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FACULTY OF SCIENCE EDUCATION
MATHEMATICS AND SCIENCE

TEACHERS CONCEPTIONS ON THE INTEGRATION OF CRITICAL THINKING INTO THE TEACHING AND LEARNING OF SCIENCE: A CASE STUDY

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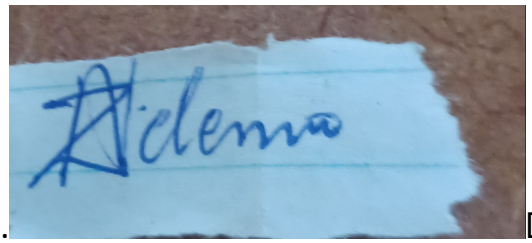
Signature ...  Date 15/07/2024

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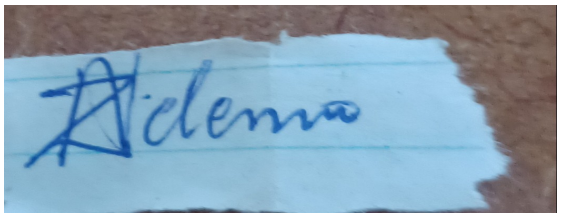

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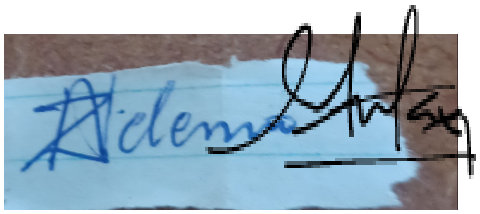

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Dedication

This research is dedicated to my family. They were always there for me during the journey in pursuit of my endeavors. Special mention goes to my wife Prisca Musambadzi and my daughters Panashe, Munashe, and Ruvarashe Mutasa.

Abbreviations and acronyms:

DSI	District Schools Inspector
ICT	Information and Communication Technology
MOPSE	Ministry of Primary and Secondary Education
HOD	Head of Department
NOS	Nature Of Science
SACE	South Africa Council for Educators

Abstract

This qualitative research study investigated the conceptions and experiences of science teachers in integrating critical thinking skills into their teaching practices. Semi-structured interviews were conducted with 5 science teachers, and the data was analysed using thematic analysis. The study sought to explore teachers' conceptions regarding the integration of critical thinking skills into the teaching and learning of science. Thus, a case study of one Secondary School in Makonde District of Mashonaland West province was done with a view to recommend strategies that can be adopted to enhance integration of critical thinking skills in Science Education. The findings revealed that teachers' conceptions of critical thinking varied, with some emphasizing enquiry-based learning and others focusing on problem-solving skills. While teachers recognize the importance of critical thinking in science education, they faced challenges in implementing it in their classrooms, including limited resources and pressure to meet curriculum standards. The study highlights the need for professional development programs that support teachers in developing their understanding of scientific concepts and experiments as well as critical thinking and its integration into science teaching practices. The findings have implications for

enhancing the quality of science education and promoting critical thinking skills among learners

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Interview questionnaire

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Thank you for participating in this interview. Please feel free to share your thoughts and experiences. Remember, your responses will remain confidential.

Section 1: Background Information

1. Can you briefly describe your role and experience in the field of teaching
2. How long have you been working in this field?
3. What other responsibilities do you have besides teaching?

Section 2: Main Interview Questions

1. How do you perceive as a teacher the impact of integrating critical thinking skills on students' understanding and engagement with scientific concepts?
2. What strategies do you use to promote the development of critical thinking skills while teaching scientific concepts?
3. How do you collaborate with colleagues or school leaders to support the integration of critical thinking in their science classroom?
4. What challenges do you face when trying to integrate critical thinking skills in your science classroom?

Section 3: Probing Questions

1. Can you elaborate on that point?
2. What led you to that conclusion?
3. How did you feel about that experience?
4. What did you learn from that situation?

Section 4: Demographic Information

1. Age: _____
2. Gender: _____
3. Educational level: _____
4. Years of experience: _____

Conclusion

Thank you for sharing your valuable insights. Is there anything else you would like to add or discuss?

CHAPTER 1: INTRODUCTION

1.1 Introduction to the chapter

This chapter presents background to the study, statement of the problem, research objectives, research questions, significance of the study, delimitations, limitations, and assumptions, definition of terms as well as summary of the chapter focusing on conceptions of teachers on integration of critical thinking into the teaching and learning of science

1.2 Background to the study

The integration of critical thinking into the teaching and learning of science is a crucial aspect of science education. Critical thinking skills are essential for students to analyse, evaluate, and make informed decisions based on scientific information. However, there may be varying conceptions among teachers regarding the integration of critical thinking in their teaching practices. Understanding teachers' conceptions on this integration is important as it can influence their teaching approaches, strategies, and the extent to which critical thinking is emphasized in the science curriculum. Teachers' beliefs, attitudes, and knowledge about the relationship between critical thinking and teaching and learning of science can impact their instructional practices and ultimately, students' learning outcomes.

This research project aims to explore teachers' conceptions on the integration of critical thinking in the teaching and learning of science. By examining teachers' perspectives, attitudes, and practices, this study seeks to identify potential barriers, challenges, and opportunities for enhancing the integration of critical thinking skills in science education through a qualitative research approach, data will be collected through interviews, surveys, and classroom observations to gain insights into teachers' beliefs and practices related to the

integration of critical thinking in science instruction. The findings of this study can provide valuable information for curriculum developers, teacher educators, and school administrators to support teachers in effectively integrating critical thinking skills in the teaching of science.

Scientists, who include chemists, biologists and physicists in particular, have managed to bring understanding, order, consistency and predictability to our universe and will continue with that endeavour into the exciting future. Nowadays countries all over the world especially the developing ones like Zimbabwe are striving to develop technologically and scientifically since the world is turning scientific and all proper functioning of lives depend on science. Duncan (2020), asserts that physics is the science on which all other natural and engineering sciences are built. Chemistry learning also involves understanding the laws and principles that govern these reactions, as well as how to use this knowledge to solve problems and make predictions about the world around us, Chang, (2005)

Educators in science have to produce students with scientific knowledge because they would have passed through a process of inculcating critical thinking within their course work. Scientific knowledge encompasses a vast array of information about the natural world gained through systematic observation, experimentation and analysis, Facione (1990). It is based on empirical evidence and follows a rigorous process of inquiry to understand and explain phenomena.

Key Characteristics of Scientific Knowledge include:

1 Empirical evidence

Scientific knowledge is based on observable measurable data that can be collected through experiments, observations, and measurements

2 Testability

Scientific hypotheses and theories must be testable through experimentation or observation. This allows scientists to validate or refute their ideas based on evidence which is obtainable through a critical thinking process.

3 Reproducibility

Scientific findings should be reproducible by other researchers. This ensures that results are reliable and not influenced by bias or chance. Any finding or idea which comes through a critical thinking process is more reliable than the one which does not pass through the same process.

4 Falsifiability

Scientific theories must be falsifiable, meaning they can be proven wrong through evidence obtained through critical thinking. This principle allows for the continuous improvement and refinement of scientific knowledge

5 Peer review

Knowledge obtained through science is subject to peer review where experts in the field evaluate research findings before they are published. This helps ensure the quality and validity of scientific work

The knowledge of science is constantly evolving as new discoveries are made and existing theories are refined. The knowledge provides a foundation for understanding the natural world and developing practical applications in various fields, such as medicine, technology and environmental science, Abd-El-Khalick

& Lederman (2000). By integrating critical thinking into the teaching and learning of science, researchers and students can build on existing knowledge to challenge assumptions and uncover new insights into the complexities of the universe. Since the body of knowledge in science is evolving, educators must make deliberate efforts to catch up with the developed world. Developing countries such as those in sub–Saharan Africa are being challenged to come up ways that ensures that students in the field of science are given the opportunity to vigorously work in their respective fields. Thus, this research is trying to look at teachers' conceptions on the integration of critical thinking into the teaching and learning of science. The students which come from schools, colleges and university are the ones who would be scientists who are supposed to catch up and challenge other findings from outside Africa

1.3 Statement of the Problem:

The integration of critical thinking skills in the teaching of science is crucial for developing students' ability to think critically, analyze information, and make informed decisions. However, there is limited research on teachers' conceptions of how to effectively integrate the component of critical thinking in their science instruction. Understanding teachers' perspectives on this integration is essential for designing professional development programs and curriculum resources that support the development of students' critical thinking skills in science.

