INFORMAL SCIENCE EDUCATION PRACTICES AND VIEWS OF FURTHER EDUCATION AND TRAINING (FET) TEACHERS: A UNIZULU SCIENCE CENTRE CASE STUDY

by

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DECLARATION

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Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

I declare that the above dissertation is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I submitted the dissertation to originality, checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.

06/09/2023

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SIGNATURE DATE

DEDICATION

This work is dedicated to my daughter, Uthando Madonda. May it serve as an encouragement for you to achieve all your dreams.

ACKNOWLEDGEMENT

I want to express my gratitude to God, as stated in James 1 verse 17: “Every good and perfect gift is from above, coming down from the Father of the heavenly lights, who does not change like shifting shadows”. I am also deeply thankful to my supervisor, Dr P Photo, for her valuable contribution and guidance during my academic journey. Additionally, I extend my heartfelt appreciation to my colleagues, family, and friends who supported me by provided encouragement throughout this voyage. I would also like to acknowledge the participants and staff at the UNIZULU science centre for providing a research platform.

ABSTRACT

Visiting informal learning environments, such as science centres is a widely employed teaching strategy worldwide to support science education in schools. However, there is insufficient knowledge regarding the specific roles that teachers play during visits to science centres. This study aimed to gain insight into how Further Education and Training (FET) teachers' views and their practices at UNIZULU science centre. The conceptual framework for this study was based on the definition of an informal learning environment and the Field Trip Inventory model (FTI). The FTI model describes three educational components that are useful when teachers are planning a science field trip. This framework was used to analyse the findings that emerged in this study. A qualitative case study approach was used. Data was collected through semi-structured interviews, observations, and document analysis from four participating science teachers. Each case was analysed separately to derive meaningful findings. The research findings revealed that science teachers had a comprehensive understanding of the nature of informal learning environments. They viewed their role during visits as trip organisers, monitors of learners' behaviour and learner guides. However, the findings also revealed that most of the science teachers relied on science centre facilitators to teach their learners during the visits. The results of this study provide a clear picture of the limited role of schoolteachers in the science centre and their inadequate knowledge of how to teach within this setting. The study recommends that science teachers and science centre facilitators should communicate with each other to understand each other's roles and duties with the objective of educating learners more clearly. This can assist to ensure that learners are receiving consistent and effective instruction in science, both in informal learning environments such as science centres and in the classrooms.

Keywords: Informal Learning Environment; Science Centre; FET; Secondary school; UNIZULU

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ABBREVIATIONS

CAPS - Curriculum and Assessment Policy Statement

FTI - Field Trip Inventory

DBE- Department of Basic Education

DHET-Department of Higher Education

FET- Further Education and Training

CHAPTER 1

INTRODUCTION

1.1 Background of the study

There is a decline in science activities that stimulate interest in learners who are learning science in schools (Mushaikwa, 2014; Rini & Aldila, 2023). Research shows that most teachers in Sub-Saharan Africa are still practising teacher-centred methods when teaching in their classrooms (Grimus, 2017; Syahrial et al., 2022). These teachers deliver lessons in a traditional way by using chalk and blackboards, and this applied to subjects such as the sciences which involve more practical work. Therefore, the number of science activities declines in schools due to the teaching and learning styles (Grimus, 2017; Ramadhanti, 2022). As a result, learners regard science as a tough subject and demanding science topics have little relevance to their daily lives (Mushaikwa, 2014; Walan & Gericke, 2021). Pfeiffer (2011) defines a teacher's teaching style as a major determinant of learners' attitudes toward learning science. He further elaborates that it is important how learners learn science because it affects their understanding and development of science learning.

Learning is the process of obtaining knowledge regardless of whether it takes place in a formal or informal setting, meaning that learning can take place anywhere (Harrop & Turpin, 2013). Consequently, this puts pressure on teachers to explore more strategies and varied learning opportunities to teach science while making sure that they arise learners' interest, deep understanding, and relevance to their everyday lives (Walan & Gericke, 2021). The literature indicates that incorporating informal learning environments is a strategy which schoolteachers can employ to enhance learners' enthusiasm for science (Harrop & Turpin; 2013; Kisiel, 2005; Walan & Gericke, 2021).

