Teaching Science and Technology for the Promotion of Scientific Literacy in Primary Schools: A Case of Selected Schools in Kasungu District

By

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MEDTE 1021

A thesis submitted to the Faculty of Education in partial fulfilment of the requirements for the degree of Master of Education in Leadership and Management /Teacher Education

At

Mzuzu University

April 2024

DECLARATION

I declare that the research work, "Teaching Science and Technology for Promotion of Scientific Literacy in Primary Schools: A Case of Selected Schools in Kasungu District", is my work and that all the quotes or sources used have been properly acknowledged and cited. It is being submitted in fulfilment of the requirements for the degree of Master of Education in Teacher Education by Research Report at Mzuzu University. It has never before been included in a thesis or dissertation submitted to this or any other institution for a degree, diploma, or other qualification.

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ACKNOWLEDGEMENTS

First and foremost, I would like to thank the Almighty God for the good health and wisdom He bestowed upon me throughout the research journey.

I would like to express my gratitude to my supervisor, Dr Margaret Mdolo, who provided guidance and encouragement throughout all the stages of my project and who also happened to be the Master's Degree programme coordinator. I am grateful for the technical support and guidance rendered that made it possible for this study to be completed within its time frame.

I would like to express my special gratitude to my husband Lutamyo Khonje. I simply could not have done it without his support and encouragement.

DEDICATION

This work is dedicated to my husband Lutamyo for his encouragement, and to my sons Fortune, Reymond, and Precious for their support.

ABSTRACT

The study aimed to investigate whether the teaching of Science and Technology in primary schools promotes scientific literacy. Teaching Science for the promotion of scientific literacy has become the major aim of science education in the Twenty-First Century, because of the developments that are taking place in science and technology which are bringing changes in the livelihood of people. Due to inadequate secondary schools and tertiary institutions, to achieve this goal, Malawi has to see to it that the teaching for promotion of scientific literacy in science education starts in primary schools, where the largest population is. The study was guided by the following objectives: (i) to assess primary school teachers' knowledge of scientific literacy; (ii) to analyse how teachers teach Science and Technology in primary schools for the development of scientific literacy; and (iii) to examine factors that promote or hinder teaching Science and Technology for the promotion of scientific literacy in Malawian primary schools.

This study was underpinned by the constructivism research paradigm and employed a qualitative approach under a multiple case study design. It was carried out under the Kasungu District Educational Manager in Central region, targeting teachers who teach Science and Technology in primary schools. Random sampling was used to select schools; purposive sampling was used to select teachers, and convenience sampling was used by the headteacher to select teachers based on their availability and subject allocation on the school time table. Sample size was dependent on saturation point; hence 8 schools were involved, with two participants at each school. The researcher got consent and clearance from the Mzunirec. Besides, informed consent was sought before the exercise of data collection from the district education officer, the head teacher and teachers at every school.

Data were collected using semi-structured interviews, lesson observation and document analysis. After data transcription, it was kept in files created on the laptop, flash disks, and hard copies to avoid losing the information. Additionally, data were analysed thematically. The study found that all the 16 teachers demonstrated inadequate knowledge in the area of scientific literacy, and there was the predominant use of teacher-centred methods accompanied by insufficient use of resources, which hindered the promotion of scientific literacy in primary schools during the instruction of Science and Technology.

Keywords: scientific literacy, teacher-centered approach, science and technology, livelihood

GLOSSARY OF ACRONYMS/ABBREVIATIONS

MIE: Malawi Institute of Education

MoEST: Ministry of Education, Science and Technology

MW2063: Malawi Vision 2063

MZUNIREC: Mzuzu University Research Ethics Committee

NESIP: National Education Sector Investment Plan

NPC: National Planning Commission

OECD: Organisation for Economic Cooperation and Development

PISA: Program for International Students Assessment

PSLCE: Primary School Leaving Certificate of Education

TTC: Teacher Training College

ZPD: Zone of Proximal Development

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CHAPTER ONE: INTRODUCTION

1.0 Introduction

This chapter is aimed at discussing the background to the problem, the problem statement, purpose of the study and objectives, justification of the study, theoretical framework, description of the theory, relevance of the theory to the study, scope of the study and delimitation and operational definition of key terms.

1.1 Background to the study

Teaching Science in schools for promotion of scientific literacy has become a central focus in the 21st Century (Utami et al., 2015). Different scholars have defined scientific literacy in different ways, leading to a lack of consensus on its exact meaning in the scholarly community (Ogunkola, 2013). Among others, She et al. (2018) and Singh (2016) define scientific literacy as the possession of knowledge and understanding of scientific concepts and processes, crucial for decision-making, active participation in public and cultural affairs, and fostering economic development. Ajayi (2018) and Ogunkola (2013) view a scientific literate person as the one who has the capacity to appreciate and understand the impact of science and technology in everyday life, make informed personal decisions related to science, interpret media reports on issues like climate change and pandemics critically, and actively engage in discussions concerning science. Güçlüer and Kesercioğlu (2012) add that a scientifically literate person not only knows scientific concepts, principles, and theories but also understands the scientific process and recognises the interconnections between science, technology, society and the environment.

It should be noted that most definitions of scientific literacy emphasise on the ability to understand concepts and processes of science, and the ability to use scientific knowledge and skills. Therefore, in this study, scientific literacy is being defined as the knowledge of basic scientific concepts and processes and its application in everyday life. From this definition, a scientifically literate person is viewed as one who is able to understand and apply basic knowledge of scientific concepts and processes in everyday life and be innovative in using these scientific ideas.

Nowadays, teaching science for the promotion of scientific literacy has become a central goal of science education due to global advancements in science and technology that are bringing changes to the lives of people (Law, 2022; Utami et al., 2015). Keeping up with these advancements is vital for everyone, emphasising the paramount importance of fostering scientific literacy. Development of scientific literacy not only contributes to individual and household progress, but also plays a significant role in enhancing social and economic growth at both national and global levels (Ristanto et al., 2017).

Consequently, science teachers have a vital role in helping students understand scientific ideas. To achieve this, teachers need to know a lot about scientific literacy and how to achieve it. They should also be aware of the different ideas students might have about science, whether they are correct or not (misconceptions) and find ways of clearing them. The expectation is that teachers should be scientifically literate, equipped with the necessary knowledge and awareness to facilitate a comprehensive understanding of scientific concepts and processes among their students (Ristanto et al., 2017; Sultan et al., 2018).

This involves not only fostering a better grasp of scientific principles but also establishing meaningful connections between the lesson content and real-life. So, teachers play a big part in making lessons interesting and understandable for students (Avery & Meyer, 2012).

Furthermore, to effectively teach science for promotion of scientific literacy, teachers must be creative and confident. This helps them gain the trust and attention of students, making science lessons enjoyable and interesting. In addition, teachers should ensure that every student, despite their learning differences, feels included in the classroom (Avery & Meyer, 2012). Above all, teaching science for scientific literacy requires enough resources and active participatory methods of teaching, such as inquiry-based learning, cooperative learning and others (OECD, 2017). They actively engage students in their endeavour of knowledge construction, real-world problem-solving, and conducting investigations. Ogunkola (2013) adds that giving students time for explorations, observations, testing ideas, and engaging in various activities is crucial in fostering a deeper understanding of scientific concepts and skills. Overall, effective teaching for scientific literacy requires teachers to be knowledgeable, prepared, confident, and competent in using participatory methods and resources in the teaching and learning process (Chikasanda et al., 2014; Ogunkola, 2013).

In Malawi, primary education registers the highest number of students than any other level of education and is the highest educational qualification that most Malawian citizens manage to achieve (RIPPLE Africa, 2013). So, to the majority of Malawians, primary education is terminal but it is not known if it promotes the development of scientific literacy in learners to match with the national agenda of MW2063.

Some of the reasons for not studying beyond primary education is poverty that prevails in many households (RIPPLE Africa, 2013) and low transition rate of students from primary to secondary education, because of fewer secondary schools in the country. The transition rate was about 36% in 2014 and was improved to 38.3% in 2018 (NESIP 2020-2030, 2020). This still depicts limited access to secondary education. Hence if the majority of Malawian citizens are to benefit and become scientifically literate, then promotion of scientific literacy needs to start right in primary education. Teachers in primary schools need to seriously consider promotion of scientific literacy in science lessons. According to the primary school curriculum, science is taught in Science and Technology, which starts from Standard 5 to 8. In lower classes, Standards 1,2,3 and 4, science is embedded in subjects like Life Skills, which is called 'Luso la Moyo wa Bwino'; Agriculture – 'Ulimi'; and Expressive Arts (MoEST, 2007). Science and Technology is the main science subject in primary schools.

Malawi has a vision for the next 40 years, laid out in its 2063 Agenda. Among others, the country wishes to have the majority of her citizens scientifically literate so that they have a wider opportunity to adapt with the dynamics of life and be able to increase development of the nation by creating wealth for sustainable living and self-reliance (NPC, 2020). So, the citizens are expected to be innovative and strive for socio-economic freedom by 2063 by taking part in income generating activities; observing healthy values; promoting agriculture; fighting against corruption and many more developmental agenda. This implies that if the country is to achieve this vision by 2063, Science and Technology in primary schools has to be taught in a way that promotes development of scientific literacy; however, little is understood if teachers promote it in their teaching.

1.2 Statement of the problem

Malawi expects to have a more scientifically literate society to support and contribute to the developmental agenda of the country, and realise a better and sustainable living by 2063 (NPC, 2020). A scientifically literate society is one which uses scientific knowledge to live a successful and sustainable life. The majority of Malawian citizenry only manages to attain primary school education as they do not proceed to secondary education due to poverty that prevails in many households, and inadequate secondary schools. Therefore, to achieve a scientifically literate community she desires, Malawi has to see to it that the teaching for promotion of scientific literacy starts in primary schools, where the largest population of learners is. Thus, Science and Technology in primary schools should be taught in a way that promotes the development of scientific literacy in learners. Literature emphasises that to develop scientific literacy in learners, among others, teachers should be scientifically literate and have sufficient knowledge on scientific concepts and process; and that the teaching and learning process should immerse learners into active participation through use of active participatory teaching methods; use of a variety of resources; link the lesson to real life situation; and help learners to practise being scientists in science classrooms (Aragao & Marcondes, 2018; OECD, 2017; Chikasanda et al., 2014; Ogunkola, 2013).

However, little is known as to whether the teaching of Science and Technology in primary schools promotes scientific literacy in learners so that more citizens with scientific literacy are nurtured to support Malawi 2063 Agenda. This is why the current study sought to investigate whether the teaching of Science and Technology promotes development of scientific literacy in learners in primary schools in Malawi.

1.3 Purpose of study and objectives

The study aimed at assessing if the teaching of Science and Technology promotes scientific literacy in some primary schools in Kasungu district and was guided by the following specific objectives:

1. To assess primary school teachers' knowledge on scientific literacy
2. To analyse how selected teachers teach Science and Technology in primary schools for development of scientific literacy
3. To examine factors that influence the promotion of scientific literacy in the teaching of Science and Technology in Malawian primary schools.

1.4 Justification for the study

The study sought to investigate if teaching Science and Technology promotes scientific literacy in Malawian primary schools. Promotion of scientific literacy in the teaching and learning of Science and Technology in primary schools would help the country to equip the young ones with basic scientific skills and raising more citizens with scientific literacy who would take part in the implementation of the Vision 2063 Agenda of turning the country into a wealth creating nation. This study will therefore, expose the gap(s) in primary schools about promotion of scientific literacy in Science and Technology. The education stakeholders will find this study very useful in checking if primary education curriculum and its implementation contribute towards the 2063 Agenda of achieving a scientifically literate society who can play a role in improving the face of the country from poverty to wealth creation, and fixing the policies where necessary. It is anticipated that other scholars will use the findings of this research as the basis for further scholarly research in the same field.

1.5 Theoretical framework

The study was guided by the Social Constructivism Learning Theory by Lev Vygotsky, which emerged in 1970's (Agarkar, 2017; Vygotsky, 1978).

1.5.1 Descriptions of the theory

Constructivism is a theory of learning which states that humans generate knowledge and meaning from interactions and experiences (Barnett, 2019). The theory states that learners need to construct knowledge by themselves rather than passively getting information. According to the theory, knowledge is constructed through one's own personal experiences and interactions with the outside world (Amineh & Asl, 2015). As learners experience the world and reflect upon those experiences, they build their own representations and incorporate new information into their pre-existing knowledge. It considers social interaction or collaboration with other people like parents, teachers, clever peers and classmates as helpful in the construction process of knowledge. Social interaction contributes to cognitive development of a learner; and internalisation also occurs more effectively when there is social interaction (Barnett, 2019).

Vygotsky's social construction theory is applied in four areas: zone of proximal development (ZPD), scaffolding, cooperative learning and cultural influence (Barnett, 2019). The ZPD is the difference between what a learner can do without help and what a learner can do with guidance and learning support. It defines the gap between what a learner has already mastered and what he or she can achieve when provided with potential development support.

It can be described as the distance between the actual level of development as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers. So, it focuses at developing students' thinking capability and personality, and building curiosity and inquisitive mind in learners about their environment rather than memorising information (Margolis, 2020).

Vygotsky (1978) states that every child has stages of skill development as follows:

- A level that a learner can do tasks without assistance
- A level that learner can achieve tasks with assistance from a teacher, clever peers and parents
- A level that a learner cannot do tasks even with assistance

He referred to the level where individuals can achieve tasks with help as 'their ZPD.' This is a zone where scaffolding takes place – assisting students to develop skills. Scaffolding involves a more knowledgeable person who guides students through a task which is slightly above their ability. As students become proficient, the expert gradually withdraws the help until the students can perform the skills by themselves (Margolis, 2020). Scaffolding can also be taken as cooperative learning involving learners working with other learners one-on-one; they learn from each other and put their skills and talents together to complete the assignment. The principle of ZPD and scaffolding works better when students are working within their level of ability and teachers need to take into account learners' differences. Scaffolding can take place in a classroom or outside the classroom setting (Barnett, 2019).

Cultural influence is another aspect of Vygotsky's social constructivism theory, which recognises and embraces different ethnic backgrounds of students. The theory states that social interaction and culture influence are ways of how the students learn. Therefore, there is need for teachers to recognise and embrace students' differences for effective teaching and learning (Barnett, 2019).

According to the theory, learning is an active process through which learners construct ideas based on their existing knowledge and interaction with the natural world. Learners are involved in hands-on, minds-on and mouth-on activities (Amineh & Asl, 2015). During the teaching and learning process, the teacher provides learners with materials and devises methods that are learner-centered such as cooperative learning, problem-based learning, project-based learning and many more. These strategies allow students to interact with the resources, environment and with one another in order to discover new knowledge by themselves and the instructor just facilitates the process. Teachers adopt the role of facilitators to actively engage learners and help them get to their own understanding of the content (Agarkar, 2017).

1.5.2 Relevance of the theory to the study

This social constructivist theory is appropriate for the current study because, according to Amineh & Asl (2015), constructivist teachers allow learners to explore and get to their own understanding; and put their knowledge to practice. Learners are expected to apply what they have learnt in class and outside the classroom. They are actively engaged in the lesson in social groups through learner-centered approaches and resources (Barnett, 2019).

In the same way, teaching for promotion of scientific literacy in learners, in a science classroom requires active participation of learners; and imitative learning whereby students mimic the work of scientists to experience real life situations. Learners need to build knowledge by themselves and apply it in everyday life. They need to learn through social interaction between the teacher and the learner, and learners themselves in small cooperative groups or as a class which act as ZPD where knowledge and skills are generated and tasks are completed together. Teachers and other clever students facilitate the process of learning, which is the same as scaffolding to make sure there is active participation, and relevant knowledge and skills are being generated in social groups (Agarkar, 2017). In scaffolding, the teacher acts like a facilitator to guide the process and needs to accommodate different cultural backgrounds of learners for effective learning.