1.4 Research Objectives:

1. To examine teachers' beliefs and practices related to integrating critical thinking skills in their science instruction.

2. To identify the challenges and barriers that teachers face in integrating critical thinking in their teaching of science.

3. To investigate the strategies and approaches that teachers use to promote critical thinking and scientific understanding among their students.

4. To assess the impact of teachers' integration of critical thinking on students' learning outcomes and engagement in science education.

1.5 Main Research Question

What are teachers' conceptions on the integration of critical thinking into the teaching and learning of science at Zintafuli Secondary School in Makonde District Mashonaland West Province.

1.6.0 Sub Research Questions

1.6.1 How do teachers perceive the impact of integrating critical thinking skills on students' understanding and engagement with scientific concepts?

1.6.2 What strategies do teachers use to promote the development of critical thinking skills while teaching scientific concepts?

1.6.3 How do teachers collaborate with colleagues or school leaders to support the integration of critical thinking in their science classrooms?

1.6.4 What challenges do teachers face when trying to integrate critical thinking skills in their science classrooms

1.7 Significance of the study

The importance of the research project on teachers' conceptions of integrating critical thinking in the teaching and learning of science lies in its potential to

improve science education outcomes. By understanding teachers' beliefs and practices regarding this integration, educators can develop more effective strategies to promote critical thinking skills among students. This is very important in a rapidly changing world where the ability to think critically and apply scientific knowledge is crucial for success in various fields. Education 5.0 gives emphasis to production of students in colleges and universities who have the ability to solve problems which our economy is facing and solving these problems require critical thinking. Integration of critical thinking further gives colleges and universities the ability to produce wholesome students who are well and ably prepared to face the challenges of the world. Additionally, the research can inform professional development programs for teachers, helping them enhance their instructional practices and better prepare students for the challenges of the 21st century. Ultimately the findings of this project have the potential to contribute to the advancement of science education and the development of a more scientifically literate society

1.8 Delimitations

The research study will be confined to Zintafuli Secondary School within Uyende Cluster in Makonde district Mashonaland West Province. The target group would be Science subject teachers.

1.9 Limitations

Sample size, the number of teachers participating in the study may be limited as there are not many science teachers in our cluster. This could affect the generality of the findings. Again, the findings can be affected because of bias. There may be bias in the selection of participants or in the way the data is collected and analysed, which could impact in the validity of the results. This could occur if teachers' responses are influenced by their desire to satisfy the

expectations of the researcher. However, to minimize this, the respondents were advised that the information would be treated with strict confidentiality. Respondents were advised not to take part if they were not feeling comfortable and the researcher made sure respondents understood the purpose of the study. Another limitation is subjectivity: Teachers' conceptions of critical thinking and scientific knowledge may be subjective and influenced by personal beliefs or experiences, making it challenging to draw objective conclusions. Lastly time constrains can be a limiting factor. Conducting in-depth interviews or observations with teachers may be time consuming, especially due to limited resources or access to participants.

1.10 Assumptions

- It is assumed that teachers have a clear understanding of what critical thinking and scientific knowledge entail and how they can be integrated in the teaching of science
- It is assumed that teachers are willing to participate and provide honest and accurate responses to questions about their conceptions and practices.
- It is assumed that the researcher has a good understanding of the relevant literature and theories related to critical thinking, scientific knowledge, and science education.
- It also assumed that the findings of the research will be valuable for informing teacher professional development, curriculum design, or policy decisions related to science education

1.11 Definition of terms

Critical thinking

- A process of actively and skilfully analysing synthesising and evaluating information in order to make a well informed and reasoned decisions. It involves questioning, assumptions, considering multiple perspectives, and being open to new ideas and evidence.
- Critical thinking encourages individuals to think independently, logically, and rationally rather than simply accepting information at face value. It also involves being aware of one's own biases and prejudices and being willing to challenge and revise one's beliefs in light of new information. In this research the above definition is particularly favoured as it encompasses all that is needed to be considered in terms of defining the term, 'critical thinking.' However, Bailey & Mentz (2015) go on to suggest that the foundations of critical thinking are philosophically linked to the works of Plato, Aristotle and Socrates.

Integration:

- This refers to the process of combining or bringing together different elements or components to create a unified whole. It involves breaking down barriers, prompting, collaboration and creating unity among different entities to achieve common goals or objectives.
- Klein (2016) defined integration as an approach that allows learners to explore, gather, process, refine, and present information about topics they want to investigate without the constrains imposed by traditional subject barriers. In this study, integration refer to the inclusion of critical thinking skills in science education in order to enhance scientific knowledge.

Teaching:

- Teaching is the act of imparting knowledge, skills, and values to learners or others. It involves the transmission of information from teacher to a student, with the goal of helping the student learn and understand a particular subject or concept. Teaching can take place in a variety of settings, such as schools, universities, and informal learning environments.

Learning:

- The acquisition of knowledge or skills through study, experience or being taught, learning is the process of acquiring new understanding, knowledge, behaviours, skills, values, attitudes and preferences.
- Learning is a process to change, which occurs as a result of experience and increases the potential for improved performance and future learning (Ambrose, et al, 2010)
- It is a process of acquiring new knowledge, skills, behaviours, or attitudes though study, experience, or instruction.
- It involves internalisation and retention of information, which leads to a change in behaviour or mindset.
- Learning can occur through various means, including formal education, informal experiences, observation and reflection.
- It is a continuous and lifelong process that enhances an individual's capacity to adapt, grow, and succeed.

Science:

- Science is a systematic and organised body of knowledge that is obtained through observation, experimentation, and analysis. It involves the study of the natural world and its phenomena, using evidence-based methods to understand and explain how things work. Science is also a process of

inquiry and discovery where new findings and theories are constantly being developed and tested.

- It encompasses a wide range of disciplines, including physics, chemistry, biology, astronomy, and earth sciences
- Science aims to generate knowledge, explain phenomena, predict outcomes, and improve the quality of life.
- It relies on the scientific method, which involves formulating hypothesis, conducting experiments, analysing data and drawing conclusions based on empirical evidence.
- Science is characterised by objectivity, scepticism, and a commitment to truth and accuracy.

1.12 Chapter Summary

The chapter was looking at background to the study, the statement of the problem, research questions, significance of the study, delimitations, limitations as well as definition of the problem. The next chapter looks at literature review.

CHAPTER 2 LITERATURE REVIEW

2.0 Introduction

The introduction of critical thinking skills in the teaching and learning of science has been a topic of interest for educators and researchers alike. Critical thinking is essential in the field of science as it allows students to analyse, evaluate, and apply scientific information effectively. Therefore, it is important for teachers to understand how to integrate critical thinking skills into the teaching and learning of science in order to promote meaningful learning experiences for students. This chapter is focused on literature whose main purpose is to help the researcher to define the position to be occupied by the research within the body of knowledge which has accumulated to date on similar issues. In this chapter, similar researches by other scholars would be cited. The literature is expected to give the researcher a starting point in search of new knowledge on which a case could be built through the use of logical and systematic analysis and synthesis of diverse views. In this chapter, the researcher will present a review of the literature on the challenges which have been encountered by teachers in the teaching and learning of science in trying to integrate critical thinking into the teaching and learning of science. Not only will it look at the challenges but also at how those who have managed to integrate the two were able to do it and how they went about it in navigating challenges which might be faced in trying to do so. It will also look at possible solutions to both groups of teachers and consider their perspectives.