Informal learning environments are defined as unstructured, learner-led, spontaneous, personal, continuous, contextual, collaborative, non-linear. Extracurricular learning is characterised as open (Eshach, 2007). Informal learning environments include libraries, museums, science centres, zoos, and parks. Research has shown that informal learning environments provide hands-on activities that are important to learners to grasp an understanding of in-depth science concepts (Kisiel, 2005). Harrop and Turpin (2013) and Walan and Gericke (2021) argue that when science is taught in an informal environment, learners' interest is triggered as the environment offers a

learning experience that is different from a classroom setting. Topics presented in an informal learning setting are associated with a high cognitive level (Walan & Gericke, 2021).

The teachers' views and their practices on informal science education are very important because they influence teachers' practices during school visits to informal learning environments (Sentürk, 2015). Teachers' perceptions refer to the knowledge and experience a teacher has about something which affects his/her thinking about it (Sentürk, 2015). Gomez and Jakobsson (2014) found that teachers viewed teaching in the informal learning environment as a teaching strategy that increases problem solving skills and has an impact on increasing learners' interest in science. Other teachers perceived learning at a Science Centre as an experience that bridges classroom curriculum and real-life context (Gomez & Jakobsson, 2014). Similarly, the result of the study by Anderson and Zhang (2003) showed that 90% of teachers perceived a trip to an informal learning environment, such as a science centre, as an educational opportunity for their learners, and advantageous in contributing to the science learning experience. Nevertheless, the literature in this study showed that this is still an assumption in the South African context. There is limited recognition regarding how Further Education and Training (FET) teachers perceive and practice the teaching of science in a science centre.

Research illustrates that science teachers must have a good subject knowledge in order for their learners to do well in science (Walan & Gericke, 2021). However, having good subject knowledge is not enough to improve learners' interest in science, to instil a comprehensive understanding of science concepts and relate science to their everyday lives (Walan & Gericke, 2021). Braund and Reiss (2006) recommend that science teaching in school should be integrated with an excursion to an informal learning environment such as a science centre which provides different learning opportunities to learners. However, demonstrating involvement prior to and throughout trips to informal learning settings is important for teachers (Jarvis & Pell 2005, Kisiel, 2005; Storksdieck 2001). Therefore, the current study aimed to understand how FET teachers perceive and practice the teaching of science in a science centre. This study focused on secondary schoolteachers who were either teaching physical sciences or technical sciences because literature shows that these are the subjects that are mostly taught in the science centre (Fish, 2016).

1.2 Problem statement

The primary purpose of learning science in school is to equip learners with both knowledge and skills for life after school (Department of Education, 2011). To achieve this, learning must extend beyond classrooms and textbooks, integrating theory with practical experience (Behrendt & Franklin, 2014). Informal learning environments globally support learners in understanding science through exploratory learning (Fitzgerald et al., 2013; Hofstein et al., 2011). The Curriculum and Assessment Policy Statement (CAPS) mandates formal practicals for physical and technical science subjects, with teachers urged to improvise in resource-limited settings. Conversely, science centres provide well-equipped laboratories, making excursions valuable for hands-on activities and engaging science demonstrations, enhancing the overall learning experience for both teachers and learners.

Over the past two decades, extensive international research has underscored the significance of science centres in inspiring and motivating learners, particularly in countries like Canada, the United States, and Turkey (Lelliott, 2014). Kisiel's (2005) study in the United States identified eight key motivations driving teachers to organise visits to informal learning environments, such as science museums, including connecting with the curriculum and fostering lifelong learning habits. Meanwhile, Sonmez and Ozturk's (2022) research in Turkey highlighted the transformative impact of a semester-long course on preservice science teachers, emphasising the pivotal role of natural history museums in science education. Other studies explored diverse aspects, including the influence of informal settings on learners' perceptions (Walan & Gericke, 2021), the advantages of informal learning environments (Denson et al., 2015), and the factors shaping elementary teachers' participation in science field trips (Kisiel, 2005).