Teaching for scientific literacy also requires teachers to effectively plan for instruction to actively engage learners and make sure that different backgrounds, experiences and learning styles of learners are taken into account before commencement of instructions (Ogwahemeji, 2021). So, for teachers to inculcate scientific skills in learners, they need to devise participatory methods of teaching and resources, which need thorough preparation so that leaners are actively engaged in their endeavor of knowledge construction. This would therefore, help the students achieve scientific literacy in science which is currently a desired outcome of science education, and which requires constructivism approach to teaching (Ogwahemeji, 2021). The theory helped the researcher to review relevant literature, design research objectives, collect relevant data, identify themes for coding data from document analysis and lesson observation, and analyse the data accordingly.

1.6 Scope of the study and delimitation

The study was carried out in Kasungu district, which is found in the central region of Malawi and conducted within public primary schools. The study focused on 8 primary schools in the district, which were randomly selected and has a sample of 16 Science and Technology teachers who were purposively selected; two from each school. The sample size was dependent on saturation point of data. The study aimed at investigating if the teaching of Science and Technology promotes scientific literacy in primary schools and the objectives included the following: (i) assessing primary school teachers' knowledge on scientific literacy; (ii) analysing how selected teachers teach Science and Technology in primary schools for development of scientific literacy; and (iii) examining factors that promote or hinder teaching Science and Technology for scientific literacy in Malawian primary schools.

1.7 Operational definitions of key terms

The following concepts have been defined to convey the meaning in which they were used in this study:

Scientific Literacy:

The knowledge of scientific concepts and processes, and its application to address the challenges in everyday life.

Constructivism:

The approach of active involvement of learners in the process of teaching and learning in their endeavor of constructing knowledge as instructors take up the role of a facilitator.

Scaffolding:

Guiding the process of teaching and learning.

ZPD:

Social groups where knowledge and skills are generated and tasks are completed.

Cooperative learning:

The instructional use of small groups so that students work together to maximise their own and each other's learning.

Inquiry based learning:

The learning process that engages students by making real-world connections through exploration and high-level questioning. It encourages students to engage in problem-solving and experiential learning.

Facilitator:

An educator who guides, supports, and empowers learners to become active participants in their own learning journey. He facilitates the development of critical thinking, problem-solving, and collaborative skills in learners, which eventually prepare students for success in an ever-changing world full of science and technology.

In-service Training:

Planned courses and activities in which a serving teacher, headteacher school inspector or educational administrator attends for the purpose of improving instructional or professional knowledge, interests and skills.

Pre-service Training:

Training in a teachers' college, where a student teacher is introduced to the knowledge and skills needed to do a professional job in teaching.

Continuous professional development:

lifelong career advancements which include trainings or processes that improve the job-related knowledge, skills, or attitudes of teachers and other educational stakeholders.

MW2063:

It expresses the vision and aspirations of Malawians by 2063 of becoming a wealth creating and self-reliant industrialised country.

Science and Technology:

one of the science subjects delivered in primary schools in senior classes – from standards 5 to 8.

Science and technology:

science is the systematic study of the natural world to understand its underlying principles and laws. Technology is the practical application of scientific knowledge to solve real life problems, improve processes, and create useful products or systems. Science provides a basis of knowledge whilst technology uses this knowledge to drive innovation and progress in various fields. Collectively, they play a very crucial role in shaping modern society.

Socio-economic development:

The process of improving the overall well-being and quality of life in a community or nation or region by addressing economic, social, and cultural challenges. It includes efforts to reduce poverty, improve education, healthcare, infrastructure, and create economic opportunities. The developmental process is often driven by government policies and international development programmes to encourage sustainable growth and improve living standards.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Literature review is a discussion of the current published materials available for a certain research topic. It summarises, synthesises and evaluates the materials and information according to research objectives, thesis and central themes (Ramdhani et al., 2014). This chapter presents related literature review to the study and addresses the objectives of the study. The literature is reviewed under the following headings: definition of scientific literacy; history of scientific literacy; importance of scientific literacy; characteristics of scientifically literate citizens, the goal of teaching science education, strategies for promotion of scientific literacy, factors affecting the promotion of scientific literacy and the summary of literature review.

2.1 Literature Review

2.1.1 Definition of scientific literacy

Scientific literacy undergoes constant evolution, with diverse definitions reflecting changes in the scientific field over time. The literature review reveals that scientific literacy is often described as the knowledge and comprehension of scientific concepts and processes crucial for decision-making, public and cultural participation, general education, and economic development (Aulia, 2019; Hodson & Wong, 2017; Singh, 2016; Fives et al., 2014; OECD, 2013). Notably, these definitions emphasise the practical use of scientific knowledge and skills in explaining natural phenomena and finding solutions.

In this study, scientific literacy is primarily concerned with the functional application of scientific knowledge and skills in real-life situations, rather than playing around with scientific jargons and complex scientific systems. The focus is on cultivating basic scientific common sense and utilising it in everyday activities for successful and sustainable living. So, scientific literacy in the current study is viewed as having the basic knowledge to apply scientific processes in every-day life. This perspective partially aligns with many studies, including Dragoş and Mih (2015), who see scientific literacy as the understanding and application of scientific concepts and processes for decision-making, sustainability, and the conservation of global resources. Similarly, Ogunkola (2013) argues that scientific literacy is not about mastering specialised jargon for expert careers, but serves a broader educational purpose, aiding citizens in living more productively within the natural world. Hence, this study concentrates on fostering fundamental knowledge of scientific concepts and skills for practical application in daily life.

2.1.2 History of scientific literacy

The term “scientific literacy” started in the late 1950s when Paul Hurd used it in a publication called 'Science Literacy for All Americans' (Hurd, 1958). It began because the American science community was worried about people supporting science, especially after the Soviet launch of Sputnik (Murcia, 2006). After World War II, seeing science used for making atomic bombs made scientists and interest groups realise that it was important to teach people about scientific literacy. This meant giving the public the ability to understand and influence scientific activities in both positive and negative ways (Murcia, 2006).

The creation of the National Science Foundation in 1954 pushed the integration of scientific literacy into education. The Foundation supported research in science and engineering, making education programmes spend more money to help people understand science and its impact on society (Murcia, 2006). However, despite these efforts, scientific literacy faced challenges in the late 1970s, because researchers could not agree on its definitions and meanings (Ogunkola, 2013).

In the 1970s, more concerns came up, with U.S. citizens wondering if their education system prepared children well for a society filled with scientific and technological advancements (Kauano & Marandino, 2022; Vandegrift et al., 2020). At the same time, there was a need to address societal issues based on science, promote industrial growth, and align education with market needs. This led to changes in the school curricula to make scientific literacy an important goal (Kandiko et al., 2021; Laugksch, 2000; Shamos, 1995).

In the 1980s, there was a renewed interest in scientific literacy. This was because of concerns about the U.S. losing its competitiveness and leadership in industry. The perceived crisis in science education led to a renewed focus on the importance of scientific literacy (Murcia, 2006). Since then, the world has recognised how crucial scientific literacy is, and this has put pressure on schools to make science education a priority for developing scientific literacy (Vandegrift et al., 2020).

In the present era, scientific literacy in science education responds to the ever-evolving landscape of science and technology. It reflects the acknowledgment that a scientifically literate populace is crucial for navigating the complexities of modern life and contributing to societal progress and global competitiveness (Law, 2022; Utami et al., 2015).

2.1.3 Importance of scientific literacy

Globally, scientific literacy is no longer confined to a selected few pursuing careers in science; it has become an essential tool for everyone. Law (2022) and Utami et al. (2015) argue that in today's complex, science-driven world, scientific literacy is crucial for navigating daily life. Recognising this, Five et al. (2014) emphasise prioritising scientific literacy in science education for all students, irrespective of their future careers. They highlight that instilling scientific literacy from an early age shapes values and attitudes, fostering the development of scientifically literate citizens (Yacoubian , 2017). In this contemporary era, keeping abreast of scientific and technological developments is not just a personal necessity, but a societal imperative for socio-economic growth (Ristanto et al., 2017). Monda and Das (2021) and Utami et al. (2015) align with Five et al. (2014), underscoring that achieving scientific literacy is now a primary goal in science education, irrespective of students' future careers. Ristanto et al. (2017) argues that success in a country's development necessitates students with robust scientific literacy and a commitment to lifelong learning, fostering socio-economic transformation. Ahmad and Nuangchalern (2020) add that a literate populace is essential for navigating a world driven by creativity, and with the introduction of scientific literacy at an early stage, helps shaping young ones into responsible and innovative citizens (Five et al., 2014).

Ogunkola (2013) underscores the critical role of scientific literacy in empowering citizens with essential skills, attitudes, and values for critical thinking, problem-solving, and decision-making. Ahmad and Nuangchalern (2020) stress that scientific literacy transforms individuals' mindsets, enabling them to question, analyse, and engage with natural phenomena. This transformative power makes citizens competitive, employable, and innovative, aligning with national developmental goals (Ogunkola, 2013). Smith et al. (2015) adds that scientific literacy facilitates informed decision-making on critical issues affecting individuals and their families. Ogunkola (2013) adds another layer, asserting that science not only enhances competitiveness and employability, but is also foundational for innovation in various spheres. He contends that our aspirations for a better world hinge on the scientific literacy citizens possess, enabling them to comprehend innovations and make informed decisions in their daily lives. Scientific literacy, according to Ogunkola (2013), acts as a shield against misinformation, particularly in areas like diet and medicine. Yacoubian (2017) aligns with this view, emphasising that scientific literacy equips children with skills to interpret new scientific developments and fosters competitiveness and innovation in workplaces.

Apart from this, Okada (2013) highlights that scientific literacy is a major element in developing national prosperity, raising the quality of public and private decision making and promoting the life of citizens. He further claimed that it is one of the key competences to any citizen in the 21st Century. In addition, scientific literacy has personal benefits such as being able to come up with better decisions on issues like prevention and control of diseases, balanced diet meals, food preservation, drug and substance abuse and many more (Smith et al., 2015).

However, if scientific literacy is not well regulated by the government, it may lead to creating things that would be hazardous to communities hence causing health and environmental problems (Chikasanda et al., 2014). In summary, scientific literacy is not merely about knowledge, but is a practical tool for daily life. Therefore, teaching for scientific literacy in science education plays a pivotal role in shaping students into responsible citizens who actively contribute to socio-economic developments in our technologically advancing era.

2.1.4 Characteristics of scientifically literate citizens

Ogunkola (2013) describes a scientifically literate person as someone who cares about health, environmental, and social issues. This individual is always prepared to take responsible action to address these concerns and find improved solutions. They feel empowered to apply their scientific skills as tools to tackle challenges. A scientifically literate person is consistently eager to conduct new research, displaying a research-oriented mindset. They actively seek a better understanding of scientific concepts and regularly apply this knowledge in their everyday experiences. These are some of the key characteristics of scientifically literate individuals. Scientifically literate citizens possess essential characteristics that are extensively discussed in the existing literature. Okada (2013) and Ogunkola (2013) underscore the role of critical thinking skills, emphasising their contribution to the analysis of information, innovation, evaluation of evidence, and formation of reasoned conclusions. Ahmad and Nuangchalern (2020) further supports this argument, emphasising the curiosity and inquisitiveness displayed by scientifically literate individuals, noting their natural inclination to pose questions and pursue a deeper understanding.

The application of scientific knowledge to real-world situations is another characteristic attributed to scientifically literate citizens, as acknowledged by Ogunkola (2013) and Güçlüer and Kesercioğlu (2012). This ability allows individuals to connect scientific concepts to their daily lives, enabling informed decision-making across various domains such as health, the environment, and technological advancements. Additionally, Ogunkola (2013) argues that these individuals actively seek opportunities for exploration, observation, and experimentation, challenging the conventional notion of passive information recipients. They know principles and theories about science and use the knowledge accordingly (Ahmad & Nuangchalern, 2020; Five et al., 2014).

A critical review of literature emphasises the cultivation of a healthy scepticism in scientific literate citizens. Smith et al. (2015) and Ogunkola (2013) highlight their role as discerning consumers of information, capable of critically evaluating claims and being vigilant against potential misinformation and make informed decisions. This argument aligns with Sultan et al., (2018) assertion that ongoing learning is a characteristic of scientific literacy, acknowledging the dynamic nature of scientific knowledge and the need for individuals to stay informed about the latest developments. The interconnectedness of science with other societal aspects is a recurrent theme in the literature, supported by Güçlüer and Kesercioğlu (2012). The ethical implications of scientific advancements and consideration of broader societal impacts are critical components of scientific literacy, empowering individuals to contribute meaningfully to discussions and make informed choices. In conclusion, the arguments presented in the literature underscore the vital role of these characteristics in fostering scientific literacy and active participation in the evolving landscape of science and technology.

2.1.5 The goal of teaching science education

One of the main objectives of science education is to promote scientific literacy, and science education should start in basic education in order for citizens to develop some basic skills for scientific literacy (Aragao & Marcondes, 2018). The fact that different studies have emerged to promote the teaching of scientific literacy in schools, is great evidence that the goal for science education has not been reached (Ongunkola, 2013). The studies reveal that both short- and long-term interventions that were made to promote scientific literacy have proven futile because they did not show broader trends on how to teach for promotion of scientific literacy. Ongunkola (2013) concludes that looking at both interventions- short and sustained- researchers have emphasised that scientific skills need to be addressed in their appropriate context, which aligns with Aragao and Marcondes (2018) that teaching observational sciences leads to better understanding of the nature of science, which is one of the components of scientific literacy. This implies that although no consensus has been made on the understanding of the term scientific literacy, teaching science for scientific literacy is of utmost importance in the 21st Century.

2.1.6 Strategies for promoting scientific literacy

2.1.6.1 Instruction through participatory methods and resources

Different strategies have been identified on how to promote scientific skills in science classrooms by different scholars (Okada, 2013). Above all, OECD (2017) claims that teaching science for scientific literacy requires active participatory methods of teaching such as inquiry-based learning, cooperative learning and others. This aligns with Okada (2013), that several researchers emphasise participatory methods and resources as the meaningful approach for teaching scientific literacy, which supports learners to apply scientific concepts and methods as scientists. It is argued that acquisition of scientific literacy is a process which develops as a product of inquiry - learning activities are designed to encourage students to find inquiry-based solutions for authentic problems. These methods make students active in their endeavor of constructing new knowledge and practicing the work of scientists in a classroom. They encourage students to become actively involved in creating, designing and conducting their own investigations and communicating the findings to their fellows; students work in groups collaboratively, attempting real world problems, and questions.

Sultan et al. (2018) adds that teaching for promotion of scientific literacy requires teachers to have wide knowledge on what scientific literacy is and how it can be achieved, and stay updated. Besides, it requires them to have sufficient knowledge about the scientific concepts and processes; and be aware of the naïve ideas of children about science, since they come in a classroom with different ideas, correct and wrong ones. Therefore, teachers are expected to be scientifically literate to deliver, bring about better understanding in students of scientific concepts and processes, and link the lesson to real-life situations. Ristanto et al. (2017) also emphasises the need for teachers to find and devise better methods of clearing out the misconceptions in students. They also need to be creative and confident when teaching scientific concepts to gain trust and attention from the learners and make science lessons fun and interesting to them. They also need to make sure that everyone is accommodated in the classroom, despite their learning differences (Avery & Meyer, 2012). Therefore, to achieve this, teachers need to have thorough preparation.

Additionally, Ogunkola (2013) claims that learners need to be given time for explorations, observations, testing ideas, building and collecting things. They also need to be given time for constructing resources such as models, applying the knowledge in dealing with real problems or questions, asking questions, reading and arguing, and grappling with unfamiliar and counter-intuitive ideas. They need to be actively involved in their endeavor of constructing new knowledge. Therefore, teaching for scientific literacy requires teachers to be knowledgeable, creative, prepared, confident and competent in devising and using participatory methods and resources in teaching and learning process (Chikasanda et al., 2014; Ogunkola, 2013). On the same note, Ogunkola (2013) suggests four strategies for educators to improve scientific literacy in science classrooms:

- *Identify science topics of interest*: It is important to select interesting science topics and include them in the curriculum. There is a need for classroom science teachers to accumulate an extensive list of interesting and important topics before organising and planning for the lessons and then invite students to add some more topics of their interest. The goal is to make science lessons lively and interesting (Ogunkola, 2013).