2.1 Teachers' beliefs and conceptions about the nature of science (NOS)

Several studies have been conducted to explore teachers' conceptions of the integration of critical thinking in science education. A study by Abd-El-Khalick and Lederman (2000) investigated teachers' beliefs and conceptions about the

nature of science and its incorporation in science teaching. The findings revealed that teachers often struggle with integrating critical thinking skills due to a lack of understanding of how to effectively teach these concepts. It emphasizes that science education must have a perennial goal of preparing and producing scientifically literate students thus science teachers must strive by all means to effectively teach concepts. Adequate understanding of nature of science, was found to be a central component of scientific literacy. Prospective and practicing science teachers' conceptions of nature of science must be effectively undertaken and considered in order to improve their capability. The research reviewed attempts was categorized into two general approaches which are implicit and explicit. Implicit attempts utilized science process skills instruction or engagement in science-based inquiry to improve science teachers' conceptions of nature of science. Explicit attempts used instruction geared towards various aspects of nature of science and or instruction that used elements from history and philosophy of science. Implicit was found to be affective as compared to having a cognitive learning outcome. The assumption on explicit attempt is that learners would necessarily develop understandings of nature of science (NOS) as a by product of engaging science related activities. However, the study found out that despite the comparatively relative effectiveness of the explicit approach, much is still required in terms of fostering among science teachers 'desired understandings of NOS. The paper emphasizes that explicitness and reflectiveness should be given prominence in any future attempts aimed at improving teachers' concepts of NOS.

2.2 Relationship between critical thinking and scientific knowledge

Facione, (1990) examined the relationship between critical thinking and scientific knowledge. The research highlighted the importance of developing

critical thinking skills in students to help them better understand and apply scientific principles. However, the study also found that teachers often prioritize the transmission of factual information over the development of critical thinking skills in their science classrooms. In most cases during teaching and learning of science no enough room is given to learners to fully grasp the concepts behind certain topics. There is need to fully understand the importance of teaching and learning in order to produce students who are able to solve problems faced by the nation. Most entrepreneurs and innovators are problem solving individuals. If there is proper integration of critical thinking and scientific knowledge in the teaching and learning of science, more students with potential to become world class innovators are produced.

On another note, Behar-Horstein an Niu (2011) observes that the term critical thinking is often used to describe competencies which not only seem to be applicable to the teaching and learning context, but also to learning in many workplace contexts. Such competencies may include the skills of argument, reflective thinking, clarifying and focusing the problem, analyzing, understanding and making use of inferences, inductive and deductive logic, as well as judging the validity and reliability of the assumptions, sources of data or information. Other researchers view critical thinking as a process. Liu (2015) describes critical thinking or critical reflection as being characterized by two important dimensions which are the content and the process. Content in this case refer to what teachers reflect on, while processes refer to what thinking process they go through while reflecting.

2.3 Implementation of critical thinking in science education and the role of teachers

Additionally, a study by Tsai (2000) explored the perceptions of science teachers on the integration of critical thinking skills in science education. The findings indicated that while teachers recognized the importance of critical thinking in science learning, they faced challenges in implementing it effectively in their classrooms. Teachers often lacked the necessary training and support to integrate critical thinking skills into the teaching and learning of science during their practices.

The integration of critical thinking skills in the teaching and learning of science has been recognized as a crucial aspect of science education. Teachers play a key role in shaping students' understanding and application of critical thinking skills in the context of scientific knowledge. This literature review aims to explore teachers' conceptions of integrating critical thinking in science education.

Several studies have investigated teachers' perspectives on the integration of critical thinking skills in science education. For example, Kaya and Cakiroglu (2017) conducted a study with science teachers in Turkey and found that teachers perceived critical thinking as an important component of science education but faced challenges in implementing it effectively in their classrooms. Similarly, Venville and Dawson (2010) explored teachers' beliefs and practices regarding critical thinking in science education and found that teachers varied in their understanding and implementation of critical thinking skills in the teaching of science.

Moreover, research has also examined teachers' conceptions of integrating critical thinking skills into the teaching and learning of science for instance, McPeck (1990) argued that critical thinking should be integrated into the teaching of science to help students develop a deeper understanding of scientific concepts and theories. Additionally, Tobin (1990) highlighted the importance of fostering critical thinking skills in science education to promote scientific literacy and enhance students' ability to analyze and evaluate scientific information.

Overall, teachers' conceptions of integrating critical thinking in science education are influenced by various factors, including their beliefs, experiences, and pedagogical practices. It is essential for teachers to receive professional development and support to effectively integrate critical thinking skills with scientific knowledge in their teaching practices. Future research should continue to explore teachers' perspectives on this topic and investigate effective strategies for promoting the integration of critical thinking skills in science education.

The integration of critical thinking skills is essential in the teaching and learning of science. Teachers play a crucial role in facilitating this integration, as they are responsible for designing and implementing instructional strategies that promote both content knowledge and critical thinking skills among students. Understanding teachers' conceptions of how critical thinking skills can be effectively integrated is important for enhancing science education.

In order to make sure that all learners are catered for in science education, it is prudent for a teacher to use a variety of teaching methods, or practices during teaching and learning. Varying teaching strategies accommodate different learning styles. This makes it possible for all students to have access to the

material in a way that works for them and this ensures all learners have the opportunity to become critical thinkers. Different students may have different learning styles and preferences and by using a variety of strategies, teachers can provide a way for each student to engage with the material, Benny & Blonder (2018). For example, some students may prefer to work in groups and collaborate on projects, while others may prefer to work independently. By using a variety of teaching strategies, teachers can reach all students and help them learn the material in a way that is most effective for them. Another way which promotes integration of critical thinking in teaching and learning of science is through varying teaching methods. Varying teaching methods accommodates more students with different learning needs, for example, some students may have a learning disability that makes it difficult for them to understand or retain information in the same way as other students. In this case, a teacher might use assistive technology or provide additional support to help the student to understand the material. When more students understand material, it creates constructive competition among learners, thus more of the students strive to be critical thinkers. In the same scenario, students who are not good at English may benefit from additional support or instruction in their native language. Using local language in conjunction with English helps students to understand material and capture concepts with much easy. Most advanced nations in terms of science, use their native language as a means of instruction. It is very difficulty for a country to advance scientifically using a foreign language. For example, China has made so much inroads within a short space of time. It is assumed that one of the major contributors to their development is their ability to use their native language as a means of instruction in schools. Other countries which developed rapidly within the 20th to the 21st century are Japan, India and South Korea.

Another way of promoting the integration of critical thinking into the teaching and learning of science in teaching and learning is by creating a classroom environment that is respectful and supportive of all students. This can involve the use of positive language, encouraging students to participate, addressing any discrimination or bullying that may occur. It is important to set clear expectations for behavior and to consistently enforce them. This can include creating a code of conduct that outlines the rules and consequences for breaking those rules. Positive reinforcement must be used to encourage good behavior either a good response during class discussion or general social behavior. A safe space for discussion and sharing can help to create a supportive classroom environment. Additionally, teachers should try to get to know their students on an individual level and to show respect for their cultures and backgrounds, Vaugh & Wanzek (2014). Knowing students on an individual level help in mentoring those students with the ability to exceedingly excel in their respective areas of study by then inculcating critical thinking on a much higher level in their areas of study.

