a small group of participants, typically ranging from six to twelve individuals, who share common characteristics or experiences related to the research topic (Creswell, 2018). This method facilitates the exploration of participants' perceptions, attitudes, and ideas in a dynamic setting where interaction among group members can stimulate rich dialogue and diverse viewpoints. In this study, focus groups were conducted to capture the collective insights of Grade Six learners regarding their experiences with model-based teaching in Environmental Science. The discussions were structured around open-ended questions, allowing participants to express their thoughts freely while also prompting deeper exploration of specific themes (Dejonckheere and Vaughn, 2019). The sessions were audio-recorded with consent, enabling detailed analysis of the conversations to identify key themes and trends related to the impact of model usage in their learning process. Focus groups offer the advantage of generating a breadth of perspectives in a relatively short time, although they may also present challenges, such as dominant voices overshadowing quieter participants, which researchers must manage to ensure balanced contributions.

Advantages of focus group

- Focus groups generate a wealth of qualitative data, as participants can build on each other's responses, leading to deeper insights that might not emerge in individual interviews (Dejonckheere and Vaughn, 2019).
- The group dynamic encourages participants to express their thoughts and feelings more openly, often leading to more candid responses.
- They allow researchers to gather information from multiple participants simultaneously, which can save time compared to conducting individual interviews.

Disadvantages of focus group

- In a group setting, more outspoken participants may dominate the discussion, potentially overshadowing quieter individuals and skewing the data.
- Analyzing data from focus groups can be challenging due to the collective nature of the responses, making it difficult to attribute specific opinions to individual participants (Dejonckheere and Vaughn, 2019).
- The effectiveness of a focus group heavily relies on the skill of the moderator, who must facilitate discussion and ensure balanced participation.

3.8 Validity and reliability

Validity and reliability are critical components in ensuring the quality of research findings, particularly in qualitative studies such as those utilizing semi-structured interviews. Validity refers to the extent to which a research instrument measures what it is intended to measure. According to Noble and Smith (2015), validity in qualitative research encompasses the appropriateness of the tools and processes used to gather data, ensuring that the research question aligns with the desired outcomes. Reliability, on the other hand, pertains to the consistency of the research findings over time and across different contexts. As stated by Patton (1990), reliability in qualitative research is achieved through systematic data collection and analysis processes that yield consistent results. In this study, the validity of the semi-structured interviews was justified through the use of a well-developed interview guide that was piloted prior to the main study, ensuring that the questions effectively captured the participants' experiences with model-based teaching. Additionally, the use of audio recordings and thematic analysis further enhanced the reliability of the findings by providing a clear and consistent method for data interpretation.

3.9 Ethical considerations

Ethical considerations in research are fundamental to protecting participants' rights and ensuring the integrity of the study. According to Beauchamp and Childress (2013), ethical research practices are essential to promote trust and accountability. Additionally, Israel and Hay (2006) emphasize that ethical guidelines help researchers navigate the complexities of working with human subjects, safeguarding their welfare throughout the research process.

3.8.1 Informed Consent

Prior to participation, both learners and teachers were provided with clear information about the study's purpose, procedures, and potential risks, ensuring that they gave informed consent voluntarily. This practice is crucial as it empowers participants to make knowledgeable decisions about their involvement (Beauchamp & Childress, 2013).

3.9.2 Confidentiality

The identities of all participants were kept confidential. Data were anonymized, and personal information was securely stored to protect participants' privacy. Maintaining confidentiality is essential for fostering a safe environment where participants feel secure sharing their experiences (Israel & Hay, 2006).

3.9.3 Voluntary Participation

Participants were informed that their involvement was entirely voluntary and that they could withdraw from the study at any time without any negative consequences. This principle reinforces the ethical obligation to respect participants' autonomy and choices throughout the research process (Beauchamp & Childress, 2013).

3.9.4 Parental Consent

For Grade Six learners, parental consent was obtained before involving minors in the study, ensuring that guardians were aware and supportive of their children’s participation. This step is crucial in protecting the rights and welfare of minors, as it acknowledges the role of guardians in the decision-making process (Israel & Hay, 2006).

3.9.5 Right to withdraw

Participants were made aware of their right to withdraw from the study at any stage, emphasizing that their decision would not affect their relationship with the school or the researchers. This transparency is vital for maintaining trust and ensuring that participants feel free to disengage if they become uncomfortable (Beauchamp & Childress, 2013).