- *Engage the students in reading research*: Science teachers must always create connections among science concepts, societal issues and the vocabulary that students will meet as they read research. The students build interest in science when they discover scientific knowledge on their own or with the help of their teachers (Ogunkola, 2013).

- *Teach students to read like scientists*: It is very important for students to be taught how to read and think like scientists, thus developing strategies for reading scientific writings and be able to build a deep understanding of related vocabulary. Teachers should model the thinking that occurs while reading graphs, charts, data tables, and data analysis sections.

- *Guide learners to evaluate data:* It is important for students to be able to interpret and evaluate data sources. Just like scientists, students need to know where and how to collect data, what the data represents and also multiple sources of data from multiple references can be drawn.

He concluded that using these methods would help students to understand the world around them and make informed decisions on how to interact with the world. However, these methods require clinical supervision and can be a challenge to the context of Malawian primary schools because of high teacher-pupil ratio. Ogunkola (2013) further suggested that science field trips or youth camps in schools should be designed to help the students interact with science. Parents also have a role to play in promoting the scientific literacy of their children. For example, they should be involved in answering questions for their children about how things work, helping them to form conceptual models and help them to see how pieces fit together. They can assist in developing the curiosity of their children, by spending time in relevant parks. They can also be exemplary to their children by taking part in simple scientific activities such as planting trees, doing garden work, recycling, and explaining why such things are beneficial so that they become motivated and follow suit.

Furthermore, traditional approaches to learning science encourage memorisation of scientific facts and information of phenomena. Aragao and Marcondes (2018) agree with Okada (2013), who established inquiry-based learning as one of the fundamentals of scientific literacy. Similarly, Barron and Darling-Hammond (2008) highlight that other learning models such as project-based learning, problem-based learning, cooperative learning, discovery, can also increase students' science literacy if effectively facilitated to the learners. This implies that they can also hinder the learning of science concepts if they are not well devised by the teacher.

2.1.6.2 Teaching science through indigenous knowledge

Kraijitmate et al. (2019) point out in a study they conducted in Thailand, that indigenous knowledge of our forefathers can be a successful tool for teaching science for scientific literacy. Teachers should draw science lessons and connect to indigenous knowledge and let the students apply the knowledge and then construct new knowledge. Apart from this, curriculum and text books should be constructed based on indigenous knowledge of that locality. This is one way of bringing the lesson closer to students' lives and making the lesson practical to everyday life. The results of the study reveal that teaching science based on indigenous knowledge of a locality or personal experience helps to promote scientific literacy and innovations. The study further reveals that this kind of teaching will help to transform the country from 'more for less to less for more' through scientific research, technology and innovations for security, prosperity and sustainability. Therefore, this method can be effective because children will be learning scientific concepts using their local experiences.

2.1.6.3 Teaching following scientific methodologies

According to Kilts (2022), teaching following scientific methods allows learners to acquire certain levels of scientific literacy in order to become prepared citizens and consumers of scientific knowledge. It involves employing approaches and practices consistent with the principles and methods of the scientific method. It includes encouraging students to engage in systematic observation, experimentation, analysis, and critical thinking to explore and understand scientific concepts (Kilts, 2022). This teaching approach emphasises hands-on learning, inquiry-based activities, and the application of scientific principles in problem-solving. The goal is to foster a deep understanding of scientific concepts and processes, promoting scientific literacy and skills among students. Philips (2019) and Duschl and Grandy (2013) debate around the use of fixed-step methods of hypothesis testing such as teaching 'the' scientific method. The method was claimed to leave the students with the assumption that if individuals follow the set steps of a particular scientific method, then they will always find the right answer to their questions. This scientism is a common problem in most science classrooms, because it encourages 'cookbook' impression of learning science concepts among students. The method does not promote creativity and innovation.

Kilts (2022) also highlights that the problem of scientism is being addressed by the National Science Teachers Association in their standards for Science Teachers preparation, which disapproves that scientific inquiry-based learning should not be compromised to a set of predetermined steps, but rather should be dynamic, depending on the situation and locality. Students need to be trained to explore their own methodologies for investigations.

However, most teachers still teach ‘the’ scientific method which is pre-defined steps in the science text books (Abd-El-Khalick et al., 2017). This does not promote learning and functionality part of scientific skills, but promotes memorisation of scientific jargons and processes hence compromises the acquisition of scientific literacy

2.1.7 Factors affecting promotion of scientific literacy

According to Chikasanda et al. (2014), lack of teachers’ knowledge and self-confidence in science and technology makes teachers feel insecure to promote interactive learning in the classroom for fear that they may be unable to attend to questions arising from learners. As a result, teachers tend to devise traditional methods of teaching, which promote rote learning in learners. Dragoş and Mih (2015) argue that developing teachers’ knowledge, skills, values and positive attitude towards science is crucial in an endeavor of improving scientific literacy in students. Teachers need to be lifelong learners to ensure sustainability in teaching Science and Technology for new scientific development. They need to keep themselves up to date to catch up with the emerging issues since Science and Technology is evolving every now and then. On the same note, Hardinata et al. (2019) supports the idea of an ongoing learning process of teachers, which builds knowledge about teaching in the context of developing teacher professionalism in science. So, in regards to the studies above, it can be concluded that teachers need to be scientifically developed so that they understand what scientific literacy is all about, which can ease the burden on students’ understanding of the phenomena and promote scientific literacy. Therefore, there is a need for intervention programmes in schools to support teachers in promoting Science for scientific literacy. This would help to fully equip teachers with the desired knowledge on how to teach Science education.

The implication of OECD (2017) report in line with Chikasanda et al. (2014), points out that teaching methods that teachers embrace are accompanied by lack of knowledge, which puts them at disadvantage to effectively equip learners with the required level of scientific literacy. As a result, there are poor levels of scientific literacy among the students internationally (OECD, 2013), which negatively affect the productivity of citizens and their ability to make intelligent and informed decisions (Achieve, 2013).

According to Barron and Darling-Hammond (2008), some of the factors that disturb the promotion of science literacy in a classroom, such as textbooks, learning models, learning media, worksheet, and evaluation tools, are supposed to be developed basing on science literacy. They need to contain proportional content of science as a body of knowledge, science as a way of investigative tool of nature, science as a way of thinking, and the interrelation of science with the environment, technology and society, to improve science literacy among students.

2.1.8 Literature review gap

One notable gap in the current literature on teaching Science and Technology for the promotion of scientific literacy in primary schools, particularly in the context of Malawi, is the lack of empirical evidence regarding the effectiveness of teaching practices in fostering scientific literacy among learners. While there is a growing recognition of the importance of scientific literacy and the role of education in achieving national development goals (Law, 2022), there is limited research specifically examining how primary education, in particular Science and Technology is taught in primary schools and whether the teaching approaches effectively promote scientific literacy among students in line with MW2063 (NPC,2020).

Existing studies provide insights into the conceptualization of scientific literacy and the significance of active participatory methods in teaching (Chikasan et al., 2014; Ogunkola, 2013), but there is a dearth of research that investigates the actual implementation of these methods in primary school classrooms and their impact on students' scientific literacy skills. Therefore, there is a need for empirical studies that explore the teaching practices employed by primary school teachers in Malawi, the resources available to support teaching and learning in Science and Technology, and the extent to which these practices and resources contribute to the development of scientific literacy among learners. Such research can provide valuable insights into the strengths and limitations of current teaching approaches and inform the design of evidence-based strategies to enhance scientific literacy in primary schools, aligning with the goals of the Malawi 2063 Agenda for national development.

2.2 Summary of literature review

The literature review delves into the multifaceted concept of scientific literacy, tracing its evolution, emphasising its practical application in real-life scenarios, and examining its historical significance since the late 1950s. Scientific literacy is portrayed as an essential tool in navigating the complexities of the modern world, contributing to societal progress and fostering economic growth. Its importance is underscored by scholars who argue that it goes beyond a mere acquisition of knowledge, serving as a means for making informed decisions on health, environmental concerns, and technological advancements. However, there is a cautionary note regarding the potential risks of unregulated scientific literacy, emphasising the need for responsible governance.

The characteristics of scientifically literate citizens, including critical thinking, curiosity, and the application of scientific knowledge, are highlighted, empowering individuals to actively participate in discussions and contribute meaningfully to the dynamic landscape of science and technology. The goal of teaching science education is identified as the promotion of scientific literacy, starting from basic education and emphasising the importance of addressing scientific skills in their appropriate context. Strategies for promoting scientific literacy, challenges, and factors affecting its promotion, such as teachers' knowledge, confidence, resources and teaching methods are explored. Essentially, the literature emphasises the transformative power of scientific literacy in shaping responsible and innovative citizens who actively engage with the complexities of modern life. Teaching science for scientific literacy is recognised as a crucial goal in education, contributing to individual development, societal progress and global competitiveness.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

This chapter provides an overview of the methodology which brings about the understanding of the whole research process (Creswell, 2018). It encompasses the research paradigm, approach, design, site, population, sample size, sampling techniques, data collection methods and instrument, data management, data analysis, trustworthiness and ethical considerations.

3.1 Research methodology

3.1.1 Research paradigm

A research paradigm serves as a foundational set of beliefs and assumptions guiding the research approach. It influences how scholars perceive and study the world, determining how they formulate research questions, methods of data collection, and interpretation of findings. There are several types of research paradigms, with the two main categories being positivist and interpretivist. Positivism focuses on objective reality that can be measured and observed, emphasising quantitative methods and statistical analysis. It seeks universal laws and generalisations, prioritising objectivity and replicability (Cohen et al., 2018; Creswell, 2018). In contrast, interpretivism recognises the subjective nature of reality, focusing on the point that different people in society experience and understand reality in different ways. It allows exploration and interpretation of meanings, emphasising deep understanding of social phenomena (Cohen et al., 2018). In this research, the philosophical assumption of constructivism is adopted.

Constructivism, falling under the interpretivist paradigm, speculates that reality is socially constructed and subjective. It asserts that understanding is context-dependent and emphasizes multiple perspectives, believing that all knowledge is a result of our experiences and reflections on those experiences and opposes the idea that there is a single procedure of generating knowledge. Constructivism allows in-depth exploration of participants' perspectives and understanding of the social reality (Creswell, 2018).

The adoption of constructivism in this research aligns with its interpretive nature, allowing for an in-depth exploration of participants' subjective experiences and perspectives in the context of promoting scientific literacy in primary schools, particularly in Science and Technology. Constructivism provides a framework to delve into the socially constructed nature of reality and the intricate ways individuals perceive and navigate educational experiences (Cohen et al., 2018; Creswell, 2018).

3.1.2 Research approach

A research approach refers to the overarching strategy or plan that guides the researcher in conducting a study. It outlines the methods and procedures employed to collect and analyse data, shaping the overall design of the research. Research approaches can be categorised into two: qualitative and quantitative (Creswell, 2018). Qualitative research is exploratory and focuses on gaining an in-depth understanding of a research phenomenon by examining details in a specific setting (Creswell, 2018). It employs methods like interviews, observations, and content analysis to gather rich, non-numerical data.

Qualitative research is adopted when exploring subjective experiences, social contexts, and the meanings individuals attribute to their experiences. Quantitative research, on the contrary, involves the collection and analysis of numerical data to identify patterns, relationships, or trends. It employs methods like surveys, experiments, and statistical analyses which allows generalisation and validation of findings across larger populations (Cohen et al., 2018; Creswell, 2018).

The choice to adopt either qualitative or quantitative approaches in research depends on the research questions, the nature of the phenomenon under investigation, and the goals of the study. In this research, a qualitative approach was chosen. This approach was deemed suitable for the study for exploring the intricate aspects of teachers' knowledge and practices related to scientific literacy in primary schools. The qualitative approach helped thorough exploration of the specific factors that influence the promotion of scientific literacy in the context of Science and Technology in primary schools. This aligns with the study's goal of understanding teachers' views and practices in this specific educational context (Cohen et al., 2018; Creswell, 2018).

3.1.3 Research design

A research design is the overall plan or structure that guides the process of collecting, analysing, and interpreting data in a research study (Creswell, 2018). There are several types of research designs, each serving specific purposes. One common type is the exploratory design, which is used to study a topic in-depth and generate understandings.

Another type is the explanatory design, which aims to understand the relationships between variables. The descriptive design is aimed at providing a detailed account of a phenomenon, while the experimental design involves manipulating variables to establish the cause-and-effect relationships. The choice of research design is crucial as it influences the study's validity and reliability. In this research, a multiple case study design was employed. A case study allows an in-depth investigation of a particular instance or a small number of instances within their real-life context. The multiple case study approach involves studying several cases to provide a broader perspective and enhance the generalisability of findings (Creswell, 2018). The decision to use a multiple case study design aligns with the research objectives of understanding teachers' perspectives on scientific literacy, examining how teachers teach Science and Technology, and scrutinising the various factors that impact promotion of scientific literacy in the context of teaching Science and Technology within primary schools. The main aim was not to compare the cases, but to conduct a thorough exploration of the diverse experiences and practices encountered by teachers (Creswell, 2018). Therefore, the study emphasised only on extracting valuable insights from the participants without engaging in case-to-case comparisons.

3.1.4 Research site

The research was carried out in primary schools under the jurisdiction of the Kasungu District Education Officer in central region. The selection of this research site was deliberate and based on accessibility, and logistical feasibility were key factors, ensuring that the researcher could effectively collect data from the selected schools.

3.1.5 Study population

The primary focus of this study was primary school teachers responsible for teaching Science and Technology. These teachers were chosen as they play a crucial role in the implementation of the Science and Technology curriculum at primary school level**.**

3.1.6 Sampling methods

Sampling techniques are methods used to select a subset of individuals or elements from a larger population for research purposes (Creswell, 2018). There are various types of sampling methods. Random sampling involves selecting elements from a population at random, giving each element an equal chance of being selected. This ensures that the sample is a representative of the entire population, reducing bias and promoting the generalisability of findings. Purposive sampling includes selecting specific individuals or elements basing on predetermined criteria that align with the research objectives. It allows researchers to focus on participants who possess the information or experiences relevant to the research questions, providing depth and specificity. Convenience sampling involves selecting participants based on their easy accessibility or availability. Convenience sampling is practical when time and resources are limited and allows for the inclusion of participants who are readily accessible (Creswell, 2018). In this study, a combination of sampling techniques was employed. Random sampling was used to select schools, ensuring a diverse representation and minimises biases. Then, purposive sampling was employed to select teachers based on their teaching subjects for the study focused on Science and Technology teachers. Finally, convenience sampling was utilised by the headteacher to select teachers based on availability and subject allocation on the school timetable.

3.1.7 Sample size

Sample size is the number of participants or elements chosen from a large population for inclusion in a research study (Creswell, 2018). Different techniques are employed to determine sample size in both quantitative and qualitative research. In quantitative studies, statistical methods like power analysis are often employed to determine the appropriate sample size. These methods aim to ensure that the sample is large enough to detect meaningful effects. Conversely, sample size in qualitative research depends on the concept of data saturation. This is a point where the sample size is deemed sufficient and it occurs when the new data no longer brings extra insights or themes to the study (Creswell, 2018). Determining an appropriate sample size is crucial as it directly impacts the study's outcomes. A sample size that is too small may lack generalisability, while an excessively large sample can result in unnecessary resource consumption. For this study, the sample size was guided by data saturation, a common approach in qualitative research: a point where data could not generate new themes (Creswell, 2018). It involved eight schools, with two Science & Technology teachers from each school, totaling 16 participants. This ensured a comprehensive exploration of teachers' perspectives on scientific literacy without unnecessary redundancy. The study contained only teachers from standards 5 to 7 because the time data was collected, standard 8 class had written PSLCE. This could not affect the results because requirements of teaching science for scientific literacy follow the same procedure. Further details about the participants are found in Table 3.1.