Visual aids can play a vital role in promoting inclusivity and creativity within teaching and learning of science. For students who are visual learners, seeing the concepts represented visually can help them to understand and retain the information more effectively, Kousa, Kavonius, & Aksela (2018). Visual aids help students to understand scientific concepts more easily. An instruction instrument with more visuals is more effective compared to those without. Visual aids can also be helpful especially to students who have a disability that impacts their ability to process information. For example, using visual aids can help students with dyslexia to understand the material more easily. Dyslexia is a neurological condition that affects the way the brain processes language. It is a common learning disability that can impact a person's ability to read, write,

spell, and sometimes speak. Furthermore, some students may have difficulty focusing on spoken instruction and may benefit from having visual aids to help them stay engaged. Visual aids give all students the opportunity to fully comprehend the material being taught. By comprehending material being taught, students are more inclined to become critical thinkers as they understand the concepts behind the content being taught. They are able to question assumptions or theories more easily.

The fourth practice that can promote inclusivity in chemistry learning is to give learners the opportunity to do hands- on activities and practice cooperative learning. For example, when students are allowed to engage in hands-on experiments, they can explore the concepts being taught in a more concrete and tangible way. This can be especially helpful to learners who learn best through kinesthetic means. This is where students learn best through physical activity and movement. By mixing chemicals during experiments and observe the reactions learners are able to acquire more knowledge for themselves other than being given explanations through oral concept exposition. Students might also make models of molecules or atoms out of craft materials, or act out the movement of particles during chemical reaction. These activities allow students to get hands-on experience with the material, and can help to reinforce their understanding of the concepts. According to Eyler, (2000), a key instruction strategy that allows integrative approaches is the reflection process through which students are encouraged to understand their experiences by among different practices through experimenting. In addition, they can also be a fun and engaging way to learn about chemistry. On another note cooperative learning can help to ensure that all students feel included and have a chance to contribute to the class. When students are encouraged to work together on

projects, they can share their different perspectives and learning styles, resulting in a more inclusive and effective learning environment.

The above mentioned are some of the practices which promote inclusivity in chemistry learning. There are other various teacher practices which promote inclusivity which can also be used in teaching and learning of chemistry to diverse classes. More knowledge is still needed though on how science especially chemistry teachers' positive beliefs and practices could be connected to better student achievement. Inclusivity is about creating a diverse and welcoming environment for all; thus, teachers need to be aware of the various teaching practices available and select those that are most appropriate for their students and the subject matter they are teaching.

2.4 Importance of Critical Thinking in Science Education:

Numerous studies have highlighted the importance of critical thinking in science education. Critical thinking involves analyzing and evaluating information, forming reasoned judgments, and solving complex problems. In the context of science education, critical thinking helps students to question, evaluate evidence, and make informed decisions based on scientific principles.

2.5 Integration of Critical Thinking into the Teaching and Learning of Science

The integration of critical thinking in science education is essential for developing students' ability to think critically about scientific concepts and apply them in real-world situations. Research has shown that when students engage in activities that require them to think critically about scientific information, they develop a deeper understanding of the subject matter and are better able to apply their knowledge in new contexts.

2.6 Teachers' Conceptions of Integration:

Teachers' conceptions of how critical thinking can be integrated in the teaching and learning of science play a significant role in shaping their instructional practices. Some teachers may view critical thinking as a separate skill that needs to be taught independently of scientific content, while others may see it as an integral part of the learning process that should be integrated into all aspects of science instruction.

2.7 Challenges in Integrating Critical Thinking into the Teaching and Learning of Science:

Despite the benefits of integrating critical thinking skills in science education, teachers may face challenges in implementing this approach in their classrooms. These challenges may include a lack of time, resources, and training in how to effectively integrate critical thinking skills with scientific content.

2.8 Strategies for Integrating Critical Thinking:

Research suggests several strategies that teachers can use to effectively integrate critical thinking in their teaching. These strategies include incorporating problem-solving activities, engaging students in discussions and debates, and providing opportunities for students to apply their knowledge in real-world contexts.

2.9 Summary

Teachers' conceptions of how critical thinking can be integrated in the teaching and learning of science play a crucial role in shaping their instructional practices. By understanding teachers' perspectives on this integration, educational policymakers and curriculum developers can provide support and resources to help teachers effectively integrate critical thinking skills with scientific content in science education.

CHAPTER 3

RESEARCH METHODOLOGY

3.0 Introduction

This chapter focusses on research methodology of the study. It will highlight the research design and the target population that will be adopted and it will give a detailed description of the sampling techniques, sample size and research instruments that will be used to collect data. The data collection procedures validity and reliability are also going to be stressed out.

3.1 Research approach

The research is going to concentrate on qualitative approach which focuses understanding the meaning behind human experiences, perceptions, and behaviours, Cresswell (2019). Thus, there is no need of collecting and analyzing numerical data as human experiences, perceptions, and behaviours are difficulty to quantify. The approach is an inductive, which means that it starts with data collection and then builds theories based on the data. According to Cresswell (2019), qualitative research approach emphasizes the importance of understanding the meanings and experiences of participants, rather than reducing them to numbers or categories. Thus, a variety of research methods, which includes interviews which takes into account focus groups, and employing different strategies and approaches such as, grounded system, narrative approach and phenomenological approach are used. The research also used observation and document analysis. Cresswell (2019), goes on further to assert that qualitative approach seeks to understand complex phenomena by exploring the context in which they occur.

3.2 Research design

According to Cresswell (2019), a research design is an action plan for gathering, analysing, providing meaning and communicating data in research investigations. This view is also supported by Kothari (2019) who proposes that a research design is a framework for conducting research, consisting of the strategy for data gathering, measurement and examining. The two definitions from authorities give an indication that a research design may be considered as a detailed plan indicating how data is going to be collected, methods to be utilised, and ways of analysing and communicating the findings. It can be argued that the purpose of the research design is to keep the researcher focused and to ensure the collected data addresses the research questions convincingly. Thus, it is a roadmap that facilitates the realisation of the study goal. As alluded to earlier, the qualitative research method approach which will be adopted for this study has a grounded system approach. According to Cresswell (2019), grounded research approach involves developing theoretical frameworks and explanations based on the data that emerges from the study. In grounded theory, the researcher starts with no preconceived ideas about the phenomenon being studied, and instead allows the theory to 'emerge' from the data itself. In this research teachers are going to be interviewed using the available research questions and responses from the various teachers would then be triangulated. In this way, design ensures corroboration within the conduct of the same study. The study intends to follow a descriptive survey design during data collection. A descriptive survey attempts to ascertain the characteristics of a specific population, either at a specified time or comparably over a period (Gray, 2009). This method is deemed appropriate as it involves the collection of extensive and cross-sectional data for the purpose of describing and interpreting an existing situation under study. The descriptive survey has the potential to identify, extract and describe challenges encountered by

teachers in trying to integrate critical thinking into the teaching and learning of science using samples and different techniques of data collection and analysis.

Qualitative data solicits deeper understanding of science teachers' views, experience and challenges encountered when integrating critical thinking into the teaching and learning of science, and this will be sought through a structured interview. Data triangulation is facilitated through the use of a closed questionnaire and interview guide to collect the same information.

3.3 Population, Sample and sampling.

The target population of the study was science teachers at Zintafuli Secondary School in Uyende cluster in Makonde district Mashonaland West province. The process of selecting research participants from a population was done in such a way that the selected persons were a true representative of the large group. According to Kothari (2021), sampling is concerned with the selection of the total population, basing on it, the decisions to be made about the population. In essence sampling refers to the business of soliciting information about a total population through studying a section of it. Ogula (2015), define sampling as the process of choosing a subgroup to participate in the study. Individuals are chosen in such a way that they represent the large group from which they were selected. For descriptive studies, Mugenda (2019) suggested that thirty percent of the target population is adequate to represent the population. It is on the bases that the researcher selected 4 out of 8 teachers. The study used purposive sampling to select the teachers who would answer the questionnaires. The researcher chose participants based on characteristics of the population and objectives of the study. Purposive sampling method allowed the teacher to reach at a sample that can adequately answer the research objectives. The selection of a purposive sample is often accomplished by applying expert

knowledge of the target population to select a sample that can represent a cross section of the population. Thus, purposive sampling strategy was then employed in selecting teachers.