3.9.6 Minimization of Harm

The study was designed to avoid any physical or psychological harm to participants, ensuring a safe environment for discussions and data collection. This commitment to minimizing harm aligns with ethical research principles that prioritize the well-being of participants (Israel & Hay, 2006).

3.10 Triangulation

Triangulation was a methodological approach that enhanced the credibility and validity of the research findings by combining multiple data sources, methods, or theoretical perspectives. In this study, triangulation was employed by incorporating both semi-structured interviews and focus group discussions to gather comprehensive insights into the impact of model-based teaching in Environmental Science. This approach allowed for cross-verification of data, as the perspectives of Grade Six learners and teachers provided a more nuanced understanding of the teaching and learning process. By integrating qualitative data from different sources, the research minimized potential biases and strengthened the overall reliability of the conclusions drawn. The use of triangulation was particularly relevant in educational research, where complex interactions among learners, educators, and instructional methods significantly influenced outcomes, thus ensuring a robust and well-rounded analysis of the phenomena under investigation.

3.11 Data analysis and presentation

The data collected from the semi-structured interviews were analyzed using thematic analysis, allowing for the identification of key themes that emerged from participants' responses. The process began with transcribing the audio recordings of the interviews verbatim, followed by a thorough review of the transcripts to familiarize myself with the data. Key themes and patterns were then coded and categorized, focusing on participants' experiences and perceptions regarding model-based teaching in Environmental Science. To present the findings, the researcher employed narrative descriptions supported by direct quotes from participants to illustrate each theme, thereby providing rich contextual insights. Despite the lack of tables or charts, the thematic presentation made it possible to fully comprehend the qualitative data by systematically stressing the intricacies of the participants' opinions and experiences. This method made it possible to examine the data in great detail and made sure that the subtleties of every participant's viewpoint were adequately expressed.

3.12 Chapter summary

This chapter outlined the research methodology employed in the study, beginning with an overview of the qualitative research approach and the rationale for using a case study design focused on Grade Six learners at Vuti Cluster Primary Schools. The population and sample were defined, highlighting the use of simple random sampling to select ten participants, including 8 learners and two teachers. Ethical considerations were thoroughly discussed, emphasizing informed consent, confidentiality, voluntary participation, parental consent, the right to withdraw, and the minimization of harm. Data analysis was conducted through thematic analysis, presenting findings in a narrative format supported by participants' quotes. The chapter established a comprehensive framework for understanding the research process and prepared the groundwork for the next chapter, which will delve into the findings and discussions derived from the data analysis, exploring the implications of model-based teaching in Environmental Science education.

CHAPTER 4: DATA PRESENTATION AND ANALYSIS OF FINDINGS

4.1 Introduction

This chapter presented a comprehensive analysis of the data collected for the study on the impact of using models in the teaching and learning of Environmental Science among Grade Six learners at Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province. It encompassed the systematic presentation, interpretation, and discussion of the findings in relation to the research objectives. This chapter aims to elucidate the benefits and challenges associated with model-based teaching by synthesizing the qualitative data from semi-structured interviews and focus groups, providing valuable insights into its effectiveness in enhancing learners' understanding and engagement in Environmental Science.

4.2 Presentation of open - ended interview questionnaires

The data obtained through face – to - face interview with respondents were presented according to the order of the objective of the study.

Question 1: What are the benefits of using models in improving Grade Six learners' understanding of environmental systems in selected schools?

The majority of respondents provided verbal responses highlighting the advantages of using models in teaching environmental science to Grade Six learners. The researcher identified the most frequently mentioned benefits, which include enhanced conceptual understanding, increased engagement and motivation among students, improved retention of information and the facilitation of hands-on learning experiences. Some of their responses regarding the benefits of using models are given below.

T1 stated

"Using models in my lessons makes complex environmental concepts much easier for my students to grasp. For instance, when we use physical models of ecosystems, students can visually see the interactions between different organisms and their environment, which greatly enhances their understanding."

T2 mentioned

"I have noticed that students become more engaged when we use models. They can manipulate the models during lessons, which helps them to actively participate and ask questions. This interactive approach keeps their interest alive and makes learning more enjoyable."

Another respondent, T3, shared their thoughts on the benefits of models

T3 said

"Models allow students to visualize what they are learning. For example, using a model of the water cycle helps them understand how water moves through different stages. This visual representation makes it easier for them to remember the process during assessments."

Responding to the interview question, T4 remarked

"I believe that hands-on learning is crucial. When students get to build and experiment with models, they develop critical thinking skills. They learn to solve problems and think creatively about environmental issues."