Table 3.1: Participants details

Participants	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
Gender	F	F	F	F	M	M	F	F	M	M	M	M	M	M	M	M
Age	27	31	35	43	42	26	37	48	54	27	33	28	40	29	49	45
Standards	5	6	7	5	7	6	7	5	7	6	7	6	7	5	7	6
School	Q1	Q1	Q2	Q2	Q3	Q3	Q4	Q4	Q5	Q5	Q6	Q6	Q7	Q7	Q8	Q8

KEY:

- P for participant
- F for female
- M for male
- Q for school

3.1.8 Data collection methods

Data collection is the process of gathering and obtaining information systematically for research purposes (Creswell, 2018). In both quantitative and qualitative research, various methods are employed to collect data. In quantitative research, common data collection methods involve surveys, experiments, and observations. Surveys involve structured questionnaires administered to a sample, experiments manipulate variables to observe their effects, and observations systematically record behaviours or events. Quantitative methods of data collection provide precise numerical data, allowing for statistical analysis and generalisation (Cohen et al., 2018; Creswell, 2018).

On the contrary, qualitative research employs methods such as interviews, focus groups, document analysis, and observations. Interviews, especially semi-structured interviews, involve open-ended questions that allow probing participants to express their perspectives in-depth. Focus groups gather information from group discussions. Document analysis involves examining existing records, documents, or artifacts. Observations provide a first-hand information of certain behaviours in its natural setting. Qualitative methods offer rich, context-specific data which facilitates a deep understanding of complex phenomena (Cohen et al., 2018; Creswell, 2018).

This study utilised semi-structured interviews, document analysis, and lesson observation as its data collection methods. Semi-structured interviews allowed for open-ended discussions, allowing the researcher to pose follow-up questions, exploring responses more deeply and extracting information pertinent to the research objectives (Creswell, 2018). This helped to collect data on all the three research objectives: teachers understanding of scientific literacy, how teachers teach for promotion of scientific literacy and factors that influence promotion of scientific literacy. Document analysis examined relevant materials such as lesson plans, offering a historical context of how teachers promote scientific literacy and this helped to gather data to address the second and third research objectives. Lesson observation provided direct observations of classroom practices of how teachers teach Science and Technology, also enhancing the triangulation of data. Lesson observation helped to collect data to answer all the three objectives of the study.

3.1.9 Data collection instruments

In the semi-structured interviews conducted for this study, an interview guide (Appendix IV) was utilized, collecting data to address all the three objectives of the study and the data were recorded using a voice recorder. A voice recorder served the purpose of ensuring the interviewer's focus on the conversation, avoiding potential distractions associated with note-taking during the data collection process (Creswell, 2018). For document analysis, a checklist (Appendix VI) was employed to gather data from lesson plans to address second and third objectives: to analyse how selected teachers teach Science and Technology and examine factors influencing promotion of scientific literacy and this information was recorded through note-taking (Cohen et al., 2018; Creswell 2018). Concurrently, during lesson observation, a lesson observation guide (Appendix V) was utilized to address all the three research objectives, concentrating on specific areas to acquire pertinent insights into teaching for the promotion of scientific literacy. Similar to document analysis, the data obtained from lesson observation was recorded through note-taking (Creswell, 2018). The selection of lesson observation was motivated by the aim of observing Science and Technology teaching in authentic settings, providing a more detailed and precise understanding compared to other data collection methods (Cohen et al., 2018; Creswell, 2014).

3.1.10 Data analysis

Data analysis is the process of inspecting, cleaning, transforming, and modelling data to discover useful information, draw conclusions, and support decision-making. In both quantitative and qualitative research, different methods are employed for data analysis.

In quantitative research, common data analysis methods include descriptive statistics, inferential statistics, and statistical tests. Descriptive statistics summarise and present data in a meaningful way, providing main features of dataset such as its central tendency, variability and distribution. Inferential statistics draw inferences and make predictions about a population based on a sample. Statistical test are mathematical ways of determining whether two sets of data are significantly different from each other, such as parametric statistical test and non-parametric statistical test. Although quantitative methods of analysing data offer statistical rigor, they may oversimplify complex phenomena and fall short of in-depth understanding of the context. Contrastively, qualitative research uses methods like thematic analysis, content analysis, and narrative analysis. Thematic analysis involves identifying, analysing, and reporting patterns or themes within the data. Content analysis is often used to quantify and analyse the presence of specific words, themes, or concepts within a set of texts. Narrative analysis involves examining the structure, content, and context of narratives (Cohen et al., 2018; Creswell, 2018).

All data analysis methods provide an in-depth exploration of participants' perspectives and experiences, but they may be influenced by the researcher's interpretation and subjectivity. Despite this inherent limitation, the present study chose to employ thematic analysis to unveil patterns and meanings within teachers' responses. Thematic analysis was selected for its capacity to facilitate deep understanding of the data, making it suitable for exploring the complex nature of teachers' perspectives on scientific literacy. The study adopted the combination of inductive and deductive coding methods. In deductive coding themes were predefined based on theory or research questions.

The data collection instruments were aligned to the constructs of the theory required for the study, and research objectives. So, the researcher had already predetermined themes during data collection. Inductive coding, on the other hand, was used in the analysis to allow themes to emerge organically from the raw data that was collected (Linneberg & Korsgaard, 2019).

3.1.11 Trustworthiness

The study employed various measures to promote trustworthiness such as credibility, transferability, dependability and confirmability (Cohen et al., 2018; Creswell, 2018; Lincoln & Guba, 1985). Credibility or internal validity refers to the extent to which the findings, interpretations, and conclusions of a study are trustworthy and believable. It measures whether the findings of the study are correct and accurate. This was achieved through triangulation of data from multiple sources, for instance, on implementation of promotion of scientific literacy, the findings were similar from all sources of data collection. Transferability, or external validity, in qualitative research refers to the extent to which the research results can be applied to different contexts or settings. In this study, transferability was enhanced by providing a detailed description of the research context, participants, and data collection methods. This thorough documentation enables readers to evaluate the relevance and applicability of the findings to various situations. Dependability, on the other hand, assesses the extent to which the study's results could be replicated by other scholars with consistent outcomes. To ensure dependability, a clear audit trail of the entire research process was maintained, documenting every decision and modification made during the study. This transparency allows for an examination of the study's dependability and its potential replication by other researchers.

Confirmability refers to the degree of neutrality in the findings of a study, ensuring that interpretations are grounded in participants' responses rather than influenced by potential bias or personal motivations of the researcher. To address confirmability, the researcher engaged in reflexive practices, acknowledging and documenting their biases and assumptions. An external auditor, unfamiliar with the study, reviewed both the research process and findings to minimise researcher bias. Additionally, an audit trail documenting every step of the data analysis was provided, serving as a transparent record to establish that the data faithfully represents participants' responses. This comprehensive approach contributed to the confirmability of the research outcomes (Creswell, 2018).

To achieve trustworthiness, the study incorporated other measures like member checking, triangulation of data and a pilot study. Member checking is a process in which participants were given the opportunity to review and validate the findings to ensure the accuracy of the data. Triangulation of data from multiple sources was employed to cross-verify information, recognising that discrepancies may exist between what is reported and the actual occurrences on the ground. A pilot study was also carried out to test the effectiveness of data collection tools, ensuring that relevant and reliable information could be gathered (Cohen et al., 2018; Creswell, 2018).

3.1.12 Ethical issues

The researcher followed ethical guidelines to ensure that all the participants of the study are treated with respect and consideration. The responses were kept strictly confidential. Ethical approval (Appendix II) was obtained from Mzuzu University Research Ethics Committee

(Mzunirec) to ensure that the involvement of participants in data collection agrees with local and international ethical guidelines. Permission to collect data in schools was obtained from the District Education Manager for Kasungu, headteachers of selected schools and all participants before the onset of the study (Appendices VII, VIII and IX). Furthermore, the participants were informed of the nature and purpose of the study and signed consent forms. The signed forms are not attached for confidentiality purposes but the form is in Appendix III. Permission was also sought from the headteachers and members that were snapped and the faces were masked to ensure the confidentiality and anonymity of the participants, as stipulated by Creswell (2014).

CHAPTER FOUR: FINDINGS AND DISCUSION

4.0 Introduction

This study aimed at assessing whether the teaching of Science and Technology in Malawian primary schools contributes to the promotion of scientific literacy. The study pursued three main objectives: assessing primary school teachers' knowledge of scientific literacy, analysing the teaching practices of selected Science and Technology teachers for the development of scientific literacy, and examining factors that either promote or hinder the teaching of Science and Technology for the development of scientific literacy in Malawi's primary schools.

Cohen et al. (2018) propose five methods for presenting qualitative data. The first approach involves presenting data through groups, which is effective for summarising responses from participant groups. This automatically organises data, making themes and patterns more apparent. However, this method is more suitable when a single data collection instrument is used, and it becomes challenging with multiple instruments. The second method is individual presentation, where responses from one participant are presented first before moving on to the next. This preserves the coherence and integrity of the responses from an individual and allows presentation of the whole picture of an individual. However, it is not possible to summarise data or issues arising across the individuals. The third method is by presenting all the data that are relevant to a particular issue. This is where the data that is relevant for a particular issue is collected and summarised together. However, individual's responses lose wholeness, coherence and integrity because comparison across all responses from individuals is difficult.

The fourth method involves organising data according to research questions or objectives. This method brings together all the relevant data from multiple sources to collectively address the research question. The fifth method of organising and presenting data is by instrument, where research findings of each instrument are organised and presented separately. The method is often supported by other methods such as by issue or by people. This study organised and presented its findings through research objectives. This decision aims to consolidate relevant data from various sources, directly addressing the study's objectives. The study does not intend to compare cases or isolate each issue; instead, issues are presented as they relate to each objective. The primary focus is on understanding teachers' perspectives on scientific literacy, examining how they teach Science and Technology, and identifying factors influencing scientific literacy in primary schools.

4.1 Findings and Discussion

4.1.1 Objective 1: Teachers' understanding of scientific literacy

The objective was to evaluate teachers' knowledge of scientific literacy, focusing on three key areas: their ability to define scientific literacy, which has been elaborated and adopted in the study; identify the characteristics of a scientifically literate person; and articulate how the promotion of scientific literacy can be implemented. Data was gathered through participant interviews using a set of questions from the interview guide (see Appendix IV) and classroom observations that targeted specific areas outlined in the lesson observation guide (Appendix VI). Following the analysis, the identified issues were categorised into three main themes: the definition of scientific literacy, attributes of a scientifically literate person, and the implementation of scientific literacy. The information obtained demonstrated a diverse understanding of scientific literacy among primary school teachers.

4.1.1.1 Definition of scientific literacy

The study evaluated teachers' comprehension of scientific literacy by examining their responses to the definition of scientific literacy. The study identified three key themes in the definition: knowledge of scientific concepts, knowledge of scientific processes, and application of knowledge. Participants were expected to incorporate these three themes in their descriptions. During interview, member checking was done which involved the researcher restating, summarising or paraphrasing the information received from participants to make sure that correct information is collected and not based on the researcher's motivation. In addition, the researcher spent extended period, interacting with participants and gaining an in-depth understanding of their perspectives. Surprisingly, out of the 16 participants, seven admitted encountering the term "scientific literacy" for the first time during the study, while 5 participants could articulate one key aspect of the definition, and the rest struggled to mention or grasp any fundamental aspect of the definition. Table 4.1 provides a summary of the analysis depicting how participants described the meaning of scientific literacy.

Table 4.1: How participants described the meaning of scientific literacy

Key themes of SL mentioned	**Participants**	**Frequencies (n = 16)**
Understanding scientific concepts	P3, P4 & P9	3
Understanding scientific process	-	0
Application of knowledge	P2 & P15	2
All three key aspects	-	0
Failed to mention any aspect	P7, P8, P12 & P14	4
Meeting the word for the first time	P1, P4, P6, P10, P11, P13 & P16	7

The study also summarised the responses of participants in 7 categories in Table 4.2 as those that were able to mention one aspect, two aspects, all the three aspects, failed to mention any aspect and meeting the term for the first time.

Table 4.2: Number of participants under 7 categories

Number of key aspects mentioned	Frequency of participants (n = 16)
One aspect	5
Two aspects	0
All three aspects	0
Failed to depict any aspect in their responses	4
Meeting the term for the first time	7

From the analysis, the study found that there are three categories of issues: teachers who mentioned one theme of the definition; those who failed to mention any theme and the ones who were encountering the term for the first time. The findings give valuable insights into the primary school teachers' knowledge about scientific literacy, as outlined by themes of the definition of scientific literacy: the understanding of scientific concepts, the understanding of scientific processes, and the application of scientific knowledge to everyday life. The responses varied, revealing a range of awareness and comprehension of the term “scientific literacy” among the participants.

A significant portion of the participants (7 out of 16) admitted to encountering the term “scientific literacy” for the first time during the study. This lack of awareness about the concept, ‘scientific literacy’ is alarming, especially considering that science education goals emphasise the promotion of scientific literacy in the 21st Century (Law, 2022; Utami et al., 2015), aligning with the aspirations of MW2063 for the development of scientifically literate societies. This discrepancy between educational goals and teachers' unfamiliarity with the term scientific literacy raises concerns about the alignment of teachers' perceptions with the evolving nature of scientific literacy. To bridge this gap, it is crucial for teachers to familiarise themselves with the correct terminology and ensure that their understanding aligns with the educational objectives outlined in official documents.

Five participants demonstrated a partial understanding of scientific literacy, articulating only one theme out of the three in their definitions, with none mentioning an understanding of scientific processes. This suggests that while some teachers may have some awareness of scientific literacy, they might not grasp the full scope of scientific literacy. This partial understanding underscores the necessity for support to ensure teachers grasp the broader scope, including understanding scientific concepts, processes, and their application in everyday life.

Furthermore, four participants failed to define the term "scientific literacy," offering responses that indicate a lack of clarity, as depicted in these responses:

> *P7: "To me I feel like it is knowing how to read and write and doing experiments"*
>
> *P8: "It is about how to civic educate the learners on science"*
>
> *P12: "Scientific literacy is about taking science subjects, learning science"*
>
> *P14: "Lacking knowledge of science.*"

Such responses show potential misconceptions or confusion in teachers' knowledge of scientific literacy. They indicate a disconnection between the intended definition and teachers' perceptions. The findings highlight a varied understanding of the term "scientific literacy" among primary school teachers, indicating a potential gap in awareness and exposure to the concept. This diversity in comprehension suggests that these teachers may face challenges in preparing and delivering lessons aligned with the goals of science education, particularly in promoting scientific literacy (Law, 2022). This was witnessed during classroom observation where the researcher observed only few lessons (4) which incorporated the element of active social interaction through group discussion though their discussions were not effective. The discussions diverted from the lesson activity due to lack of proper guidance. It is crucial to address this gap in teachers to ensure a cohesive and effective promotion of scientific literacy in primary schools. As emphasised by Sultan et al. (2018), teaching to promote scientific literacy requires teachers to possess a broad understanding of the concept, enabling them to deliver science lessons in accordance with these objectives. Therefore, teachers need to familiarise themselves with the concept of scientific literacy, aligning with the goals of science education in the 21st Century and concurrently meeting the national aspirations of MW2063, which aims to cultivate a scientifically literate citizenry which can contribute to the country's developmental agenda.

4.1.1.2 Attributes of scientific literate person

This aspect of the study aimed at gauging the knowledge of primary school teachers regarding scientific literacy, specifically their ability to recognise the characteristics of a scientifically literate individual. The anticipated attributes of a scientifically literate person were categorised into two themes: possessing scientific knowledge and skills, and applying them in daily life. These were used as criteria for analysing data. Following data analysis, the outcomes reflected a variety of responses from the participants, as outlined in Table 4.3.