3.4.0 Research Instruments

The researcher used interviews as research instrument. Structured interviews and closed questions were used. Closed questions were because they are simple and easy to answer. They save time on both parties, that is respondents and researcher.

3.4.1 Interviews

An interview is an interaction between two or more people for purpose of exchanging information through a series of questions and answers, (Bryant, 2011). According to McNamara (2011), interviews are used to get the story behind a participant's experience and to get in-depth information about a certain topic. Woods, (2019) agrees with this notion by stating that a lot of relevant information about people's experiences are collected by directly questioning or talking to them. Interviews are in-depth, rich and detailed form of gathering information rather than gathering answers categorised to specified questions, (Flick, 2014). An interview can be considered as a talk between two persons, where one of the persons is playing researcher's role (Gray, 2019). He goes on to further point out that interviewing affords the researcher the opportunity to delve into the ideas, feelings, values, responses and motives of the participants' lived experiences. Flick, (2014) highlight that interviews are a potential source of rich, relevant and pertinent data.

Interviews can be structured, semi-structured or unstructured (Dawson. 2020). The researcher used both structured and semi-structured interviews to obtain

the required information relevant to the study. Structured interviews are type of interviews in which the researcher prepares questions before hand and they are arranged and asked in a particular order, (Dawson, 2020). Identical questions are asked for each individual and the researcher does not probe the participants but only clarifies instructions, (Taylor, 2018). Structured interview was selected for this research because they make it easier to replicate discussions and to get standardized views on the topic. It is also easy to simplify the findings. The interviews will be recorded rather that relying on written notes as recorded information proved to be more reliable and allowed the researcher to properly analyse it at later stage.

Semi-structured interview a type of interview where the researcher compares and contrasts specific information with information that was gained by means of other interviews. The interview uses an interview schedule with topics or questions to be discussed. However, the order in which questions are asked is not fixed but is determined by the conversation between the researcher and the participants, (Woods, 2020). This type of interview makes use of flexible questions. The role of the researcher is to probe the participants for more information, (Taylor, 2018). With a semi-structured interview, the researcher has a specific number of questions to put to the interviewee, (Denscombe, 2010). Tuner, (2020), proposes that the researcher allows the interviewee room to develop an elaborate on issues raised by the interviewer. The researcher also opted for the semi-structured interview based on its ability to give the participant room to elaborate and perhaps give examples in areas of vested interest. Through the semi-structured interview, the researcher was in a position to ask probing questions as follow up to issues raised by the participants, and the interviewee was able to spell out details pertaining to his or her conceptions and practices which were ideal for the study (Gray, 2019).

Collection of detailed descriptions from participants enabled the researcher to bring out the meaning of what the teachers attached to their instructional practices. Notwithstanding possible bias, the researcher made an effort to ne as neutral as possible. The study conducted interviews to explore the teachers' conceptions on the integration of critical thinking in the teaching and learning of science. It seeks to explore in its findings possible remedies if there are challenges being faced and improvements if any, where challenges are not being encountered. The researcher took the advantage of interviews to gather verbal data to answer questions related to teacher conceptions, perceptions, experiences, values and beliefs that shape their teaching practices. The interviews afforded researcher the opportunity to probe further on particular issues and to take note of the body language of respondents as they reflect on their experiences. The interview schedule was developed to add something separate and new to what has been collected from the questionnaire to add an in-depth dimension. It also allowed participants to freely express themselves and give account of detailed descriptions of their instructional practices. The interview questions were concentrated on the same focus areas as those in the questionnaire. The interview questions were guided by the study themes; hence the proposed questions were either direct or indirect depending on the specific theme guiding the questions' construction. To facilitate easy focusing of the participant on research issues raised, more than one question was designed to measure each research construct. Content validity was ensured and developed by taking the sample questions to two curriculum experts for scrutiny. The same questions were also given to one language teacher to enhance clarity of questions. Advice received from the three experts were considered by the researcher when crafting the interview questions. The questions were grouped under the thematic areas as they were developed.

3.5 Reliability and validity

Reliability was guaranteed through data triangulation. Reliability refers to the consistency or repeatability of research findings or results, according to Gray (2019). Reliability was achieved through the use of multiple data gathering tools such as the questionnaire and interview guide. Gray, (2019) observes that for validity, a research instrument must measure what it is intended to measure. To ensure validity, the research instruments were pilot-tested on four purposively selected science teachers not included in the sample who completed the questionnaire. The responses were scrutinized for clarity and whether they measured what they intended to measure. Some of the statements were rephrased to make them completely understandable to the science teachers. To establish the truth-worthiness of the interview guide, it was given to two colleagues who are experts in science education to review questions. The purpose was to minimize ambiguity, emotive, and stressful questions. The feedback obtained was incorporated into the interview guide. In addition, four science teachers in Makonde district were interviewed using designed interview schedule. Feedback obtained was used to improve the data gathering instruments prior to the use in the field. The findings were provided to the research participants in follow-up feedback sessions. In addition, the findings were shared with colleagues and presented at conferences for peer review.

3.6 Data collection procedure

The researcher asked for permission from the District Schools Inspector, school heads, Science Head of Departments in the four selected schools selected in Makonde District to administer questionnaires and conduct interviews to the teachers. Preliminary visits were made to the four schools a week before the

data collection exercise to familiarize the researcher with the participants and their working environments. On the day of actual business, the researcher explained the purpose of the visit to the participants. The researcher explained to each participant that he or she is free to withdraw from the study at any time and that participation in the study would require commitment since it has demands on the participants' time. The teachers completed the questionnaires after their consent had been enlisted and having gone through the instructions of the questionnaire with the teacher. The questionnaires were handed to the researcher as soon as each respondent had completed it. The researcher checked each completed questionnaire to ensure all sections and spaces have been completed. This was done to ensure that there is completeness of data in each questionnaire submitted by the respondents.

On the implementation of interviews, the researcher used face to face interviews. The interviews were premised on the basis that it would be easy to organise since it coincided with the diaries of the researcher and participants, (Denscombe, 2010). The interviews were conducted soon after the researcher had checked on the completeness of the filled questionnaires, if the responded expressed willingness to be interviewed. The researcher focused on one individual's ideas at a time, hence, the face-to-face interviews were deemed ideal by the researcher and were anticipated to bring maximum reliable and authentic information to the study. Notwithstanding interviewer and interviewee bias, the researcher made an effort to remain focused on the points of interest and guided the participants to stick to issues that are pertinent to the study. The researcher explained the purpose of the interview and the anticipated benefits of the study. This rich and in-depth information gathering was made possible by helping respondents to relax by asking them general questions related to science education. The researcher then solicited

permission to record the proceedings of the interview, assuring the respondent of the confidentiality of the data gathered and any other information shared with the researcher and the anonymity of each participant. The researcher insisted on completeness of issues or ideas raised by the respondent on his or her conceptions regarding the integration of critical thinking into the teaching and learning of science. All interviews were recorded with a cell phone. During the course of the interview, the researcher took down some notes with respect to facial expressions and body language, and encouraged responses through occasional nodding. The interviews were carried out in e carried out in way that minimise disturbances at each respective school.

3.7 Data analysis procedures

Data analysis is a way that the researcher makes meaning of the data collected (Zar, 2020). In this research, the data was collected both qualitatively and quantitively. Zar, (2020) emphasizes the importance of excluding biases from the study. The biases should be avoided to produce accurate results. The quantitative data was collected by use of questionnaires. The data was analysed using Statistical Package for the Social Sciences, (SPSS). The responses from the questionnaires were studied and categorized into themes and then to variables. The responses from the questionnaires were studied and analysed and the data belonging to each variable were then recorded and summarised using descriptive statistics. Descriptive statistics summarise data and makes clear of any trends and patterns from the data, (Jaggi, 2013). The type of descriptive statistics used in this research was frequency distribution which is defined as an organised visual representation of the number of individuals per category or scale of measurement (Manikandan, 2019). This study used frequency distribution because it gave a clear picture of how individual responses from

each category of the questionnaire were distributed. It further simplified the information in forms of graphs and tables which made it easier to see patterns and trends derived from a lot of respondents. The tables and graphs from the descriptive statistics were then interpreted using existing knowledge, literature review and expertise about the topic.