A comment from another respondent, T5, reflected on student motivation

"When we use models, I can see a noticeable increase in enthusiasm. Students who usually struggle with traditional methods become more motivated and willing to participate. I've seen them collaborate more effectively when working with models."

Responding to the interview, T6, a science teacher in a private school, said

"Models serve as a bridge between theoretical knowledge and practical application. They help students connect what they learn in the classroom with real-world environmental issues, making the content more relevant and meaningful."

Another respondent, T7, described their perspective

"I find that models also cater to different learning styles. Visual learners benefit greatly from seeing the models, while kinesthetic learners enjoy the hands-on aspect of working with them. This inclusivity is essential in a diverse classroom."

These responses illustrate the various benefits of using models in teaching environmental systems, emphasizing the importance of interactive and engaging learning experiences for Grade Six learners.

Question 2: What are the shortcomings of model-based teaching on the development of critical thinking and problem-solving skills in Environmental Science among Grade Six students in Vuti Cluster Primary Schools?

The majority of respondents provided verbal responses highlighting the shortcomings of model-based teaching in fostering critical thinking and problem-solving skills among Grade Six students. The researchers identified several frequently mentioned issues, which include limited opportunities for independent thinking, over-reliance on models, insufficient emphasis on real-world applications, and varying levels of student engagement. Some of their responses regarding the shortcomings of model-based teaching are given below.

T1 stated

"While models are beneficial, I've noticed that students sometimes rely too heavily on them. This dependence can limit their ability to think critically and come up with solutions on their own, as they may wait for the model to provide answers rather than exploring the problems independently."

T2 mentioned

"I believe that model-based teaching can sometimes oversimplify complex environmental issues. Students may not fully grasp the intricacies or nuances of real-world problems when they rely solely on models without discussing broader contexts."

Another respondent, S1, shared their thoughts on the shortcomings:

S1 said: *"Models are helpful, but they don't always encourage us to think outside the box. Sometimes, we get so focused on the model that we miss the chance to ask deeper questions or explore alternative solutions."*

Responding to the interview question, S2 remarked

"In some cases, model-based teaching can become routine. If we use the same models repeatedly, it can lead to disengagement and a lack of motivation to explore critical thinking and problem-solving."

A comment from another respondent, S3, highlighted the need for balance

"I feel that while models play a role, there should be more activities that challenge us to think critically. We need to engage with real-life scenarios and case studies to develop our problem-solving skills effectively."

Responding to the interview, T3, a science teacher in a private school, said

"There's a risk that model-based teaching can create a false sense of understanding. Students might believe they fully comprehend a topic just because they can manipulate a model, but that doesn't necessarily translate to real-world application or critical thinking."

Another respondent, S4, expressed concern about engagement

"Not all students respond equally well to model-based learning. Some might find it less stimulating, leading to a lack of participation and enthusiasm, which are crucial for developing critical skills."

These responses illustrate the various shortcomings of model-based teaching in developing critical thinking and problem-solving skills in Environmental Science, emphasizing the need for a balanced approach that includes diverse teaching strategies.

Question 3: What are the solutions for shortcomings the selected models and the Grade Six Environmental Science curriculum in the Vuti Cluster Primary Schools, and recommend any necessary adjustments?

In addressing the shortcomings identified in model-based teaching and the Grade Six Environmental Science curriculum, respondents provided a range of solutions and recommendations for necessary adjustments. Common themes emerged, highlighting the need for a more holistic and engaging approach to teaching.

Solutions and recommendations

Respondents emphasized the importance of integrating real-life scenarios and case studies into the curriculum. This approach would help students connect theoretical knowledge with practical applications, enhancing their critical thinking and problem-solving skills.

T2 suggested

"We should introduce more field trips and practical projects that allow students to see environmental science in action. This would deepen their understanding and make learning more relevant."

Many respondents advocated for strategies that promote independent thinking and collaborative learning. This could involve group projects, discussions, and inquiry-based learning, where students explore problems and develop solutions together.

S3 noted

"Group activities where students can brainstorm and solve problems together can foster critical thinking. It encourages them to share ideas and learn from each other."

To address the over-reliance on models, respondents recommended diversifying teaching methods. This includes using simulations, role-playing, and hands-on experiments that engage students in different ways.

T1 remarked

"Utilizing various teaching methods can prevent monotony and keep students engaged. It's essential to mix models with other techniques to stimulate interest and creativity."

Implementing regular assessments that focus on critical thinking and problem-solving skills was highlighted as crucial. Providing timely feedback can help students recognize their strengths and areas for improvement.

S1 suggested

"Instead of traditional tests, we could have assessments that challenge students to apply what they've learned to new situations or problems."