Table 4.3: Attributes of a scientifically literate person

Responses	Participants	Frequency (n=16)
Have scientific knowledge and skills	P2, P3, P4, P10, P13 & P16	6
Use the knowledge to solve problems in everyday life	P9 & P15	2
Mentioned both themes	P5 & P11	2
Mentioned neither of the two themes	P1, P6, P7, P8, P12 & P14	6

After crosschecking the results with the participants indicated that six participants mentioned only one theme "having scientific knowledge and skills," two mentioned the use of scientific knowledge in everyday life, and two correctly identified both attributes. The varied responses show a range of understanding among primary school teachers regarding the components of scientific literacy - some focused solely on having theoretical knowledge while others recognised it as the practical application of scientific understanding in daily life. This indicates partial understanding of the concept scientific literacy to those that correctly identified one of the two attributes, either "having scientific knowledge and skills or using it in everyday life." This partial understanding may affect deliverance of science lessons to bring meaningful understanding and skills in learners for daily consumption. According to Chikasanda et al. (2014), lack of teachers' knowledge makes teachers feel insecure to promote interactive learning in the science classroom, as a result, teachers tend to devise traditional methods, which is contrary to the principles required for promoting scientific literacy. Development of scientific literacy requires teachers to integrate interactive methods and resources for learners to socially interact with the environment and construct new knowledge basing on their pre-requisite knowledge.

Therefore, for teachers to effectively deliver science lessons, there is need to bring awareness to teachers in primary schools, that scientific literacy goes beyond theoretical knowledge and includes the practical aspect of that knowledge in everyday situations, as indicated in the study that a scientifically literate person is the one that has scientific knowledge and skills and applies it in everyday life. Nonetheless, the results reveal that some few teachers (2) are aware that scientific literacy involves not only acquiring knowledge but also applying it in real-life situations.

The findings also indicate some responses which were considered incorrect that the study got from 6 participants who failed to mention either of the two attributes. Some of the responses were like: "*any-one taking science; is a learner who learns Science; the one that lacks knowledge of science; and knows how the world goes on."* These responses indicate a lack of alignment with the expected attributes of scientific literacy, revealing a potential misunderstanding among this group of teachers or lack of clarity regarding the characteristics of a scientifically literate person. These teachers cannot articulate scientific concepts to learners in line with promotion of scientific literacy (Chikasanda et al., 2014). This was evident during lesson observation which involved few teachers involving learners in group discussions.

This reveals a gap in teachers' knowledge of the term scientific literacy that needs on going intensive training and clarification so that teachers stay informed. This can enhance a more unified and effective promotion of scientific literacy in primary schools. For teachers to be effective in science classrooms, they must be scientifically literate, possessing comprehensive knowledge of scientific concepts and the ability to apply this knowledge. As suggested by Sultan et al. (2018), teachers need a better understanding of scientific literacy and its underlying principles. This emphasises the importance of ensuring that teachers in primary schools are well-versed with the term scientific literacy and aligning with the broader goals of science education and MW2063 Agenda.

4.1.1.3 Implementation of scientific literacy

The study aimed to investigate teachers' understanding and awareness of scientific literacy by assessing how they interpret and implement its promotion. Key components, such as active involvement of learners through interactive teaching methods and materials, construction of their own knowledge, teachers' subject knowledge, addressing misconceptions, fostering teacher creativity, and incorporating real-life examples in the teaching and learning process, were specifically examined. The data collected from interview and lesson observation was crosschecked and compared.

Following data analysis, a noteworthy observation emerged regarding the prevalence of responses related to the utilisation of active methods and resources. During interviews, a majority of the participants, 11 out of 16 teachers, emphasised their consistent use of active participatory methods and resources in Science and Technology lessons. This indicates an acknowledgment among teachers regarding the significance of actively involving students in the learning process through interactive methods and integrating teaching resources. Despite acknowledging the significance of interactive teaching approaches and integrating resources into lessons during interview, only a smaller number of teachers (4) actually employed some element of active social interaction during their teaching sessions. This could indicate a potential gap between teachers' intentions or beliefs about effective teaching practices and their actual implementation in the classroom, indicating limited knowledge on how scientific literacy can be promoted hence hampering their teaching practices in science classrooms (OECD, 2017).

However, a contrasting perspective emerged from the remaining 5 participants, indicating inconsistency in their utilisation of active methods and resources. Their responses reveal a tension among some teachers, between the desire to cover syllabus content and prepare students for examinations, and the perceived “waste of time” associated with inculcating skills and deeper knowledge in the lesson. This tension reflects a broader issue within the education system, where an emphasis on exam-centric priorities may impede the comprehensive development of scientific literacy in students. While our focus is on completing the syllabus, we must also prioritise instilling necessary skills for promoting scientific literacy. This can be achieved through the integration of interactive classroom practices (OECD, 2017).

None discussed around other key components of scientific literacy, such as learners constructing their own knowledge, teachers' subject knowledge, clearing misconceptions, teacher creativity, and the use of real-life examples. The absence of not discussing these components, raises questions about teachers' understanding of scientific literacy. This could be an indication of a potential gap in teacher training programmes or an inadequate emphasis on these aspects in the current educational setting, which would humper promotion of scientific literacy in primary schools. It is important to encourage teachers to incorporate these components in the lesson presentation. As Dragoş and Mih (2015) assert, enhancing teachers' knowledge, skills, and values is crucial for improving scientific literacy among students. The summarised perceptions of teachers on implementation of scientific literacy are presented in Table 4.4.

Table 4.4: Use of participatory methods and resources

Participants	**Responses provided**	**requency (n = 16)**
P1, P2, P3, P4, P5, P6, P7, P8, P10, P12 & P16	Expressed consistent use of active participatory methods and resources in the lessons.	11
P9, P11, P13, P14 & P15	Expressed inconsistency in using active participatory methods.	5

Participants who acknowledged inconsistency in integrating participatory methods and resources in the teaching and learning process shared the following insights:

> *P9:* "*Sometimes, I do use active methods and use resources teaching, sometimes I do not, I just rush to finish the syllabus so that I cover a lot and learners should pass exams, I do just lecture.*"

> *P11*: "*I much focus on finishing syllabus, pass exams and we end there, and we do not focus on the students practising the skills. Learners should read and memorize and pass exams which is important. But sometimes we do.*"

P13: "*I do but I don't do it frequently because to be honest, we much focus on how exams will come. We see impartation of other things rather than knowledge as a waste of time to finish the syllabus. So, in short, we much focus on examinations for students to pass examinations. We sometimes do hands on activities, doing experiments and sending them what to bring on part of resources.*"

P14: "*Since it is new to me, so I don't know whether I promote it or not. But sometimes I use materials and active methods like group work.*"

P15: "*Sometimes I achieve sometimes not. Involving students in the lesson. For example, lack of resources make us not to involve them teaching of Science and Technology.*"

The responses provided by some participants highlight a prevailing tension within the education system regarding the use of active methods and resources in teaching and learning. Many teachers seem to find it hard to balance covering the syllabus, focusing on examinations, making sure students pass their exams, and fostering skills regarding promotion of scientific literacy. This tension is evident in statements that emphasise the rush to finish the syllabus, prioritise exam success, and perceive other activities as a potential waste of time. The main concern seems to be the pressure to adhere to a curriculum so that students pass examinations, that is exam-centric, leaving limited room for the integration of participatory methods and resources essential for promotion of scientific skills (Ogunkola, 2013). It is noteworthy that two teachers (P14 and P15) acknowledged the importance of hands-on activities and interactive methods but cited challenges such as limited resources and unfamiliarity to scientific literacy. This suggests a need to emphasise practical implementation of interactive classroom practices and strategies to overcome resource constraints. Additionally, the perception that imparting skills and fostering deeper understanding is a “waste of time” indicates a potential gap in the understanding of the broader goals of education, including the promotion of scientific literacy. Addressing these perceptions and providing support for teachers to integrate interactive methods could contribute to a more holistic and effective approach to science education (Ogunkola, 2013).

Through lesson observation, the study also checked on mastery of subject content by teachers, and classroom activities and teachers’ creativity, as part of gauging their understanding on scientific literacy. The results of the study revealed significant insights on the challenges of promoting scientific literacy in primary schools.

Firstly, the assessment of mastery of subject content identified misconceptions or confusion among three participants (P5, P12 & P15). For instance, participant P5 provided inaccurate information to the students about the cause of rickets, attributing it to “soft bones and heavy weight” instead of deficiency of ‘vitamin D’. Participant 12 demonstrated confusion between 'types of matter' and 'properties of matter.' These misconceptions highlight the need for targeted professional development to enhance teachers' subject knowledge and ensure accurate dissemination of scientific concepts as claimed by Sultan et al. (2018), that teaching for promotion of scientific literacy requires teachers to have sufficient knowledge about the scientific concepts and processes; and be aware of the naïve ideas about science.

Secondly, the findings from observation of classroom activities diverged from the responses obtained during interviews. There was misalignment of information between what was proclaimed by teachers and the reality observed in the classrooms. Most lessons (12), as indicated by the observation of sixteen lessons, did not facilitate social interaction among learners or encourage them to construct their own knowledge actively. Instead, students were depicted as passive recipients of information delivered by the teacher through lecturing as indicated in Figure 4.1.

Figure 4.1: Learners in a science classroom learning scientific concepts passively.

This deficiency of interactive classroom practices would impede promotion of skills necessary for scientific literacy, contradicting goals of science education and our national aspirations of raising scientifically literate citizens to support developmental agenda of the country as stipulated in MW2063. In the observed lessons, four out of sixteen tried to incorporate the element of social interaction through activities like group work and think-pair-share methods, but the lessons left a lot to be desired due to inadequate involvement of group members and lack of supervision by teachers. In these instances, groups lost focus, diverting their discussions away from the lesson's content. Some groups were reported to discuss unrelated topics instead of engaging with the material being taught. Additionally, in some groups, members were not actively participating, allowing others to complete the work on their behalf.

This is contrary to the principles required for promotion of scientific literacy, which require learners to be fully engaged in the lesson and close monitoring of groups by a proficient person to make sure right information is generated during teaching and learning (Margolis, 2020; Barnett, 2019). Therefore, teachers need to prepare enough activities for the lesson to engage learners fully, and supervising the groups as they perform the activities despite having large classes – clever students should assist in taking supervisory roles. Moreover, the predominant teaching method observed in ten out of sixteen lessons was lecture method, where teachers delivered information to students in a one-way communication. Two other lessons used lecture method with little question-and-answer approach, but the questions posed were of low order, requiring recall of information rather than encouraging deeper understanding or critical thinking.

As Margolis (2020) argues, classroom practices should aim at developing learners' critical thinking, curiosity, and inquisitive minds about their environment, rather than simply encouraging memorisation of information. So, it is better for teachers to ask provocative questions to nurture critical thinking skills rather than encouraging rote memory, which humpers promotion of scientific skills. Basically, the interpretations indicated a misalignment between teachers' self-confessions regarding their teaching methods, especially in promoting active learning and social interaction, and the observed classroom practices. What was seen in most classes was teacher-centered classes, which opposes the development of scientific literacy (Ogunkola, 2013).

Partially it might be because of resources, as it was witnessed in some of the lessons, teachers had no teaching and learning resources, but in some cases where there was potential for active learners' engagement, it might be because teachers were not interested in taking long, they claimed learner-centered approaches are time consuming. They just wanted to tell the students and go as indicated in the responses of some participants. This difference highlights the need to bridge the gap and ensure that teachers are effectively implementing strategies that promote student engagement, interaction, and construction of their own knowledge (Margolis, 2020; Barnett, 2019). In addition, it was observed that teachers demonstrated limited creativity in improvisation, only 3 out of 16 participants incorporated teaching and learning resources into their lessons. Some teachers failed to produce visual aids like a chart, resorting to displaying diagrams directly from the teacher's guidebook as shown in the Figure 4.2.

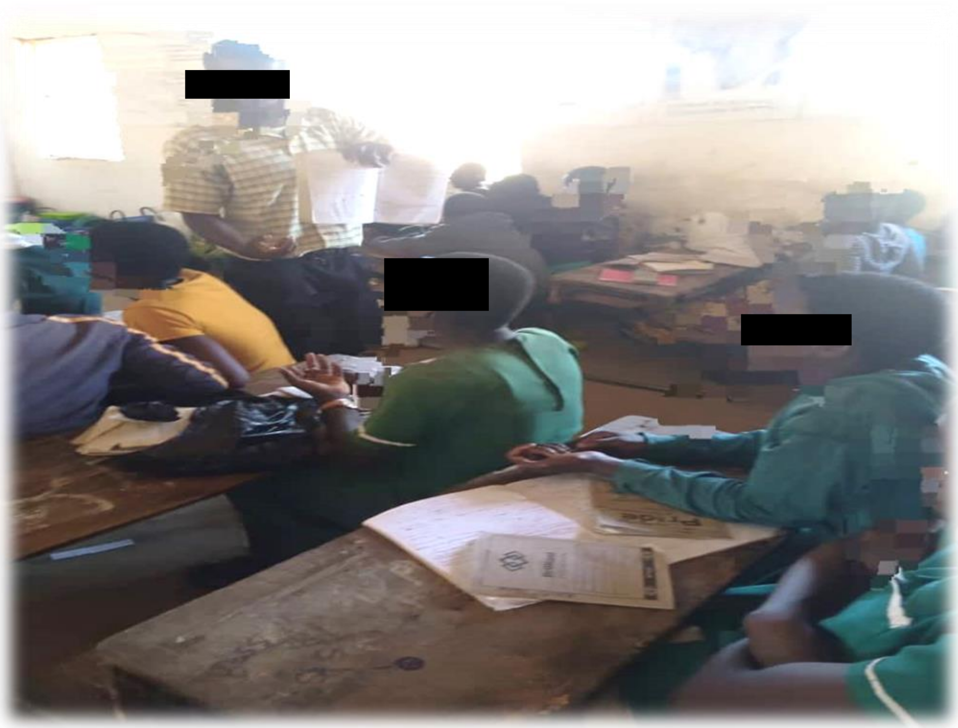

Figure 4.2: Teacher showing learners a diagram from teacher's guide book.

This lack of creativity hinders the effectiveness of teaching methods and diminishes the potential for engaging students in a meaningful way, opposing ways of promoting scientific literacy which require active participatory methods (OECD, 2017). The study provided valuable insights into the understanding and implementation of scientific literacy among primary school teachers. While there is a commendable emphasis on the use of active methods and resources, the study highlighted significant challenges in implementing scientific literacy in terms of subject content mastery, classroom activities, and creativity. This misalignment with the principles required for the promotion of scientific literacy, as asserted by OECD (2017); Ogunkola (2013) and Okada (2013), that promotion of scientific literacy needs active participation of learners through the use of active participatory methods and enough resources that would assist learners in the endeavor of constructing new knowledge (Barnett,2019), underscores the need for addressing the challenges in the implementation process. It is crucial to prioritise the effective development of scientific literacy in primary schools to align with the goals of science education and the MW2063 Agenda, ensuring that the transformation of the country from poverty alleviation to wealth creation is inclusive and comprehensive (NPC, 2020).

4.1.2 Objective 2: Teaching science and technology

This objective focused on analysing how selected primary school teachers teach Science and Technology, specifically focusing on the development of scientific literacy. To address this objective, the study examined the nature of teaching and learning strategies, materials used, and the types of lesson activities engaged. The primary aim was to assess whether learners could socially interact, construct new knowledge, and effectively internalise and practise newly acquired skills and knowledge.

To gather information on this objective, the study employed all the three methods: semi-structured interview, document analysis and lesson observation. Interview was guided by interview guide in Appendix IV. Document analysis involved scrutinising relevant documents using a checklist provided in Appendix V. The lesson observation, which was guided by lesson observation guide in Appendix VI, provided a real-time evaluation of how teachers taught, used the resources and integrated the lesson activities. Through the use of various data collection methods, researcher was privileged to cross-validate information and obtain a more comprehensive understanding of the research topic. For example, findings from interviews with teachers about how to teach for promotion of scientific literacy were compared with observations of classroom practices and document analysis to ensure consistency and reliability. The study aligned with literature recommending the promotion of scientific literacy through active participatory methods such as inquiry-based learning, problem-posed learning, cooperative learning, think-pair-share, group work, question and answer, among others (Aragao & Marcondes, 2018; Okada, 2013). These methods under proper guidance, allow learners to socially interact, construct new knowledge, internalise and use the new knowledge and skills. After organising the data and coding, two themes came up: Teaching Strategies and Learning Materials.