The qualitative data was collected by means of interviews. This data was analysed manually. The analysis of the qualitative data was with a view to understanding the participants' experience, (Thomas, 2013). The researcher transcribed the information collected from the interviews. These transcripts were then read and important categories were identified and data was sorted and grouped according to similar concepts. This was done to separate the data into workable units. This is supported by McMillan and Schumacher (2020) when they asserted that collected data should be read, identified and sorted accordingly. The data was then scrutinised to find how one concept influenced another, and alternative explanations were searched for. This was done by describing the responses from the respondents. Patterns were sought from this and were interpreted. The findings were then reported. Since this was a method of triangulation both the qualitative and quantitative analysis were reported on simultaneously.

3.8 Ethical considerations

In research there is a moral obligation to build trust between the researcher and the participants (Cresswell, 2019). First, the issue of access to both subjects which are participants in this case and institutions was considered. Permission will be sought from relevant authorities that is school heads, district authorities and heads of departments where the study was undertaken. The issue of confidentiality will be granted through assurance of anonymity and it was hoped

that respondents would open up and provide honest and reliable responses to questions in the questionnaire and interviews based on those two aspects. The importance of the participants' right to the knowledge, privacy and participation was fully explained before their corporation was sought. The purpose of he study was explained to each participant as well as his or her right to refuse to participate or to choose to withdraw at any stage of the study. This was to ensure informed consent of the participants. Clearance was also obtained from Bindura University of Science Education (BUSE)

3.9 Summary

The chapter described research design and explained why it was chosen and sampling methods used in the study were discussed in detail. The chapter further described the data collection instruments and the rationale behind their selection. The researcher also described the methodology to be implemented to gather and analyse data. The chapter also clarified how validity and reliability was ensured and also explained how the ethical considerations were adhered to during collection of the data. The next chapter will see the researcher presenting the results, give an analysis of the results and deduce the conclusion.

CHAPTER 4 DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Introduction

The purpose of the study was to investigate teachers' conceptions on the integration of critical thinking into the teaching and learning of science. The study made use of interviews to determine teachers' conceptions on the integration of critical thinking into teaching and learning of science. In this chapter the researcher reports on the presentation, analysis of data, and discussions. It contains responses from science teachers on their conceptions on integration of critical thinking into the teaching and learning. The responses were recorded during the interview and then compiled.

4.1 Data presentation of teachers' interviews

Interviews were carried out using prepared questions mainly obtained from the research questions. (see appendix A) Their responses were recorded, group discussions and triangulation done in order to determine whether individual responses were backed up during group discussions. The information obtained was then used to create statistical data after their responses were analysed statistically and presented in form of tables. The group comprise of five teachers and all were handled in the same manner meaning the same prepared questions were asked before group discussion was carried out. A random selection was done for class observation where only two teachers were observed.

Table 4.1 biographical background of the science teachers

Items	Yes	No
Do you have electricity at your school?	0	5
Do you have science laboratory?	0	5
Do you have access to internet at your school?	3	2
Do you have science laboratory assistants?	0	5
Do you have adequate science equipment at your school?	1	4
Do you have enough text books at your school?	0	5
Do you have a school library?	0	5

Table 4.2 Biographical background of the learners

Items	Yes	No
Is there any electricity at your school?	0	40
Do you have science laboratory at your school?	0	40
Do you have library at your school?	0	40
Do you have enough science equipment?	5	35
Do you have laboratory assistance?	0	40
Do you have enough science teachers at your school?	40	0
Does your teacher use different teaching aids?	25	15
Does every student have an individual text book?	0	40
Does the number of learners have a negative effect to your learning?	30	10
Does your teacher use ICT tools during lessons?	20	20

Does your teacher improvise some equipment?	30	10
Do you have adequate desks at your school?	10	30
Do you have access to internet?	5	35

4.2.0 Discussion and analysis of research findings.

4.2.1 Use of ICT

Visual aids can play a vital role in promoting critical thinking in teaching and learning of science. For students who are visual learners, seeing the concepts represented visually can help them to understand and retain the information more effectively, Kousa, Kavonius, & Aksela (2018). As learners understand and retain information, they are able to critically anallyse concepts, there by promoting critical thinking within learners. Limited use of ICT tools during lessons impact negatively to learners' ability to critically analyse concepts. Visual aids can also be helpful especially to students who have a disability that impacts their ability to process information. Furthermore, some students may have difficulty focusing on spoken instruction and may benefit from having visual aids to help them stay engaged. Visual aids give all learners the opportunity to fully comprehend the material being taught.

Information Communication Technology provides software and apps for molecular modelling, simulation and visualization, therefore enhancing students' understanding of complex chemical concepts for example in chemistry. According to Koszalka & Wang, 2002; et al, ICT increases efficiency and can reduce teachers' time spent performing administrative tasks. Teaching stereochemistry for example, with chalk and talk method is always a tedious job for teachers because it requires a lot of three-dimensional (3 D) structure of molecules and drawing 3 D objects on black board is not possible. Thus, the use of several available drawing tools on internet in which 3 D objects can be drawn and several other information such as bond angles, angle strain and chiral carbon, among other examples can be visualized and make it easier to calculate. Sokolowski & Banks 2010, define modelling and simulation visualization as a

process that generates visual representation such as imagery, graphs, and animations of information that is otherwise more difficult to understand, therefore their use in teaching and learning of chemistry makes concepts much easier to understand. All the teachers interviewed agreed with the aspect of increasing the knowledge and use of ICT tools during teaching and learning.

4.2.2 learners' involvement during lessons

Learners' involvement during teaching and learning of science instigates critical thinking within learners. Teaching and learning become more interesting when learners are given the opportunity to do hands- on activities and practice cooperative learning. For example, when students are allowed to engage in hands-on experiments, they can explore the concepts being taught in a more concrete and tangible way. This can be especially helpful to learners who learn best through kinesthetic means. This is where students learn best through physical activity and movement. By mixing chemicals during experiments and observe the reactions learners are able to acquire more knowledge for themselves other than being given explanations through oral concept exposition. Teachers were in agreement that there is need to make learners more involved in teaching and learning, however they are hamstrung by lack of resources, time and blotted classrooms. Students might also make models of molecules or atoms out of craft materials, or act out the movement of particles during chemical reaction. These activities allow students to get hands-on experience with the material, and can help to reinforce their understanding of the concepts. According to Eyler, (2000), a key instruction strategy that allows integrative approaches is the reflection process through which students are encouraged to understand their experiences by among different practices through experimenting. In addition, they can also be a fun and engaging way to

learn about chemistry. On another note, cooperative learning can help to ensure that all students feel included and have a chance to contribute to the class. When students are encouraged to work together on projects, they can share their different perspectives and learning styles, resulting in a more inclusive and effective learning environment which promotes critical thinking among learners.