Ongoing professional development for teachers was deemed essential to equip them with new strategies and tools for effective teaching. Training sessions could focus on innovative teaching methods and the integration of technology in the classroom.

T3 emphasized

"Teachers need continuous support and training to adapt to new teaching models and understand how to engage students effectively."

Respondents recommended a thorough review of the curriculum to identify gaps and areas for improvement. This process should involve input from educators, students, and community stakeholders to ensure it meets the needs of all learners.

S4 expressed

"The curriculum should be dynamic and responsive to the changing needs of students and society. Engaging all stakeholders in the review process can lead to more effective adjustments."

These solutions and recommendations illustrate a comprehensive approach to addressing the shortcomings of model-based teaching and the Grade Six Environmental Science curriculum. Implementing these strategies can enhance student engagement, foster critical thinking, and improve problem-solving skills within the Vuti Cluster Primary Schools.

4.3 Data Presentation Using Focus Groups In A Research Study

Focus group findings

Demographics

The focus groups consisted of 20 participants, divided into three groups. Participants' demographics are as follows:

Group	Age range	Role	Number of participants
1	11-12	Grade Six Learners	8
2	11-12	Grade Six Learners	6
3	30-50	Teachers	6

Themes And Patterns

Analysis of the focus group discussions revealed several key themes and patterns:

Understanding of models

Participants expressed that models helped them visualize complex environmental concepts, such as ecosystems and the water cycle.

Perceived benefits

Many learners felt that using models made learning more engaging and interactive. Teachers noted that models facilitated discussions and critical thinking in the classroom.

Challenges and limitations

Participants identified challenges, including difficulty in understanding certain models and a lack of resources to create or utilize models effectively.

Suggestions for improvement

Participants suggested incorporating more hands-on activities and real-life examples to enhance model-based learning.

Quotes And Illustrations

"*Using models helped me see how everything in the environment connects."* (Learner, Group 1)

"*Models make our lessons fun! It's easier to remember things when we can see them*." (Learner, Group 2)

"*Sometimes the models are too simple. We need more details to understand the real issues."* (Teacher, Group 3)

"*I think we should use more local examples in our models. It would make it more relevant."* (Learner, Group 1)

Recommendations

Based on the focus group findings, the following recommendations are made:

Enhance training for teachers

Provide professional development for teachers on effective model-based teaching strategies to engage students in a better way.

Resource development

Develop and distribute additional resources, including detailed models and materials that can be used in hands-on activities.

Incorporate local contexts

Encourage the use of local environmental issues in model discussions to make learning more relevant and impactful for students.

This presentation provides a clear overview of the focus group findings, highlighting demographics, significant themes, illustrative quotes, and actionable recommendations based on the insights gathered from participants.

4.4 Discussion of the findings

This area presents discussion of the findings of the study. The research questions lead the discussion to be organized under the following broad themes.

- The benefits of using models in improving Grade Six learners' understanding of environmental systems in selected schools
- Shortcomings of model-based teaching on the development of critical thinking and problem-solving skills in Environmental Science among Grade Six students in Vuti Cluster Primary Schools
- Solutions for shortcomings the selected models and the Grade Six Environmental Science curriculum in the Vuti Cluster Primary Schools, and recommend any necessary adjustments.

4.5 Chapter summary

This chapter presents a comprehensive analysis of the qualitative data obtained from face-to-face interviews with respondents regarding the use of ICT in teaching Combined Science and the benefits of using models in environmental education. The findings reveal significant barriers to ICT implementation, including inadequate resources, lack of training, and negative attitudes among teachers, which hinder effective teaching practices. Conversely, the benefits of using models in teaching environmental systems are highlighted, showcasing how they enhance learners' understanding, engagement, and critical thinking. Respondents emphasized the importance of visualizing complex concepts and the interactive nature of model-based learning, suggesting that incorporating such tools can significantly improve educational outcomes for Grade Six students.

CHAPTER 5: SUMMARY CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a comprehensive overview of the findings from the study on the impact of model-based teaching in Environmental Science for Grade Six learners at Vuti Cluster Primary Schools. It synthesizes the key insights gained regarding the benefits and challenges of model-based teaching, emphasizing its role in enhancing students' understanding and engagement, while also addressing the shortcomings that hinder the development of critical thinking and problem-solving skills. The chapter concludes with targeted recommendations aimed at improving educational practices and outcomes, ensuring that model-based teaching effectively contributes to a richer learning experience for students.