The literature on informal learning environments shows that schoolteachers do visit informal learning environments with learners for different purposes but their objectives are not planned (Kisiel, 2005; Mosabala, 2014; Photo, 2022). Lelliott (2014) testify that teachers did not understand how to use science centres for informal learning. Although it is likely that South African teachers follow the international trend, there is little evidence to confirm these findings. Bilankulu (2018) draws attention to the scarcity of research on the significance of informal learning contexts in science education, particularly in the South African context. Consequently, there is a lack of

understanding regarding how South African teachers perceive teaching science in science centres, with existing insights mostly based on speculations derived from international research. Therefore, this study sought to address the void in South African literature by exploring FET teachers' views on teaching science and examining their practices in science centres.

1.3 Rationale for the study

A visit to an informal learning environment is a teaching approach that is used by schoolteachers to enhance learners learning of science and may improve scientific understanding of the curriculum learned in school (Eshach, 2007). Therefore, teachers in schools need to know the use, role, and benefit from these environments (Behrendt & Franklin, 2014). Hence it was important to do this study because the insights derived from this study could offer teachers valuable lessons on how to effectively prepare and assist learners during their visits to informal learning environments.

This study has the potential to enrich the field of research by providing insights and comprehension regarding the educational significance of informal learning environments in the context of science education, with a specific focus on South Africa. Following the findings of this study, school district directors, schools, government officials, parents, and learners could come to recognise the importance of incorporating science education within informal learning settings, even within rural regions as a crucial component of the learning journey.

1.4 The research questions

The following research questions guided this study:

1.4.1 Primary research question

How do FET teachers perceive and practice the teaching of science in a science centre?

1.4.2 Sub-questions

1. What is the extent of understanding regarding the teachers' knowledge of how and when to teach science in the science centre?

2. How do teachers plan and prepare for a visit to a science centre?

3. How do the science teachers facilitate teaching and learning in an informal learning environment such as a science centre?

1.5 Purpose of the study

The purpose of this study was to explore FET teachers' views and practices on informal science education at UNIZULU science centre. This study focused on the science centre as an informal learning environment. In this study, the science teachers were teaching either physical sciences or technical sciences in secondary schools.

1.6 Aim and Objectives

This study aimed to gain an understanding how FET teachers perceive and practice the teaching of science in a science centre. To achieve this aim, the following objectives guided the study:

- To understand teachers' knowledge of how and when to teach science in the science centre
- To explore teachers' planning and preparations when visiting a science centre.
- To explore teachers' facilitating of teaching and learning in an informal learning environment such as a science centre

1.7 Delimitations of the study

This study focused on four teachers from different schools who were teaching either physical sciences or technical sciences. The UNIZULU science centre has been chosen as the observation site due to its accessibility to the researcher and being the sole science centre available in Richards Bay. Interviews were conducted with all four teachers individually at their respective schools, and their interactions were observed within the UNIZULU science centre. It is noteworthy that this research was conducted within the Richards Bay, KwaMbonambi circuit, situated in the province of KwaZulu-Natal.

1.8 Research design and Methodology

This study adopted an interpretivist paradigm to understand FET teachers' views and practices at a science centre. Interpretivist research, as explained by Bertram and Christiansen (2014), focused on describing and comprehending how people constructed meaning in their social world and reflected on their behaviour within their natural environment. Employing a qualitative research approach, the study explored teachers' experiences in teaching science at a science centre, as defined by Creswell

(2014) for investigating into individuals' or groups' meanings and experiences within their natural settings.

The research employed a case study design, a method aimed at gaining a comprehensive understanding of a complex subject in its natural context (Henning, 2004). This design was chosen to achieve an in-depth understanding of FET teachers' views and practices in teaching science at the science centre.

To select participants, purposeful sampling was used, as described by Cohen et al. (2007), which involved gathering information from individuals with extensive knowledge of a specific subject. The selection criteria included teachers who taught physical sciences and technical sciences and planned to visit the UNIZULU science centre (Mayaba, 2008).