4.2.3 Lack of resources

It has been observed that there is critical shortage of resources in at the school which is also a reflection of most schools in the district. Resources such as laboratories, internet access, science equipment, furniture, modern interactive teaching aids, textbooks and science apparatus were seriously lacking in as far as all the teachers were concerned. If resources are lacking, teaching and learning of science becomes difficult and boring because there would not be enough practical work to motivate learners, and this means that science would mainly be taught orally. Once there is more of oral concept exposition in the teaching and learning of science, learners are not given enough opportunity to critic the concept being taught. Thus, it becomes difficult for the teacher to integrate critical thinking among learners since learners are not accorded that opportunity. Mwenda (2013) commented that if sciences are taught by means of theory, it leads to the learners losing interest and poor performance. Loss of interest does not induce critical thinking among learners. Learners tend to critically analyse things when there is interest over that particular subject, topic or concept. This is also collaborated by Onwu (2013) who carried out research that compared schools with resources and those without resources. The result from the comparison was that inadequately resources schools performed poorly compared to those well-resourced schools. The finding, is an indication that

effective teaching and learning of science needs adequate resources. Onwu (2013) further avers that professionally qualified teachers, no matter the training, would be unable to put the ideas into practice if the school setting lacks the equipment and materials to translate competence into reality. Resource availability ultimately improves the teaching and learning of science. Learners and teachers are motivated and when they are motivated, they develop interest to further critically analyse concepts and ideas.

4.2.4 Pedagogical content knowledge

It has been observed that majority of the teachers have no pedagogical content knowledge to teach science at higher levels such as advanced level. According to SACE (2011), there is a correlation between teachers' knowledge and student academic performance. Academic performance of learners in science has an impact on other learners to develop interest of taking up science subjects as their carrier path. Learners tend to gauge their prospective performance by looking at previous results produced by other learners in those respective science subjects.

Mwenda (2013) opined that teachers play an important role in order to dispense the curriculum effectively. Zimbabwean science teachers pass through different universities and colleges with different curricula and personnel, and since they are unique individuals, their mastery of content is bound to differ. Weak content knowledge contributes to low confidence in executing science lessons, which is a recipe for poor quality lessons according to Venkat, (2014).

The study has indicated that most science teachers use teacher cantered approaches in teaching and learning of science due mainly to reasons beyond their control, some of which include lack of materials. However, Etkuna (2010) tend to disagree by advancing the notion that teachers tend to teach in the

manner they were taught. Teachers would imitate exactly the teaching methods they were taught as majority of them would likely have been subjected to traditional transmission teaching strategies.

4.2.5 Lack of teacher motivation

Teachers expressed a sense of discontentment over remuneration, poor teacher welfare, lack of science related resources, harsh working environment, large classes, lack of science related workshops, lack of teacher consultation when making decisions, lack of ICT tools, work overload and poor calibre of students as major challenges they are facing. They claimed that these factors do not only motivates them but greatly affect their teaching experience and hence causes them to sometimes overlook the importance of integrating critical thinking in their classes. Once again teachers felt not appreciated and this reduced their commitment levels. Science subjects require a lot of commitment from teachers and learners as within most schools the number of periods allocated pe per week are not enough for proper coverage of the syllabus when taking into account all what is supposed to be done in order to inculcate concepts to learners. Chux (2013) in support of this notion asserts that science educators have lost their passion for the subject due to conditions of work such as lack of growth opportunities in the education sector, low salaries, poor working environment among others. Improving teacher's welfare will motivate them to discharge duties effectively.

4.2.6 Limited opportunities to share experiences.

Findings from the interviews espoused that there was lack of financial support from the school and other schools to share with colleagues, ideas and experiences on how effectively scientific concepts can be taught. The respondents lamented that seminars are not going as expected. Considering

that most schools in Zimbabwe are under staffed, having not more than two teachers per station, thus teachers have no expanded options to share and seek assistance when in need. This raises an urgent need to revisit the idea of district seminars and mobilize resources to ensure that the venture is a success. This finding is consistent with Fullan (2017) who notes that new competencies are enhanced through teachers sharing ideas and exchanging positive experiences regarding their work. Frequent Seminars and workshops provide teachers with in-depth knowledge on how to effectively teach scientific concepts which is aided by raising critical thinkers within learners who can challenge established concepts with current scientific information. For example, the notion that the first sperm is the one that fertilises the egg during sexual reproduction in humans has since been proved to be not the case. Critical thinkers would then raise such new discoveries that the egg is actually selective during class discussions after doing their research using the internet for current scientific discoveries. Teachers are also going to be informed by attending such workshops and seminars as they challenge each other into finding new scientific discoveries.

From another perspective, teachers' narrow conception of teaching some science concepts may also be an indication that there was no effective curriculum dissemination, therefore the full-scale implementation of the revised science curriculum. This perspective is also shared by Carl (2012) who posits that effective dissemination is a critical requirement for the effective curriculum implementation. A conclusion that subject related seminars and workshops where teachers meet and share experiences are important and can improve the teaching and learning of science subjects may be reached. It is inevitable that science as a body of knowledge needs critical thinkers as this is the only way our country can prosper. There is no prosperity without the raising of critical

thinkers through integrating critical thinking skills into the teaching and learning of science.

4.2.7 Administrative barriers

The participants strongly felt that bureaucracy and red tape were frustrating them with respect to procedures to be followed to obtain permission to undertake school educational trips with the learners. Administration support is an important ingredient of motivating both teachers and students. The teachers lamented that is a cumbersome process to seek permission to embark on educational trips with learners. The limited support with respect to timeous facilitation of field trips and other enrichment excursions is a serious impediment to meaningful science teaching and learning. The government should be more proactive to facilitate the reduction of bureaucratic procedures to enable learners to embark on industrial visits and other learning excursions as scheduled by the school. One may conclude that removal of administrative barriers to obtain permission to undertake school educational trips would improve the teaching and learning of science.

4.2.8 Staff Development Opportunities

Fullan, (2007) opined that creating opportunities for teachers to engage as students themselves fosters growth and enhance practice. This scenario is a recipe of cross-pollination of ideas which will benefit teaching and learning in the school. The teachers expressed dissatisfaction with their perceived competency inadequacy in the planning and execution of practical work activities and their need for in-service training to be capacitated with skills to facilitate learners designing and conducting their own experiments. This finding agrees with Kim and Tan (2010) who reported that learners are subjected to practical work activities dominated by teacher demonstrations and teacher-

directed confirmatory experiments. Depriving learners' hands-on activities undermines learners' creativity and autonomy, rendering it inappropriate for science teaching and learning activities. Respondents also expressed the need for an in-service training in the use of instructional technology in the teaching and learning of science. Buabeng, (2015) avers that science teachers rarely use modern technologies in their teaching practices. Science teaching practices which are devoid of modern technology integration are critical concern and desire urgent redress in the form of professional development.

In order to resolve some of their challenges, the interviewees suggested that staff development seminars should be led by experienced teachers whenever they are conducted in schools. They insisted the workshops would be more beneficial if they are conducted within the school contexts and facilitated by respective subject experts within the teaching fraternity. The teachers further maintained that such scenarios would make the in-service courses address their needs and more relevant to their responsibilities. Such workshops may have the potential and capacity to address teachers' needs, weaknesses and concerns. This is consistent with the finding of Belibas and Gumus (2016), who posits that staff development conducted in schools and facilitated by seasoned teachers address real classroom problems. It was noted from the finding that teachers are satisfied with professional development opportunities availed to them in schools. The results from the interviews seems to suggest that there is a narrow scope or scarcity of staff development opportunities being offered to science teachers in schools. There is need for sustainable contextualised and appropriate staff development seminars facilitated by seasoned teachers or experts to be instituted in schools. The matter has to be treated as matter of urgency in order for teachers to be able to inculcate the aspect of critical

thinking in learners during science teaching with enough capacity and knowledge on how to do it.