4.1.2.1 Teaching strategies

The study scrutinised the employed teaching methods, using various methods of data collection: document analysis, lesson observation, and semi-structured interviews to ensure accuracy of data. However, the findings from these three sources showed inconsistency. In interviews, out of 16, 11 participants openly asserted the use of active participatory methods such as group work, pair work, presentations, and think-pair-share. In contrast, the document analysis of lesson plans revealed that out of the 16 participants, only six teachers had documented lesson plans. Among these, five teachers indicated the utilisation of group work, while one participant indicated think-pair-share. Contrary to the claims made in interviews by 11 participants and the limited availability of documented lesson plans, the divergence became more apparent during lesson observations. It was found that only 4 participants incorporated participatory methods in their lessons such as group work, presentations, and think-pair-share. However, these observed methods did not fully integrate social interaction, and active engagement of learners within groups. Knowledge construction during group presentations appeared insufficient, as teachers mostly dominated the information delivery during group presentations, and groups struggled to provide accurate information which was required of them. Some groups exhibited noise and lacked control, signaling reduced learner engagement. A summary of key observations is outlined as follows:

Key Observations:

- Inconsistency between proclaimed methods in an interview and observed lesson plans
- Limited lesson plans (6 out of 16 participants had them)
- Minimal incorporation of social interaction and active engagement
- Dominance of teachers during group presentations
- Learners' minimal contribution during group discussions and presentations
- Noisy groups lacking control during lesson activities
- Less activities for active learner engagement
- Four lessons observed using learner-centered methods
- Ineffectiveness noted in the use of learner-centered methods (4 out of 16 lessons).

The results revealed that there is misalignment between what teachers claimed in the interview, the content of the analysed lesson plans, and the actual teaching practices observed in the classroom implying limited knowledge on how they can promote scientific literacy in the classrooms. Most of the lessons observed utilised teacher-centred approaches, despite most of them claiming in an interview of using active participatory methods in their lesson delivery such as group work, think pair share, pair work and presentations. This inconsistency observed, implies a possible mismatch between teachers' intentions and the practical implementation of classroom practices. This misalignment may impede the effective use of active participatory methods, hindering the promotion of active engagement, social interaction, and knowledge construction among learners. These components are crucial for fostering scientific literacy, as highlighted in the literature (Barnett, 2019; Amineh & Asl, 2015). This underscores the importance of aligning active pedagogical strategies across teacher claims, planning and implementing by emphasising clinical supervision in primary schools to ensure the effective implementation of active participatory strategies in Science and Technology lessons. The limited availability of lesson plans among teachers indicates potential challenges in lesson planning. This could lead to insufficient preparation for incorporating active participatory methods since promotion of scientific literacy requires teachers to be creative and thorough prepared to integrate participatory classroom practices (Chikasanda et al., 2014; Ogunkola 2013), which can support learners in constructing their own knowledge and experience real life situation.

A lesson plan is a crucial tool for educators to structure detailed methods and activities to ensure learners are actively engaged in the lesson. This was contrary to what was observed during document analysis, most of the lesson plans analysed had no detailed description of teaching and learning methods. This could be one of the reasons why most teachers go for teacher centred methods as observed during lessons presentations because active methods require thorough planning and preparation (Ogunkola 2013). Therefore, the absence of comprehensive lesson plans may hinder the achievement of intended science educational goal of promoting scientific literacy in Science and Technology in primary schools which require thorough planning of active participatory methods and resources in order to engage learners actively. The observed minimal contributions during group discussions, domination of teachers during group presentations and the lack of active engagement within groups indicated minimal participation of learners in the learning process, which is contrary to principles of promoting scientific literacy as highlighted in literature that full and active engagement of learners is required in its promotion (Aragao & Marcondes, 2018; Ogunkola, 2013; Okada, 2013).

This limited engagement can impede the development of critical thinking skills and knowledge construction, thereby affecting development of scientific literacy in learners. Furthermore, the absence of effective social interaction in the observed participatory methods may hinder collaborative learning which allows students to share ideas, question concepts, determine the answers and collectively construct knowledge, which is crucial for development of scientific literacy, as argued by Ahmad and Nuangchalern (2020).

The revealed deficiency in the number of activities designed indicated a compromise in learners' engagement in the lesson. The lessons observed had less activities to fully engage learners; as a result, noisy classroom groups were observed. Scientific literacy development requires a variety of hands-on activities, experiments, and interactive tasks as pointed out in literature. So, absence of these activities may limit students' opportunities to explore and apply scientific concepts actively.

4.1.2.2 Teaching materials

As one way of analysing how some teachers teach Science and Technology in primary schools, the study aimed at scrutinising the nature and use of teaching and learning materials. From literature, promotion of scientific literacy requires a variety of resources for learners to interact with, and these resources among other things should help learners to: socially interact; construct new knowledge; bring the lesson to real life situation; internalise and practise the skill and knowledge (Barnett, 2019; Amineh & Asl, 2015; Okada, 2013).

Upon analysing data of the lesson plans, 6 out of the 16 participants prepared lesson plans for their lesson delivery. However, there were disparities in the integration of teaching and learning materials within these lesson plans. Three participants (P1, P7 and P10) failed to document any teaching and learning aid for their lessons, while the other three (P2, P15 and P16) clearly outlined the resources to be employed in their lessons.

During lesson observation, participants P1, P7 and P10, whose lesson plans lacked teaching materials, conducted their lessons without employing any teaching and learning materials apart from the teacher's guidebook. On the contrary, participants P2, P15 and P16 incorporated the specified resources in their lesson deliveries.

Notably, among the participants lacking formal lesson plans (P3, P4, P5, P6, P8, P9, P11, P12, P13 and P14), one participant (P12) utilised teaching and learning resources during lesson delivery. In total, only four participants (P2, P12, P15 and P16) employed teaching and learning materials in their lesson presentations out of 16. However, the effectiveness of using teaching and learning resources varied among these participants.

While participants P15 and P16 successfully utilised materials for the intended purpose initially planned in their lesson plans, participants P12 and P2 faced challenges. For instance, participant P2 intended to use a hoe and a broom for practical activities related to the lesson topic, but only displayed the resources in the classroom to the learners without involving learners in real-life applications. Similarly, participant P12, although lacking a formal lesson plan, brought a broom as teaching aid, though its impact on facilitating social interaction, new knowledge construction, and real-life contextualisation was limited. The summary of findings is presented in the Table 4.5.

Table 4.5: Incorporation of teaching materials in lessons.

Participant	Lesson plan availability	Mentioned materials in lesson plan	Used materials effectively
P1	Yes	No	No
P2	Yes	Yes	Partially
P7	Yes	No	No
P10	Yes	No	No
P15	Yes	Yes	Yes
P16	Yes	Yes	Yes
P3-P14	No	-	-
P12	No	Yes	Partially

Key observations:

- "Yes" in lesson plan column indicates having a lesson plan.
- 'No' in lesson plan column indicates having no lesson plan
- "No" in mentioned materials column indicates not mentioning materials in the lesson plan.
- "Yes" in mentioned materials column indicates mentioning materials in the lesson plan.
- "Yes" in used materials effectively column indicates effectively using materials in the lesson.

- "Partially" in used materials effectively column indicates using materials but with limitations.

The observed pattern, where a significant number of participants did not utilise teaching and learning materials in their lesson plan, may have a negative bearing on the promotion of scientific literacy in science education, in particular, Science and Technology in primary schools, since it requires a variety of resources for students to interact with in the process of teaching and learning. According to literature, teaching and learning resources help to facilitate understanding of science concepts in learners and their application (Barnett, 2019; Amineh & Asl, 2015; Ogunkola, 2013 & Okada, 2013). After asking them why they do not use science materials in lesson delivery, some had the following to say:

> *P3:* "*science resources are not easy to find. I make some but we cannot manage to make all the resources, more time is required and we have large classes. We also have families to look after. The government should do something especially schools in villages. Other resources like computer and fax machine, teachers have never used them and how we teach.*"
>
> *P4:* "*…We teach for formalities; we teach for learners to pass examinations and put the school on map when many learners have gone to secondary schools. We cannot manage to prepare teaching resource each and every day for the class and we have large classes…*"

P5: "*...Most materials that we use ere locally available but they are time consuming...*"

The comments from some of these teachers who did not write lesson plans revealed several challenges that teachers face to make resources available. For example, participant number P3 mentioned the difficulty in finding science resources and highlights that they are time-consuming to make, particularly with large classes and personal responsibilities. Participant P4 emphasised teaching for formalities without regarding the use of teaching and learning resources; focusing on examination success and school's reputation rather than comprehensive teaching practices which can promote scientific literacy. Additionally, participant P4 underscored the difficulty in preparing teaching resources daily and having large class sizes. Participant P5 recognised the need for improvisation but said it is time consuming. Overall, these comments pointed to some of the factors that make teachers fail to plan and utilise resources in their lesson delivery, which opposes the guide lines for promoting scientific literacy as outlined in literature. This highlighted the need to emphasise more on comprehensive and effective teaching approaches to science education in primary schools with integration of enough resources.

The use of various resources is crucial in the promotion of scientific literacy for learners to engage in social interaction, construct new knowledge, and apply lessons to real-life situations–promoting the practice of skills and knowledge (Ogunkola, 2013).When teachers do not effectively utilise teaching and learning materials, it limits students' opportunities to participate actively in the lesson, construct meaningful understanding, and connect theoretical knowledge to practical applications of the lesson. According to Margolis (2020), this passive learning approach may impede the development of a comprehensive scientific literacy which requires students to actively engage with the subject matter using diverse resources. To enhance the promotion of scientific literacy in primary schools, it is essential for teachers to incorporate a variety of teaching and learning materials in their lessons and these resources should be used effectively. This can create a conducive environment for students to actively participate, ask questions, collaborate with peers, and apply their knowledge to real-life situations as indicated in the study by Ogunkola (2013).

The findings highlight challenges relating to planning, execution, and the overall impact on student engagement and learning outcomes. Addressing these issues is crucial for enhancing the quality of Science and Technology education in primary schools that can foster scientific literacy among students.

4.1.3 Objective 3: Examining factors that hinder or promote scientific literacy

This component aimed to examine the factors that influence promotion of scientific literacy in the teaching of Science and Technology in primary schools. The investigation involved interviews, document analysis of lesson plans, and classroom observations. After comparing and crosschecking the data with participants, the analysis and discussion were structured around two main themes: factors hindering the promotion of scientific literacy and potential resolutions to these challenges.

4.1.3.1 Factors that hinder scientific literacy

After data analysis, the identified challenges hindering scientific literacy are presented in the Table 4.6.

Table 4.6: Factors that hinder teaching for scientific literacy.

Challenges of promotion of scientific literacy	**Participants who Mentioned**	**Frequency (n=16)**
Shortage of books (text books and teachers guides)	P4, P5, P6, P8, P9, P10, P11, P12, P13, P14, P15 & P16	12
Lack of science equipment such as computer, fax machine, periscope and pendulum	P2, P4, P8, P9 & P12	5
Shortage of teachers	P6, P9, P13 & P15	4
High enrolment/large classes	P1, P3, P4, P6, P7, P8, P9, P10, P11, P13, P15 & P16	12
Shortage of classroom blocks	P1, P4, P6, P7, P12, P13 & P15	7
Lack of other various Teaching and Learning materials/resources	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14, P15 & P16	16

Lack of creativity for teachers to improvise	P2 & P8	2
Lack of knowledge by teachers on some scientific concepts	P3	1
Science materials are expensive	P9, P11, P13 & P15	4
Language barrier	P2 & P8	2
Absenteeism	P8, P9, P10, P14, P15 & P16	6
Lack of interest in the subjects by learners	P1, P5, P8 & P9	4
Unpreparedness of teachers	P1, P15, P3, P13, P3 P2 & P4	7
Personal responsibilities	P3	1
Theft of resources from the classroom	P7 & P8	2

Participants identified several hindrances that affect the promotion of scientific literacy, and these challenges are interrelated. Among the factors, the most frequently mentioned challenge by participants was shortage of teaching and learning resources such as books (text books and teachers guides); lack of science equipment; shortage of teachers; shortage of classroom blocks and other resources. According to the findings, lack of resources was a predominant challenge that teachers face when it comes to the promotion of scientific literacy. These challenges revealed problems that are faced in the context of promoting scientific literacy in the teaching of Science and Technology in primary school. The deficiency of these resources in schools not only impedes the implementation of interactive teaching approaches, but also restricts students' understanding of scientific concepts, active exploration and application of these concepts and skills. A critical aspect of scientific literacy involves hands-on experiences and practical applications, which are hindered by the absence of teaching and learning resources (Barnett, 2019; Amineh & Asl, 2015; Ogunkola, 2013). The scarcity of books mentioned by 12 participants limits students' exposure to scientific concepts, hindering their understanding, as some of the participants said:

> *P4*: "*…there are no Science and Technology books for learners in the whole zone and we don't have teachers guides as well, so how can students read? As a result, we teach lecture methods.*"

> *P5*: "*…books are also a challenge; I have 1 text book for the whole class and 1 teachers' guide which I share with my partner. This is because the government has taken too long to distribute the books in schools. So, this has negatively affected teaching and learning in schools especially in senior section.*"

> *P12*: *"… I have 10 text books against 223 students and 1 teachers' guide and when student teachers come from Kasungu TTC, we share the teacher's guide.*"
> *P15*: "*…there are no books for standard 7, I have 1 teachers' guide and no learners book, learners cannot see the pictures or study using books…*"

Participants cited challenges such as the absence of Science and Technology text books in the entire zone, insufficient teachers' guides, and inadequate distribution of books by the government; citing examples like having one textbook for an entire class (see Figure 4.3)

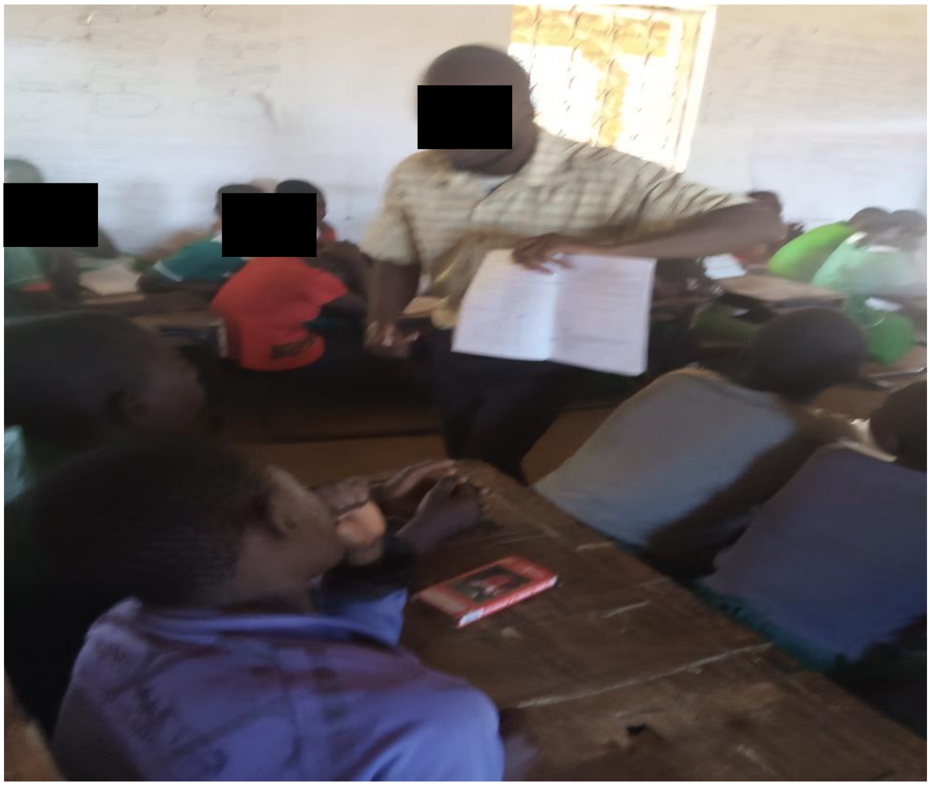

Figure 4.3 A teacher and learners sharing one book in a classroom

Sharing resources due to limited availability, underscores the negative effect on promotion of scientific literacy in Science and Technology in science education. This is not in line with the principles that underline the promotion of scientific literacy, which hinders learners from interacting with the resources (Ogunkola, 2013). The shortage of books can hinder the promotion of scientific literacy in schools by limiting students' access to essential learning materials and resources. Books serve as vital tools for students to acquire knowledge, understand scientific concepts, and explore various topics in depth. Without an adequate supply of books, students may struggle to grasp scientific principles and engage meaningfully with the subject matter. Additionally, books provide valuable reference materials that students can consult to deepen their understanding and reinforce their learning. The absence of books can impede students' ability to conduct independent research, critically analyze scientific information, and develop essential literacy skills. Overall, the shortage of books undermines the quality of science education and inhibits students' opportunities to become scientifically literate individuals hence opposing the national goal of MW2063 (NPC, 2020).