1.9 Concepts clarification

The following concepts are defined based on their usage in this study:

- **Informal learning environment**

  An informal learning environment is an environment where teaching and learning takes place outside the classroom (Coll & Coll, 2018). Informal learning environments can be unstructured, learner-led, spontaneous, personal, continuous, contextual, collaborative, non-linear, and extracurricular learning characterised as open (Eshach, 2007).

- **Formal learning environment**

  A formal learning environment refers to an institute such as a school that provides learning in a structured manner, in which a formal curriculum is presented in accordance with policies and norms (Lelliott, 2014; Bilankulu, 2018).

- **Science teachers**

  Teachers who hold a major in either technical sciences, Natural sciences, Life sciences or physical sciences (Bawaneh et al., 2020).

- **Field trip**

  Zaca (2018) defines a field trip as a journey taken by a group of people outside a classroom to a site that is designed for interactive learning. A field trip is

experienced by a learner outside a classroom environment (Behrendt & Franklin, 2014).

- **Science centre**

A science centre is an informal educational facility that employs effective techniques to impart knowledge in the fields of science, technology, mathematics, and engineering, while fostering interactive engagement with the exhibits (Sentürk, 2015).

- **Teaching**

The process of teaching is scientific in nature, consisting of key elements such as content delivery, communication, and feedback (Isola, 2019).

- **Learning**

Learning is the process of obtaining knowledge, regardless of whether it takes place in a formal or informal setting, meaning learning can take place anywhere (Harrop & Turpin, 2013).

- **Perception**

Perception refers to the knowledge and experience that someone has that affects their observation (Sentürk, 2015). Perception involves processing and evaluating information based on the knowledge one has about something (Mayaba, 2008).

1.10 Chapter Outline

Chapter One provides a brief introduction of learning science in an informal learning environment such as a science centre. The context of the study, the problem statement, the research aims and objectives, the research questions, the study's rationale, and the purpose are all covered in this chapter. The study's delimitation were also explored.

Chapter Two discusses the literature review of this study. This chapter also examines the role of science centres in science education, explores the benefits and challenges of informal learning environments and informal learning environment experiences. Furthermore, the chapter provides an in-depth discussion of the underlying conceptual framework that serves as the foundation for this study.

Chapter Three this chapter presents the research methodology used in this study, which includes the nature of the research, research context, sampling methods and data collection techniques, data analysis method and ethics are also discussed in detail.

Chapter Four presents the data that were collected from interviews, observations, and document analysis. The data presentation was guided by three research sub-questions and is presented in cases.

Chapter Five presents the discussion of the findings, the main contribution of the study, recommendations are also presented and the conclusion.

1.11 Conclusion

This chapter introduced the background of informal learning environment, particularly, in science centre. The study's background highlighted the critical significance of such environments, in the context of teaching science subjects. This study specifically focused on physical sciences and technical sciences subjects. The rationale behind conducting this study was to provide valuable insights to science teachers who organise visits to informal learning environments such as science centre. Additionally, the study acknowledges its delimitations, which include the involvement of one UNIZULU science centre and four science teachers from different schools. The next chapter presents the literature review related to teaching science in the informal learning environment and the conceptual framework that guided this study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The previous chapter introduced the focus of the study and its purpose. The current chapter reviews the literature on informal learning environments, especially, the science centre as the focus of this study. This chapter begins with the definitions of informal learning environments as discussed in the literature. The chapter also reviews the science centre as an informal learning environment. It then continues with an overview of the history of the UNIZULU science centre that was chosen for this study. The benefit and challenges of teaching science in informal learning environments were also reviewed. The reviewed conceptual framework that provided guidance for this study is also discussed.

2.2 Definition of an Informal Learning Environment

An informal learning environment is an environment where the teaching and learning that happens outside the classroom (Coll & Coll, 2018). All outdoor environments used by teachers and learners worldwide for different learning purposes are called informal learning environments (Behrendt & Franklin, 2014). Informal environments include museums, zoos, planetariums, aquariums, science centres, beaches, lakes, rivers, forests etc (Albadawi, 2021).