4.3 Summary

Data from structured interview guide questions, was analysed to synthesis teachers' conceptions on the integration of critical thinking into the teaching and learning of science. The science teachers were found to able to inculcate certain aspects of critical thinking within learners in form of researches as part of assignments or homework, however, teachers were found to be faced with many challenges. The challenges range from lack of resources, poor teacher motivation, work overload, large class sizes, lack of school support to teacher classroom practices due to limited finances, lack of teacher consultation on matters that affect their respective fields, limited in-service training programs, and on rare occasions inability to interpret the revised science curriculum. Linking science concepts to everyday life and ICT tools integration in science teaching was also found to be major challenges faced by teachers, thus, at times would make it difficult to introduce or decipher the aspect of critical thinking. There is need to upgrade the aspect of staff development especially in rural schools. The quality of staff development opportunities in rural schools leaves a lot to be desired. There is room for improvement on how these staff development clinics are held and their frequency. The next chapter presents the conclusion and recommendations of this study.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The aim of this investigation was to explore teachers' conceptions on the integration of critical thinking in teaching and learning of science. This chapter contains the observations that emerged from the study. From the point of view of the researcher, the chapter summarises views of participants and in summarising their views, the researcher was able to give conclusions. Recommendations based on the research findings which highlight the areas that the researcher felt are important and need to be taken into consideration in order to inculcate the aspect of improving and upgrading methods of introducing critical thinking within learners during teaching and learning of science were also enumerated in this chapter. It is anticipated that the findings will provide important implications for teaching and learning resource mobilisation, support and curriculum design in Zimbabwe or other nations who are facing similar situations to enhance effective science curriculum enactment.

5.1 Summary

The research study aimed at exploring teachers' views into the integration of critical thinking in teaching and learning of science. It aimed at finding a more holistic picture of the views of teachers on the integration of critical thinking within teaching and learning of science, thus a phenomenological analysis was done by way of conducting interviews and bracketing to gather data and minimize research bias. This was done in order to suspend all preconceived assumptions that the researcher might have. Grounded theory techniques were also used in order to develop theories based on empirical data. The data was collated into themes for discussion purposes, Creswell, (2014). Five science teachers were interviewed and data was obtained by recording and transcribing

the conversations and then analysing the transcripts to identify patterns, themes and insights. All this was done with the participants' consent and using structured interviews. This assisted in collectively constructing a holistic understanding of the science teachers' conceptions on the integration of critical thinking in the teaching and learning of science. Random sampling was done to select two candidates for class observation among the group.

5.2 Conclusions

The key findings are discussed with respect to the main study question namely 'teachers' conceptions into the integration of critical thinking into the teaching and learning of science.' However, to obtain a more holistic picture, four sub questions were used to support the major research question. The first question explored how teachers perceive the impact of integrating critical thinking skills on students' understanding and engagement with scientific concepts. The second one looked at what strategies do teachers use to promote development of critical thinking skills while teaching scientific concepts. The third one explored on how teachers collaborate with colleagues or school leaders to support the integration of critical thinking in their science classrooms. The fourth one looked at what challenges do teachers face when trying to integrate critical thinking skills in their science classrooms? The study findings are summarized in the next paragraphs.

5.2.1 School climate

The prevailing school climate in schools, particularly the targeted school has been observed to be prepared enough to offer science education which gives learners the ability to apply critical thinking in most of their tasks or during teaching and learning of scientific concepts. Teachers claimed that they are demotivated to fully discharge their duties due to prevailing conditions. The

participants were of the view that school climate can be enhanced by creating synergies with other well-established schools and colleges or even universities, in order to enable learners to access modern equipment, have exposure to real life situations in well-equipped science laboratories and be able to carry out most of the experiments. Improvisation must not always be regarded as the first port of call but must be an option where at least resources would not have permitted in certain cases and not in all cases. Authorities were encouraged to promote a culture for the desire to pursue science subjects within junior learners. There is also need for an improved consultation of science teachers with school authorities on issues such as departmental budget allocation and procurement of science equipment.

5.2.2 Lack of resources

Despite holding inquiry-based science teaching in high esteem, the main instructional methodologies for imparting inquiry skills and critical thinking skills to learners employed by science teachers are the traditional lecture method. The participants claimed that the main factors contributing to resorting to transmission teaching methods was lack of resources, inadequate supply of relevant laboratory equipment, large classes, lack of standard text books, lack of ICT tools and infrastructure, limited time to complete syllabuses and teaching science for examinations.

5.2.3 Challenges in integrating ICT in teaching science.

The majority of science teachers in Zimbabwe have basic ICT competencies to search for files on the internet and organize them into folders. However, during interviews science teachers indicated that they rarely use ICT tools in the teaching and learning. The participants attributed the low or non-use of ICT tools in their teaching and learning to lack of a clear ICT in schools, with only a

few schools allowing learners to use their smart phones for learning purposes. Use of ICT tools help learners to research widely and critically analyse scientific concepts. This promotes critical thinking within learners as they expose themselves to various sources of information other than their text books only. The teachers suggested that there was an urgent need for schools to develop basic ICT infrastructure, source modern ICT equipment and to establish a clear ICT policy for schools to implement for the benefit of learners.

5.2.4 Lack of teacher professional development opportunities

Science teachers are subjected to one shot traditional staff development workshop offered to them in schools. The staff development opportunities prevalent in schools are more focused on the teaching methods at the expense of scientific content. Participants suggested the following areas as potentially viable for staff development: science content related seminars, experimental design and hands on activities skills, and use of instructional technology and delivery during lessons. These areas are so important in teaching and learning of science as they all have the potential to greatly improve the aspect of critical thinking within learners. Teachers were also of the view that staff development opportunities should be provided for science teachers in a familiar context, facilitated by teachers, and conducted in an interactive fashion to enhance chances of adoption of skills gained. The findings from the study culminated in several conclusions about science teachers' interpretations and implementation of the curriculum in Zimbabwe.

First, teachers provided insights into their perceived positive perceptions of the various science subjects curriculum. The curricula could be enriched through suggesting more hands-on activities and reducing their breath to make them compatible with apportioned times. The study revealed that science teachers

are inadequately prepared to teach and suggested that more could be done in restructuring teacher training programs with respect to standardising science subjects related content and pedagogical content offered at universities and colleges and synchronising how student teachers are taught in universities and how they are expected to teach in schools.

The low inquiry-based science practices which do not adequately induce critical thinking within learners are attributed to an examination driven curriculum such that teachers tended to focus on specific areas, especially practical activities which were thought to be examination targets. Teachers also pointed out that time constraints, learners' prior knowledge and inadequate modern equipment forced them to rush through their respective curriculum, resulting in learners' learning which is detrimental to proper understanding of science concepts. In itself, the scientific method is born out of critical thinking and it serves to promote critical thinking within science students.

The study findings provided insight into teachers' classroom in linking science concepts with every day life. The findings suggested that science teachers at low levels at linking science concepts with everyday life. Teachers pointed out that they need more guidance in facilitating the linking of science concepts to everyday life and that the curriculum designers should provide explicit science curriculum guide lines about how to do that. The findings offered insights regarding science teachers' skills in integrating ICT into the teaching and learning of science. Teachers lacked competence with respect to ICT skills and the school was not well resourced with regard to ICT tools. No computers were available for learners to use and research. The use of internet was constrained due to lack of reliable electricity; therefore, learners were unable to express themselves adequately in terms of ICT. This had a bearing in terms of their

ability to critically analyse scientific concepts through further research. It also became a constraint to teachers as highlighted by them in that they could not integrate critical thinking during their lessons to their liking.

5.3 Recommendations

From the findings, the following recommendations are proffered

Curriculum designers and policy makers should re-structure and standardise teacher training programs offered by Zimbabwean institutions to ensure that student teachers studying at different institutions are subjected to the same basic minimum body of knowledge. This will ensure that when qualified staff are enrolled into the teaching fraternity, their curriculum interpretations are similar and their aptitudes in terms of proffering adequate facilitation to learners so that they become critical thinkers are at a higher degree.

Teacher educators are urged to use learner-centred approaches and focus on how best to prepare the prospective teachers to face aspects of the school environment that affect their instructional practices. This approach will enable prospective teachers to easily adjust to the envisaged learner-centred teaching approaches.

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