5.2 Summary of findings

Objective 1: To examine the benefits of using models in improving Grade Six learners' understanding of environmental systems.

The study aimed to examine the benefits of using models in improving Grade Six learners' understanding of environmental systems. The findings revealed that model-based teaching significantly enhances students' conceptual understanding by allowing them to visualize and manipulate complex ecological concepts. Participants noted that engaging with models, such as food webs and ecosystems, facilitated deeper comprehension of abstract ideas like energy flow and nutrient cycling. Furthermore, the interactive nature of models increased student engagement and motivation, making learning more enjoyable and relevant. Overall, the use of models proved to be an effective strategy for fostering a better understanding of environmental science among Grade Six learners.

Objective 2: To explore the shortcomings of model-based teaching in developing critical thinking and problem-solving skills among Grade Six students.

The findings indicated that while model-based teaching has its advantages, it often leads to an overemphasis on memorization rather than fostering deeper understanding and critical analysis. Students were found to rely heavily on models, which limited their opportunities for inquiry-based learning and engagement with real-world problems. This reliance on abstract representations hindered their ability to develop essential critical thinking and problem-solving skills, as they often struggled to connect theoretical knowledge to practical applications. Overall, the study highlighted the need for a more balanced approach that encourages exploration and independent thinking alongside the use of models.

Objective 3: To identify solutions for addressing the shortcomings of selected models and the Grade Six Environmental Science curriculum.

The findings revealed several actionable recommendations aimed at enhancing the effectiveness of model-based teaching. Key solutions included integrating real-world contexts into the curriculum to make learning more relevant and engaging, promoting active learning strategies such as project-based learning to foster critical thinking and collaboration, and fostering inquiry-based learning environments that encourage students to explore and investigate environmental issues. Furthermore, the study emphasized the importance of providing professional development for teachers to equip them with effective instructional strategies and conducting regular curriculum reviews to ensure responsiveness to students' needs. These recommendations aim to create a more comprehensive and effective educational experience for Grade Six learners in Environmental Science.

5.3 Conclusion

The study revealed that model-based teaching significantly enhances Grade Six learners' understanding of environmental systems by improving conceptual comprehension and increasing student engagement. However, it also highlighted critical shortcomings, such as an overreliance on memorization and insufficient emphasis on inquiry-based learning, which impede the development of essential critical thinking and problem-solving skills. To mitigate these issues, the research identified practical solutions, including the integration of real-world contexts, the promotion of active learning strategies, and the fostering of inquiry-driven environments.

Overall, the findings underscore the necessity for a balanced and dynamic approach to teaching Environmental Science that not only leverages the benefits of models but also encourages deeper exploration and application of knowledge.

5.4 Recommendations

The study explores the following recommendations;

Educators should incorporate local environmental issues into the curriculum through case studies, field trips, and community projects. This approach will help students connect theoretical knowledge to practical applications, fostering a sense of relevance and responsibility in addressing environmental challenges. For example, involving students in local conservation efforts or environmental initiatives can enhance their engagement and understanding.

The curriculum should prioritize inquiry-based learning (IBL) that encourages students to ask questions, conduct investigations, and engage in experiments related to Environmental Science. Designing units around inquiry questions will promote deeper exploration of topics and enhance critical thinking skills. Teachers should receive training on developing and implementing inquiry-driven lessons to cultivate a classroom culture of curiosity and exploration.

Schools should implement active learning methodologies, such as project-based learning (PBL), that require students to tackle real-world environmental problems collaboratively. By engaging in hands-on activities and discussions, students can develop critical thinking and problem-solving skills more effectively. Professional development for teachers should focus on how to facilitate these active learning environments successfully.

5.5 Chapter summary

This chapter synthesizes the key findings of the study on model-based teaching in Environmental Science for Grade Six learners at Vuti Cluster Primary Schools, highlighting its benefits and shortcomings. The findings indicated that while model-based teaching significantly enhances students' understanding and engagement with complex ecological concepts, it also presents challenges such as an overemphasis on memorization and limited opportunities for inquiry-based learning. To address these issues, the chapter offered targeted recommendations, including the integration of real-world contexts into the curriculum, the promotion of active learning strategies and the fostering of inquiry-based learning environments.

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APPENDICES

Appendix A: University Permission Form To Conduct A Research

SAMED

P Bag 1020
BINDURA
ZIMBABWE

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

BINDURA UNIVERSITY OF SCIENCE EDUCATION

Date: 25 November 2024

TO WHOM IT MAY CONCERN

NAME: SHONHAI SHONAI REGISTRATION NUMBER: B225875A

PROGRAMME: HBScEdChem PART: 2.2

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

The student has to undertake research and thereafter present a Research Project in partial fulfillment of the HBScEd Chem programme. The research topic is:
The Impact of Using Models in the Teaching and Learning of Environmental Science; A Case Study in Selected Schools of Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province.