Promotion of scientific literacy requires enough materials for learners to interact with, in their endeavor of knowledge construction (Ogunkola, 2013). So, addressing this challenge is paramount, to create a conducive learning environment that fosters active engagement, comprehensive understanding, and the practical application of scientific knowledge in everyday contexts.

To address the challenge of the lack of books and other resources, teachers can employ various strategies to promote scientific literacy in schools. Firstly, they can maximize the use of available materials by incorporating interactive and hands-on learning activities that do not solely rely on textbooks. Teachers can create their own teaching aids, such as visual charts, diagrams, and models, to supplement the limited resources. Collaborating with other teachers to share resources and materials can also help alleviate the shortage. Furthermore, teachers can encourage students to engage in independent research and exploration to supplement their learning. By being resourceful and creative, teachers can continue to foster scientific literacy despite the challenges posed by the lack of books and educational materials (Chikasanda et al., 2014; Ogunkola, 2013).

Shortage of school blocks/classrooms is a prominent issue affecting the learning environment. For instance, *P4 said, "…I cannot manage to put learners in groups because of insufficient space in the classroom.*" Insufficient physical spaces lead to overcrowding which hinder the ability to organise classroom activities effectively and create a conducive environment to learning as shown in the Figure 4.4.

Figure 4.4 A crowded classroom with learners sitting on the floor

In crowded classrooms, it becomes a challenge for teachers to effectively engage with each student individually, limiting opportunities for personalized instruction and feedback. Secondly, overcrowded classrooms may lack physical space for hands-on activities and group work, essential components of active learning in science education (OECD, 2017). Additionally, managing behavior and maintaining discipline becomes more challenging in crowded classrooms, potentially leading to disruptions that detract from learning. It compromises the ability of teachers to adopt learner-centered classroom practices which necessitate the promotion of scientific literacy as it requires conducive environment (Agarkar, 2017; Ogunkola, 2013).

To overcome this challenge, teachers can implement strategies such as grouping students for collaborative activities, utilizing flexible seating arrangements to maximize space and can leverage peer teaching and cooperative learning techniques to foster student engagement and participation, even in large classes. By adapting instructional methods to accommodate overcrowded classrooms, teachers can create inclusive and dynamic learning environments conducive to promoting scientific literacy effectively as outlined in Ristanto et al. (2017) and Ogunkola (2013).

In addition, lack of science equipment, including computers, fax machines, periscopes, and pendulums, limits learners from exploring knowledge and experiencing real life situation, forcing teachers to resort to passive approaches of communicating information to learners. This contradicts with the development of scientific literacy which is associated with active engagement of learners through hands-on, minds-on, mouths-on activities, for example, *P9 cited that,* "*this science equipment is just displayed to students through a chart or written in their notes to study and memorise.*" These students miss out hands-on activities and practical learning experiences, which is one of the aspects required in the teaching of Science and Technology to promote scientific literacy (Amineh & Asl, 2015).

To overcome the challenge of shortage of science equipment, teachers can employ various strategies to ensure effective teaching and promote scientific literacy in their classrooms. Firstly, they can maximize the use of available resources by creatively repurposing everyday materials. For example, instead of using expensive laboratory equipment, teachers can utilize household items like bottles, rulers, and balloons to illustrate scientific principles. Collaborating with colleagues or local community resources to borrow or share equipment can also help alleviate shortages. By creatively ultilising the available resources, teachers can mitigate the impact of equipment shortages and continue to foster scientific literacy in their classrooms (Ristanto et al., 2017; Ogunkola, 2013). Lack of such equipment in schools hinders learners' ability to grasp scientific concepts and apply them in a meaningful way.

Shortage of teachers also emerged as a major challenge, impacting the student-teacher ratio, splitting of classes and, affecting the quality of education in Science and Technology. In large classes with high enrolment, individualised attention is reduced, integrating learner-centred methods and preparing sufficient resources becomes a challenge, as said by *P15*: "*I have more learners and to prepare resources becomes a challenge and individual help is also a problem.*" This hinders effective teacher-student interactions which support promotion of scientific literacy in learners, since learning requires a more knowledgeable person to support those that are less able and make sure that relevant knowledge is generated among the learners (Barnett, 2019). So, there is need for better infrastructural planning and resource allocation to reduce class sizes in primary schools, especially in rural areas. Teachers can also facilitate peer learning opportunities to distribute the workload and maintain a high-quality learning experience for students.

The absence of creativity for teachers to improvise underscored a hindrance to the adoption of innovative teaching methods crucial in science education for the promotion of scientific literacy. This aligns with findings in the study by Ristanto et al. (2017), emphasising the need for teachers to exhibit creativity in embracing learner-centered methods that cultivate an environment conducive for nurturing scientific literacy. The less frequently mentioned but critical issue was lack of knowledge by teachers on some scientific concepts. This highlights the importance of teachers' proficiency in scientific content. This proficiency is crucial for delivering accurate information and addressing misconceptions among students. This also aligns with the findings in the study by Ristanto et al. (2017), highlighting the need for teachers to better understand scientific concepts.

Another challenge that emerged was absenteeism among students. Consistent attendance is crucial for the continuous accumulation of knowledge and skills necessary for the development of scientific literacy. Absenteeism can stem from various factors, including lack of interest in the subjects. This issue can be addressed by making science lessons more engaging and interesting through the use of learner-centered methods and resources, as suggested by Ristanto et al. (2017), to make science lessons interesting to motivate learners. The issue of teacher unpreparedness, as indicated by participants (P1, P15, P3, P13, P3 P2 & P4), can impede the delivery of effective lessons. This was evident in lesson observations and document analysis, where many teachers lacked a prepared lesson plans and teaching resources for the integration of learner-centered classroom approaches. To overcome the challenge, teachers need to conduct team planning in schools to adequately prepare and create engaging and well-structured learning experiences with enough resources, aligning with the findings of Ogunkola (2013).

The challenges highlighted by teachers, like not having enough books and materials, dealing with large classes, and facing issues with classroom blocks (learning space), are big hurdles to teaching Science and Technology in primary schools for promoting scientific literacy. These challenges make it difficult for students to better understand scientific ideas and limit the use of these concepts in daily life. Fixing these problems is crucial to create a better learning environment where students can fully grasp science concepts and apply them in real-life situations.

4.1.3. 2 Strategies used to promotion of scientific literacy

Despite the challenges highlighted by participants in the promotion of scientific literacy, after further interrogation, there was a positive aspect as they possess knowledge of how they can deal with some of the hindrances to bring about effective classroom practices that can enhance scientific literacy in Science and Technology. Though some responses diverged from the intended focus such as use of lecture method in large classes, participants offered various strategies to promote scientific literacy, as indicated in Table 4.7.

Table 4.7: Strategies used to promote scientific literacy.

Challenges	**Strategies**	**Participants who mentioned**	**Frequency (n=16)**
Large classes	Splitting the class, lecture method, government employing more teachers	P1, P4 & P6	3
Shortage of teachers	Government should employ more teachers; teachers need to be dedicated	P1 & P15	2
Shortage of materials	Government should provide, make them from locally available resources, needs teachers' creativity, improvisation, enough preparation, send learners to make some, ask school administrators to buy	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P14, P15 & P16	15
Absenteeism	Discus with parents, feeding programmes and counselling to encourage them	P1, P13, P14 & P15	4
Lack of knowledge by teachers	Enough preparation, ask friends for help	P3	1

Shortage of books	Government should provide, download information, drawing charts for learners to see, encourage learners to buy their own books, borrow books from other schools	P3, P4, P5, P7, P8, P12 & P13	7
Language barrier	Rephrase the questions, encourage English speaking culture at school	P5	1
Theft	Buy locks to secure the classrooms	P7 & P8	2

Addressing the challenges, participants through an interview offered insightful solutions. For instance, to address large classes, participants brought suggestions which included splitting of classes, and asking the government to hire more teachers. For the shortage of teachers, participants recommended government to employ more teachers so that they follow and monitor the growth of scientific literacy in learners and effectively integrate interactive methods and resources to small sizable classes, and also teachers need increased dedication. To tackle material shortages, participants accentuated the need for government provision, use of locally available resources, teachers' creativity, improvisation, thorough preparation, asking learners to bring resources, and requesting support from school administrators. This will help learners to interact with a variety of resources and bring forth the development of scientific literacy in learners. Absenteeism solutions involved engaging with parents, implementing feeding programmes, and providing counseling for encouragement to make sure that there is continuous accumulation of knowledge and skills for the growth of scientific literacy. For enhancing teachers' knowledge, involve thorough preparation and seeking assistance from colleagues.

Participants suggested addressing the shortage of books through government provision, downloading information, creating visual aids like charts, encouraging learners to purchase their own books, and fostering book-sharing initiatives between schools. This helps to ensure that students have access to the necessary learning materials that fosters a more comprehensive understanding of scientific concepts. Language barrier could be mitigated by rephrasing questions and encouraging English speaking to underscore clear communication, and theft concerns could be alleviated by purchasing locks for classrooms to ensures a secure and conducive learning environment for learning experiences, to nurture development of scientific literacy (Agarkar, 2017; Amineh & Asl, 2015; Barnett, 2019; Ristanto et al., 2017; Ogunkola 2013).

The participants' suggestions underscored a collective commitment to overcome hindrances in promoting scientific literacy. These practical solutions, tailored to the specific challenges identified, demonstrate a comprehensive approach that involves not only teachers' efforts but also calls for systemic support from educational authorities to make sure that teachers' perception and classroom practices agree with the aspects required for promoting scientific literacy – a goal in science education and a stepping stone in achieving MW2063.

4.2 Summary of the chapter

The study aimed at assessing teachers' knowledge of scientific literacy, covering the definition, attributes of a scientifically literate person, and implementation of promoting scientific literacy in schools. Findings revealed diverse understanding, with some teachers encountering the term for the first time. While some demonstrated partial understanding, others struggled to articulate key aspects of scientific literacy. The recognition of attributes highlighted the significance of both theoretical knowledge and practical application for scientific literacy. Regarding implementation, a tension among teachers emerged in balancing active participatory methods with exam-centric priorities. Inconsistencies between stated practices and observed actions underscored challenges in subject mastery, classroom activities, and resource availability, highlighting the need for improvement in Science and Technology education to foster scientific literacy in primary schools.

The examination of factors affecting the promotion of scientific literacy identified challenges like resource shortages, large class sizes, and lack of teaching materials, which hindered interactive teaching methods, limiting learners in getting scientific knowledge and skills in primary schools. The suggested solutions encompassed cooperative endeavors, highlighting the involvement of both teachers and systemic measures. These actions include improvising resources, tackling absenteeism, and interventions from educational stakeholders to create conducive learning environment for the comprehensive development of scientific literacy in primary schools.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Introduction

The chapter consolidates the primary outcomes of the study, examining the effectiveness of teaching Science and Technology in promoting scientific literacy in primary schools. It offers a comprehensive understanding of the entire research process, summarising the main findings, discussing their implications, and presenting recommendations. The aim is to enhance the teaching and learning of Science and Technology in primary schools, fostering the development of a scientifically literate generation capable of navigating the challenges of the contemporary era marked by rapid advancements in science and technology, and bringing forth socio-economic development.

5.1 Summary of Findings

5.1.1 Objective 1: Teachers' knowledge on scientific literacy

The study aimed at assessing teachers' knowledge on scientific literacy, focusing on their ability to define scientific literacy, identify the characteristics of a scientifically literate person, and articulate how the promotion of scientific literacy can be implemented in schools. The analysis revealed three main themes: the definition of scientific literacy, attributes of a scientifically literate person, and the implementation of scientific literacy. In terms of the definition of scientific literacy, the study found a diverse understanding among primary school teachers.

Seven out of 16 participants admitted encountering the term for the first time during the study. Five participants could articulate one key aspect of the definition, while the rest struggled to mention any fundamental aspect. This lack of awareness is alarming, especially considering the emphasis placed on promoting scientific literacy in science education. Additionally, five participants demonstrated partial understanding, mentioning only one theme, highlighting the need for support to ensure teachers grasp the broader scope of scientific literacy. Regarding the attributes of a scientifically literate person, the study came up with varied responses. Six participants mentioned having scientific knowledge and skills, two mentioned using knowledge to solve everyday problems, and two correctly identified both attributes. However, six participants failed to mention either attribute, revealing potential gaps in understanding among teachers. The study accentuated the importance of bringing awareness to teachers that scientific literacy involves both theoretical knowledge and its practical application in daily life.

In terms of the implementation of scientific literacy, the study observed a tension among teachers regarding the use of active methods and resources. While 11 participants emphasised consistent use, five expressed inconsistencies, citing pressure to cover syllabus content and prioritise examination success. This tension reflects a broader issue in the education system, where exam-centric priorities may impede the comprehensive development of scientific literacy in students. The study also highlighted challenges in subject content mastery, classroom activities, and teachers' creativity, emphasising the need for targeted professional development to address these issues and promote scientific literacy effectively in primary schools.

5.1.2 Objective 2: Teaching for scientific literacy

This objective aimed at assessing how primary school teachers teach Science and Technology, focusing on developing scientific literacy. It utilised interviews, document analysis, and lesson observations. The findings revealed inconsistencies between teachers' claims, lesson plans, and actual practices in the classroom. While many teachers stated using active participatory methods and resources, observations showed limited implementation. Most of the lessons observed leaned towards teacher-centred approach, hindering effective social interaction and knowledge construction among students. Additionally, some teachers lacked comprehensive lesson plans and teaching materials, citing challenges like limited resources, time constraints and large classes. These disparities underscore the necessity for well-coordinated teaching approaches and thorough supervision. Addressing these challenges is crucial for enhancing the overall quality of Science and Technology education in primary schools and fostering scientific literacy among students.

5.1.3 Objective 3: Factors affecting promotion of scientific literacy

The examination of factors influencing the promotion of scientific literacy in Science and Technology in primary schools revealed several challenges. Participants identified a shortage of teaching and learning resources, including books, science equipment, teachers, classroom blocks, and other teaching and learning materials, as significant hindrances. Lack of creativity, knowledge gaps among teachers, expensive science materials, language barriers, absenteeism, lack of learner interest, unpreparedness of teachers, and theft of resources were also reported challenges.

Notably, the scarcity of resources emerged as a predominant issue affecting the implementation of interactive teaching approaches and restricting students' understanding and application of scientific concepts. The shortage of books, especially Science and Technology textbooks and teachers' guides, was a prevalent concern, impacting students' exposure to scientific concepts hence hindering the promotion of scientific literacy. Large class sizes, inadequate classroom blocks, and the absence of various teaching and learning materials further compounded the challenges. The participants highlighted that these deficiencies impede the adoption of hands-on experiences, practical applications, and interactive learning, crucial for scientific literacy development in learners.