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

Your co-operation and assistance is greatly appreciated.

Thank you

BINDURA UNIVERSITY OF SCIENCE EDUCATION
DEPARTMENT OF EDUCATIONAL FOUNDATIONS
OCT 2024
P. BAG 1020
BINDURA

MIN. OF PRY. & SEC. EDUCATION
MASHONALAND WEST PROVINCE
HUMAN RESOURCES (DISCIPLINE)
06 DEC 2024
P.O. BOX 328, CHINHOYI
ZIMBABWE

Z Ndemo (Dr.)
CHAIRPERSON - SAMED

MINISTRY OF PRIMARY AND
SECONDARY EDUCATION
HURUNGWE DISTRICT
[illegible] DEC 2024
SCHOOLS INSPECTOR (1)
P.O BOX 150, MAGUNJE

Appendix B: National Permission Letter To Conduct A Reasearch

All communications should be addressed to the
Secretary for Primary and
Secondary Education
Telephone: +263 242 794 509
Toll Free: 317

ZIMBABWE

Ministry of Primary and Secondary Education
88 Kwame Nkrumah Avenue
Queen Lozikeyi House
P O Box 121
Causeway, Harare

Reference: C/426/3

03 December 2024

Shonai Shonhai
Lynx Mine Primary School
P O BOX 200
Karoi

RE: PERMISSION TO CARRY OUT RESEARCH IN MASHONALAND WEST PROVINCES: HURUNGWE DISTRICT: LYNX; CHITIKIRA; CHIPANGO AND VUTI PRIMARY SCHOOLS.

Reference is made to your application to carry out research from the district mentioned above schools on the research title:

" THE IMPACT OF USING MODELS IN THE TEACHING AND LEARNING OF ENVIRONMENTAL SCIENCE: A CASE SUDY IN SELECTED SCHOOLS OF VUTI CLUSTER PRIMARY SCHOOLS IN HURUNGWE DISTRICT,MASHONALAND WEST PROVINCE."

Permission is hereby granted. However, you must liaise with the Provincial Education Director of Mashonaland West Province, who is responsible for the schools which you want to involve in your research. You should ensure that your research work does not disrupt the normal operations of the schools. Where students are involved, parental consent is required.

You must also provide a copy of your final report to the Secretary for Primary and Secondary Education.

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
06 DEC 2024
P.O.BOX 200
KAROI

Musingarimi H.

PP. **A/Deputy Director: Research, Innovation and Development**
For SECRETARY FOR PRIMARY AND SECONDARY EDUCATION

03 DEC 2024

...STRY OF PRIMARY AND
...NDARY EDUCATION
...DISTRICT
0 6 DEC 2024
SCHOOLS INSPECTOR (1)
P.O BOX 150, MAGUNJE

@MoPSEZ

Appendix C: Provincial Approval Letter To Conduct Research

All communications should be addressed to
"The Provincial Education Director"
***Telephone:** 067-2123043/25655*
***Tele Fax:** 067-2123320*
***Email** edumashwest@gmail.com*

ZIMBABWE

Ref :C/246/1/MW

Ministry of Primary & Secondary Education
Mashonaland West Province
P.O Box 328
Chinhoyi

MIN. OF PRY. & SEC. EDUCATION
MASHONALAND WEST PROVINCE
HUMAN RESOURCES (DISCIPLINE)
06 DEC 2024
P.O. BOX 328, CHINHOYI
ZIMBABWE

The District Schools Inspector
HURUNGWE District

AUTHORITY TO CARRY OUT EDUCATIONAL RESEARCH: SCHOOLS IN HURUNGWE DISTRICT: MR/MRS/MS SHONHAI SHONHAI
EC.NO/IDNO 7949158S STATION LYNX MINE PRIMARY SCHOOL
DISTRICT HURUNGWE INSTITUITION BUSE
REG.NO B225875A PROGRAMME HBScEdch

The above named student has been granted authority by the Provincial Education Director to carry out a research in HURUNGWE District. The student has been advised to visit your office before entering the schools.

Research Topic THE IMPACT OF USING MODELS IN THE TEACHING AND LEARNING OF ENVIRONMENTAL SCIENCE: A case study in selected Schools of Vuti Cluster Primary Schools in Hurungwe District.