In response to these challenges, participants proposed solutions that highlighted both teacher and systemic actions. Strategies included splitting large classes, government employing more teachers, resource improvisation, encouraging creativity, thorough preparation, involving learners in resource creation, addressing absenteeism through parental engagement and counselling, and seeking external assistance to seal teachers' knowledge gaps. The suggestions emphasised the need for collaborative efforts involving teachers, educational authorities, and the community to create a conducive learning environment that fosters the comprehensive development of scientific literacy in primary schools.

5.2 Conclusion

The findings highlight several crucial implications for the advancement of scientific literacy among primary school teachers.

The diverse understanding of scientific literacy, particularly with a significant number encountering the term for the first time, indicates a potential gap in awareness and exposure to the concept. This diversity in comprehension may hinder teachers from effectively preparing and delivering science education lessons. Continuous professional development opportunities are deemed critical to familiarise teachers with the concept of scientific literacy. The partial understanding of scientific literacy exhibited by some teachers, where they mentioned only one theme of the definition or failed to mention any attributes, necessitates targeted support. Efforts should focus on ensuring that teachers comprehend the broader scope of scientific literacy, including understanding scientific concepts, processes, and their application in everyday life. This support is essential for enhancing the quality of science education and fostering the development of scientific literacy skills among students. The tension observed among teachers in implementing active methods and resources exposes a broader conflict within the education system. The study proposes a reevaluation of priorities, suggesting that the current emphasis on examinations may hinder the holistic development of scientific literacy. Addressing these challenges requires a multifaceted approach, including continuous professional development, a shift in educational priorities, and concerted efforts to bridge the knowledge gap among teachers. Ultimately, fostering scientific literacy in primary schools is crucial for aligning with educational goals and national aspirations, as outlined in MW2063, and for preparing students to thrive in the modern era of science and technology. The observed misalignment between claimed and actual teaching practices, particularly the prevalence of teacher-centred methods, suggests a potential hindrance to the effective application of participatory techniques. This misalignment may impede social interaction and knowledge construction, which are essential components for fostering scientific literacy in learners.

Additionally, difficulties in integrating teaching materials into lesson plans and delivery, caused by limited resources, time constraints, and large class sizes, underscore the requirement for specific assistance in overcoming these obstacles. Addressing these challenges is pivotal for enhancing the overall quality of Science and Technology education in primary schools. The study emphasises the importance of aligning teaching strategies with active participatory methods and integrating teaching materials effectively. Bridging the gap between teachers' intentions and practical implementation is essential for fostering scientific literacy. This comprehensive approach is vital for preparing students to actively engage with scientific concepts, construct meaningful understanding, and apply knowledge to real-life situations, ultimately contributing to the development of scientific literacy in primary schools.

The identified challenges, particularly the shortage of teaching and learning resources, large class sizes, and inadequate classroom infrastructure, have a substantial impact on the effective implementation of interactive and hands-on teaching approaches crucial for developing scientific literacy. Insufficient access to textbooks and teachers' guidebooks limits students' exposure to scientific concepts, hindering their understanding and practical application. Additionally, the lack of science equipment and materials restricts students from engaging in hands-on activities, impeding their ability to connect theoretical knowledge to real-life situations. The participants' suggestions for resolutions offer a ray of hope, accentuating the importance of collaborative efforts between teachers, educational authorities, and the community. Strategies such as resource improvisation, government support in teacher recruitment, and community involvement in addressing absenteeism demonstrate a collective commitment to overcoming hindrances.

The proposed solutions, if effectively implemented, could contribute to creating a conducive learning environment that facilitates the comprehensive development of scientific literacy in primary schools.

In conclusion, the study reveals a critical need for immediate attention to address the challenges hindering the promotion of scientific literacy in Science and Technology teaching. It highlights the interconnectedness of resource availability, classroom infrastructure, and teaching methodologies in shaping the learning experiences of students. The proposed resolutions underscore the importance of systemic support and collaborative efforts to create an environment conducive to fostering scientific literacy. Addressing these challenges is essential for realising the goals of science education and ensuring that students develop the necessary skills and understanding to engage actively with scientific concepts in their academic journey and everyday lives.

5.3 Recommendations

Having discussed the implications of the findings, the study makes the following recommendations:

1. Continuous Professional Development**:** Educational authorities should implement regular and targeted professional development programmes to enhance teachers' understanding of scientific literacy. These programmes should cover the comprehensive definition, attributes, and practical implementation of scientific literacy.

2. Awareness Initiatives: Educational stakeholders like the Ministry of Education and non-governmental organisations should conduct awareness campaigns to familiarise teachers with the concept of scientific literacy. This can include workshops and seminars, to bridge the awareness gap and ensure a unified understanding among educators.

3. Pedagogical Alignment: The government and school authorities should align pedagogical strategies with the goal of fostering scientific literacy. Emphasise the importance of active participatory methods in lesson planning and encourage teachers to integrate these approaches consistently.

4. Comprehensive Lesson Planning: The headteachers should emphasise the importance of comprehensive lesson planning, incorporating both theoretical and practical elements of scientific literacy. They should encourage teachers to create detailed plans that align with active participatory methods and implement the plans effectively.

5. Improvisation: School authorities, along with teachers, should actively promote improvisation to tackle shortages in teaching and learning resources. This includes books, science equipment, classroom infrastructure, and other materials necessary for interactive teaching approaches.

6. Government Intervention: The government should intervene in addressing systemic issues, such as large class sizes and teacher recruitment. This may involve policy changes, increased funding, and targeted initiatives to improve the overall education system.

These recommendations aim at creating a holistic approach in fostering an environment conducive to the comprehensive development of scientific literacy in primary schools.

5.4 Area of Further Research

Based on the findings of the current study, the following are the areas provided by the researcher that need an in-depth study as far as scientific literacy is concerned:

1. Investigating how teachers' knowledge about scientific literacy supports the development of scientific literacy in learners in sciences.
2. Effects of resources in the development of scientific literacy in a science classroom.
3. How do interactive learning methods and resources support the development of scientific literacy in Science and Technology in primary schools?
4. Effects of discussing the rationale of scientific concepts with learners as one of the strategies of developing scientific literacy.
5. Determining teachers' knowledge of scientific literacy in primary schools
6. How do teachers' knowledge about scientific literacy promote the teaching for scientific literacy in primary schools in Science and Technology?

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APPENDICES

Appendix I: Introduction Letter from Mzuzu University

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Department of Teaching, Learning and Curriculum Studies

12th May 2023

TO WHOM IT MAY CONCERN

Dear Sir /Madam,

LETTER OF INTRODUCTION: MS CATHERINE MZILAHOWA

Ms Catherine Mzilahowa is a registered Master of Education (Teacher Education) Program student at Mzuzu University. She has been cleared by the Mzuzu University Research Ethics Committee (MZUNIREC) to collect data for the research study she is conducting as a requirement for the program.

Kindly assist her accordingly.

Yours faithfully,

Dr Margaret M. Mdolo

Program Coordinator

Appendix II: Permission Letter from Mzuzu University

MZUZU UNIVERSITY

DIRECTORATE OF RESEARCH

MZUZU UNIVERSITY RESEARCH ETHICS COMMITTEE (MZUNIREC)

Ref No: MZUNIREC/DOR/23/47

12/05/2023.

Catherine Mzilahowa,

Mzuzu University,

P/Bag 201,

Luwinga,

Mzuzu 2.

mzilahowacatherine@gmail.com

Dear Catherine,

RESEARCH ETIDCS AND REGULATORY APPROVAL AND PERMIT FOR PROTOCOL REF NO: MZUNIREC/DOR/23/47: TEACHING SCIENCE AND TECHNOLOGY FOR PROMOTION OF SCIENTIFIC LITERACY IN PRIMARY SCHOOLS: A CASE OF SELECTED SCHOOLS IN KASUNGU DISTRICT.

Having satisfied all the relevant ethical and regulatory requirements, I am pleased to inform you that the above referred research protocol has officially been approved. You are now permitted to proceed with its implementation. Should there be any amendments to the approved protocol in the course of implementing it, you shall be required to seek approval of such amendments before implementation of the same.

This approval is valid for one year from the date of issuance of this approval. If the study goes beyond one year, an annual approval for continuation shall be required to be sought from the Mzuzu University Research Ethics Committee (MZUNIREC) in a format that is available at the Secretariat. Once the study is finalised, you are required to furnish the Committee with a final report of the study. The Committee reserves the right to carry out compliance inspection of this approved protocol at any time as may be deemed by it. As such, you are expected to properly maintain all study documents including consent forms.

Wishing you a successful implementation of your study.

Yours Sincerely,

__u..

GiftMbwele

SENIOR RESEARCH ETHICS ADMINISTRATOR

For: CHAIRMAN OF MZUNIREC

Appendix III: Consent Form

Mzuzu University Research Ethics Committee (MZUNIREC)

Informed Consent Form for Research in

Master of Education in Teacher Education

Introduction

I am **Catherine Mzilahowa** from **Mzuzu University**. I am doing research titled “T***eaching for promotion of scientific literacy in primary schools in Kasungu district”***. This consent form may contain words that you do not understand. Please ask me to stop as we go through the information and I will take time to explain. If you have questions later, you can ask me or another researcher.

Purpose of the research

This research aims to investigate the teaching for promotion of scientific literacy in primary schools in Kasungu district**.**

Type of Research Intervention

This research will involve your participation in a group discussion and/or individual interview.

Participant Selection

You are being invited to take part in this research because **you are one of the teachers of Science and Technology in Kasungu district.**

Voluntary Participation

Your participation in this research is entirely voluntary. It is your choice whether to participate or not. If you choose not to participate, nothing will change. You may skip any question and move on to the next question.

Duration

The research may take place for about 4 months, from **February to May 2023.**

Risks

You do not have to answer any question or take part in the discussion/interview/survey if you feel the question(s) are too personal or if talking about them makes you uncomfortable.

Reimbursements

You will not be provided any incentive to take part in the research.

Sharing the Results

The knowledge that we get from this research will be shared with you and your community before it is made widely available to the public. Thereafter, we will publish the results so other interested people may learn from the research.

Who to Contact?

If you have any questions, you can ask them now or later. If you wish to ask questions later, you may contact: **Catherine Mzilahowa**. Tel: 099317336

This proposal has been reviewed and approved by Mzuzu University Research Ethics Committee (MZUNIREC) whose task it is to make sure that research participants are protected from harm. If you wish to find out more about the Committee, contact Mr. Gift Mbwele, Mzuzu University Research Ethics Committee (MZUNIREC) Administrator, Mzuzu University, P/Bag 201, Luwinga, Mzuzu 2, Phone: 0999404008/0888641486

Do you have any question?

Part II: Certificate of Consent

I have been invited to participate in research about ***teaching for promotion of scientific literacy in primary schools in Kasungu district***

I have read the foregoing information, or it has been read to me. I have had the opportunity to ask questions about it and any questions I have been asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

Print Name of Participant__________________

Signature of Participant ___________________

Date ___________________________

day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the potential participant, and to the best of my ability made sure that the participant understands the research project. I confirm the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Signature of Researcher /person taking the consent__________________________

Date ___________________________

day/month/year

Appendix IV: Interview Guide for Science and Technology Teachers

INTERVIEW GUIDE FOR SCIENCE AND TECHNOLOGY TEACHERS

SEX…………………………

EXPERIENCE…………….

HIGHEST ACADEMIC QUALIFICATION………………

AGE………………………

CLASS………………………

1. What do you know about scientific literacy?
2. To you, who is a scientifically literate person?
3. What is the importance of scientific literacy to:
    i. Learners?
    ii. Families?
    iii. Society?
    iv. Citizens?
    v. Nation?
4. How do you achieve scientific literacy in the teaching of Science and Technology?
5. What are the challenges you face when teaching Science and Technology for Scientific Literacy in your classroom?
6. How can the challenges be addressed?

END OF INTERVIEW

THANK YOU FOR YOUR PARTICIPATION

Appendix V : Document Analysis Checklist

DOCUMENT ANALYSIS CHECKLIST

Documents	**Information sought**	**Comment**
Syllabus	1. Are suggested activities/methods promoting active social interaction of learners? How?	
	2. Are suggested teaching/learning materials promoting active social participation of learners? How?	
	3. Are the activities and materials designed to allow learners construct their own knowledge? How?	
Lesson plan	1. Is the lesson activity based on learner-centred?	
	2. Will the activities allow learners to socially interact in the lesson?	
	3. Will the chosen teaching / learning methods allow learners to construct new knowledge?	
	4. Will the chosen teaching / learning materials help learners to construct new knowledge?	
	5. Will the methods and materials used allow learners to internalise and practice the skills and knowledge?	

Appendix VI: Lesson Observation Guide

LESSON OBSERVATION GUIDE

Area of focus or to be observed	**Comment**
Does the introduction capture learners' attention?	
Elicitation of learners' prior ideas on lesson topic	
Learner engagement in the lesson	
Teacher's knowledge on the subject matter on concepts being taught	
Dealing with misconceptions arising on the topic	
Nature and use of teaching and learning materials	
Types and use of participatory methods of teaching and learning used	
Nature of learners' activities in the lesson	
Nature of questions asked	
Teacher creativity	
Use of examples from real-life situations	

Appendix VII: Permission Letter from the District Education Manager

P/ Bag
Luwinga
Mzuzu

To ALL CONCERNED
Allow the bearer of this letter conduct research activities as stated herein.
CEO for DEYS.

The DEM
Kasungu District
Box 38
Kasungu
29th May, 2023

Dear Sir,

SEEKING FOR PERMISS
DISTRICT

I am a student from Mzuzu University doing research on Teaching Science and Technology for Promotion of Scientific literacy in Primary Schools as partial fulfilment of the requirements for the award of a Degree *of* Master of Education in Teacher Education. The study is based in Kasungu District. Therefore, I would like to seek for permission so that I collect data in primary schools in your district. The schools will be randomly sampled. The data will be collected and used for the stated purpose, nothing else and in line with ethical rules.

Attached is the letter of introduction from Mzuzu university.

Thanks in advance for your assistance.
Yours Faithful,

Catherine Mzilahowa

Appendix VIII: Permission Letter to Headteachers of Schools in Kasungu District

Mzuzu University

P/Bag 211

Luwinga

Mzuzu

The Head teacher

C/O Box 38

Kasungu District

30th May, 2023

Dear Sir

SEEKING FOR PERMISSION TO COLLECT DATA IN YOUR SCHOOL

I am a student from Mzuzu University doing research on Teaching Science and Technology for Promotion of Scientific Literacy in Primary Schools as partial fulfilment of the requirements for the award of a Degree of Master of Education in Teacher Education. The study is based in Kasungu District. Therefore, I Would like to seek for permission so that I collect data in your school. The data collected will be treated with confidentiality and used for the stated purpose and in line with ethical rules. I will need two teachers who teachers Science and Technology for either of the following classes: 4, 5, 6 and 7. The activity will involve document analysis of lesson plan, schemes of work followed by interview and lesson observation. Voice recording will be done during interview and lesson observation.

Attached is the letter of introduction from Mzuzu university and the DEM Kasungu.

Let me take this opportunity to thank you in advance for your assistance.

Yours Faithfully,

Catherine Mzilahowa

Appendix IX: Letter of Introduction and Request for Permission from the Teacher

C/O Mzuzu University

Private Bag 201

Luwinga

Mzuzu

30th May 2023.

TO WHOM IT MAY CONCERN

LETTER OF INTRODUCTION AND A REQUEST FOR PERMISSION

I am a postgraduate student of Mzuzu University carrying out a study on Teaching Science and Technology for Promotion of Scientific Literacy in public primary schools in Kasungu. I kindly request you to voluntarily and actively participate in the research so that accurate data is collected. All responses and the data that will be collected will be handled safely and will be used only for this study, nothing else. There will be document analysis of the schemes and records of work and lesson plan for Science and Technology followed by an interview and lesson observation. Voice recording will be done during interview and lesson observation to make sure all information is captured for the research. So, you are therefore kindly requested to participate freely, the information provided will be treated with utmost confidentiality and will be used only for the purpose of this study.

Let me take this opportunity to thank you in advance for taking part in this study.

Yours sincerely,

Catherine Mzilahowa