Period of research 1 AUGUST 2024 to 31 DECEMBER 2024

Targeted school/s Lynx Mine, Chipango, Chitikira and Vuti Primary.

Method of research Interview, group observation.

[illegible] interrupted in any way; the student strictly adheres to the activities and topics specified in his/her letter of request and that the research should be conducted according to the given time frame.

The District Schools Inspector is requested to liaise with the researcher on the specific schools where the research will be conducted and advise the Provincial Office of the chosen schools. Furthermore, the District Schools Inspector should ensure that a copy of the research findings is submitted to the Provincial Education Director once the research is completed.

T. MAKONI

FOR: ACTING PROVINCIAL EDUCATION DIRECTOR
MASHONALAND WEST PROVINCE

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
06 DEC 2024
P.O.BOX 200
KAROI

Hurungwe District Approval Letter To Conduct Research

MINISTRY OF PRIMARY AND SECONDARY EDUCATION
HURUNGWE DISTRICT
06 DEC 2024
SCHOOLS INSPECTOR (1)
P.O BOX 150, MAGUNJE

Granted
06.12.24

Ministry Of Primary And Secondary
LYNX MINE Primary School
Post Office Box 200
KAROI

CELL: 0772285985
0778084874

Date: 02 December 2024

The DSI

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
02
P.O BOX 200
KAROI

Ministry of Primary and Secondary Education
P.O. Box 150
magunje
Zimbabwe

Dear Sir/Madam,

Request for Permission to Conduct Research in Hurungwe District, Mashonaland West Province

I am writing to seek permission to conduct research in selected primary schools within Hurungwe District, Mashonaland West Province. I am an Honours Bachelor of Science Education Degrree in Chemistry Candidate at Bindura University Of Science Education currently working on a research project titled The impact of using models in the teaching and learning of Enviromental Science : A Case Study in selected schools of Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province.

This study aims to explore use of household models as an alternative way of method of developing scientific skills in learners. The research findings will contribute to the incorporation of models as a teaching method in primary schools. I kindly request authorization to carry out my research in the following schools:**Lynx Mine Primary School, Chipango Primary School, Chitikira Primary School and Vuti Primary School.**

The research will involve interviews with school heads and questionairres for Grade 6 teachers and learners. All ethical protocols will be strictly observed, and confidentiality of the participants and institutions will be maintained. Furthermore, I assure you that the findings will be used solely for academic purposes. I would be grateful for your permission to proceed with this research. Should you require further details, please do not hesitate to contact me at **0775831521**.

Thank you for considering my request. I look forward to your positive response.

Faithfully yours

Shonhai Shonai

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
02 Dec 2024
P.O.BOX 200
KAROI

Committed To Quality Education For Life

Appendix D: Lynx Mine Primary School Approval Letter To Conduct A Research

Ministry Of Primary And Secondary
LYNX MINE Primary School
Post Office Box 200
KAROI

CELL: 0772285985
0778084874

05 December 2024

The Researcher – Shonhai Shonai

RE: AUTHORITY TO CARRY OUT EDUCATIONAL RESEARCH AT LYNX MINE PRIMARY SCHOOL FOR SHONHAI SHONAI – B225875A (HBScEdCh)

The researcher Shonhai Shonai has been granted permission by the Head Lynx Mine Primary School to carry out his research at the above mentioned school on the topic: ***The impact of using models in the teaching and learning of Enviromental Science : A Case Study in selected schools of Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province.***

As a school, we wish him success in his studies and endeavour to assist him in the smooth carrying out of his research project.

Yours faithfully

Mudarikwa CM
Deputy head

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
05 DEC 2024
P.O.BOX 200
KAROI

Committed To Quality Education For Life

Appendix E: Chipango Primary School Permission Letter To Conduct A Research

Chipango Primary School

Box ....533.........

Karoi

06 December 2024

The Researcher – Shonhai Shonai

RE: PERMISSION TO CARRY OUT EDUCATIONAL RESEARCH AT CHIPANGO PRIMARY SCHOOL FOR SHONHAI SHONAI – B225875A (HBScEdCh)

As the subject matter refers

The above named student has been granted permission by the Head Chipango Primary School to carry out his research at our school on the topic: ***The impact of using models in the teaching and learning of Enviromental Science : A Case Study in selected schools of Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province.***

As a school, we wish him success in his studies and carrying out of his research project.

Yours faithfully

MINISTRY OF PRY & SEC. EDUCATION
THE DEPUTY HEAD
CHIPANGO PRIMARY SCHOOL
06 DEC 2024
P.O. BOX 533
KAROI

Mr Mujawo
Head

Appendix F: Plagiarism Declaration Form

Ministry Of Primary And Secondary
LYNX MINE Primary School
Post Office Box 200
KAROI

CELL: 0772285985
0778084874

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Declarationon Plagiarism

I understand that Bindura University Of Science Education (BUSE) and the Faculty of Science and Technology Education enforce a code of conduct against plagiarism and copyright infringement. Further to that, I understand that there are severe legal and academic penalties for the breach of that code. In keeping with the said code of conduct against plagiarism and copyright infringement, I make the following declarations:

That I have read the University's code of conduct against plagiarism contained in the University's year book.

That I have not committed the offence of plagiarism and copyright infringement in my work.

That I have not colluded or otherwise co-operated with anyone in doing my work here presented.

That I have not colluded or otherwise co-operated with anyone to help them present my work as their own.

That the work I am presenting is original and that it is free from fabrication, falsification, collaboration and collusion.

Name: SHONHAI S HONAI

Signed: ...

Date: 01 - 12 - 2024

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
01 DEC 2024
P.O.BOX 200
KAROI

Committed To Quality Education For Life

Appendix G: Copyright Declaration Form

Ministry Of Primary And Secondary
LYNX MINE Primary School
Post Office Box 200
KAROI

CELL: 0772285985
0778084874

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Copyright Declaration

I hereby cede to the Bindura University Of Science Education (BUSE) library all the intellectual property rights attaching to this research project/work .As the owner of the copyright to this work, the University may store, publish or otherwise distribute the entire volume of this work or parts thereof as its discretion will dictate.

I further certify that where applicable all copyright permission and or other authorisation to use privileged information has been obtained and attached hereto.

Therefore, University should not suffer any prejudice owing to the contents of this work.

Name: SHONHAI SHONAI

Signature: ……

Date: 01 – 12 – 2024

THE DEPUTY HEAD
LYNX MINE PRIMARY SCHOOL
01 DEC 2024
P.O.BOX 200
KAROI

Committed To Quality Education For Life

Appendix H: Interview Guide

BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE EDUCATION AND TECHNOLOGY

DEPARTMENT OF MATHEMATICS AND SCIENCE

INTERVIEW FOR TEACHERS

Greetings colleagues. My name is Shonhai Shonai. I am currently studying my Honours Bachelor of Science Education in Chemistry Degree at Bindura University of Science Education (BUSE). My research has to do with the impact of model-based teaching on Grade Six learners in Environmental Science. For the purpose of this research I will be asking questions and I want you to answer them as open as you can and be honest too. You are also free to tell us what you like and dislike during the interview.

Moreover, all the information that I am going to collect during the course of this interview will be kept during safe and secret. I would not use your name or any other identifying information and everything that you would say will only be entirely used for the research purpose.

Section A: Benefits of using models

1. How do you believe using models has affected your understanding of environmental systems?

2. In what ways do you think models help you relate to real-world environmental issues?

3. Do you feel that model-based learning has made Environmental Science more engaging? Why or why not?

Section B: Shortcomings of model-based teaching

4. What challenges have you faced when learning through models in Environmental Science?

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5. In your opinion, do models help or hinder the development of critical thinking and problem-solving skills? Why?

6. Have you ever felt that a model oversimplified a complex environmental concept? If so, can you elaborate?

Section C: Solutions and recommendations

7. What improvements would you suggest for the models used in your Environmental Science classes?

8. How do you think the curriculum could be adjusted to better integrate model-based learning?

9. What additional resources or support do you feel would enhance your learning experience with models?

10. If you could design a model for a specific environmental topic, what would it be and why?

THANK YOU!!!

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P.O.BOX 200
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Appendix I: Focus Group Guide

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FACULTY OF SCIENCE EDUCATION

FOCUS GROUP GUIDE

Study title: *The Impact of Using Models in the Teaching and Learning of Environmental Science: A Case Study of Grade Six Learners of Vuti Cluster Primary Schools in Hurungwe District, Mashonaland West Province.*

Purpose of the focus group

The focus group aims to gather qualitative insights from Grade Six learners regarding their experiences with model-based learning in Environmental Science. The discussion will explore the perceived benefits, challenges and suggestions for improvement.

Group composition

Participants: Grade Six learners from Vuti Cluster Primary Schools.

Group size: 6-10 participants.

Duration: 60-90 minutes.

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LYNX MINE PRIMARY SCHOOL
06 OCT
P.O.BOX 200
KAROI