Informal learning environment are recognised for their multifaceted role in benefiting the community, including fostering community cohesion, and providing social avenues that support learning principles through enjoyable experiences (Leatherbury, 2011). They relate subject knowledge to the real-life situations of learners, as well as engage in non-traditional learning models (Walan & Gericke, 2021).

There is a thin line between the terms informal learning environment and non-formal learning environment. A non-formal learning environment is an institution or organisation where learning is planned in a highly flexible manner and in situations that are beyond the spheres of a formal learning environment (Grimus, 2017). Additionally, learners are exposed to experimental learning for a short period. Non-formal learning environments are less structured, and the motivation for learning is intrinsic (Eshach, 2007). Furthermore, Smith (2021) refers to non-formal learning as informal learning because non-formal learning and informal learning both take place

outside of the classroom and allows learners to build knowledge through their own experiences, talents, and choices. For this current study, non-formal learning is not referred to as an informal learning environment.

This study accepted an informal learning environment as learning that occurs outside of school, as defined by Coll and Coll (2018). Moreover, with the support of Straka (2004) and Billett (2002), in the context of this study, the term "informal" does not pertain to the nature of the learning process, but rather to the setting in which this learning occurs, specifically, within the science centre. Informal learning environments are characterised as open-ended, non-intimidating and exploratory, while concurrently integrating teaching, learning and entertainment (Temban et al., 2021). Therefore, the science centre aligns with the attributes of an informal learning environment. For this current study, science centre is the informal learning environment.

2.3 Science centre as an environment for teaching

Teaching is a process of content delivery, communication, and feedback (Isola, 2019). Teaching can be classified into two main approaches: teacher-centred and learner-centred. The teacher-centred method, commonly known as direct instruction, involves the teacher having full control over the content, and how it is presented to the learners (Aldila & Rini, 2023). On the other hand, the learner-centred approach focuses on learners learning by discovering concepts on their own, emphasising the active role of learners in the learning process (Mavumba & Mtitu, 2022). It takes a specialised skill set and knowledge base to successfully teach science in science centres, due to the complicated nature of the environment (Uludag, 2021). Teaching science in a science centre involves a wide collection of tasks which extends to planning, coordination and implementation of programs designed for visitors such as learners and teachers (Uyen Tran & King, 2007).

The CAPS highlight that the primary aim of physical sciences is to foster an understanding of the environment and provide learners with investigative skills concerning physical and chemical phenomena like lightning and solubility. These skills include classification, measurement, design of investigations, observation, and problem-solving.

Teaching within informal learning environment such as science Centre involves employing hands-on and inquiry-based methods. This approach aims to enhance critical thinking and problem-solving skills, thereby adding depth and meaning to both teaching and learning experiences (Albadawi, 2021). Hands-on activities in informal learning settings are designed to actively engage learners, ensuring sustained attention throughout the learning process. Additionally, employing a questioning teaching strategy not only stimulates curiosity but also motivates learners to actively seek understanding in the given topic area (Zhai & Dillon, 2014). This integration aligns with the broader educational objectives outlined in the CAPS for Physical Sciences.

2.4 Science centre as an environment for learning

A science centre is an informal learning environment, and it is an institution where people can learn informally in the fields of science, technology, and engineering. In the science centre, learners experience original, first-hand touch with exhibits to keep learners' interests alive (Sentürk, 2015). Learning in the science centre is different from formal school learning, where learners are exposed to learning materials for a longer period in classrooms, and school buildings follow an organized timetable (Meredith et al., 1997).

Science centres have become ideal institutions for science learning due to their abundance, and the diversity of exhibits available and their characteristic of combining entertainment with learning (Sentürk, 2015). This not only supplements formal education, but also offers learners a platform to reinforce their skills as they are part of physical and technical science subjects (Grimus, 2017). Additionally, science centres have science development programmes where they equip teachers to use exhibits and teach them how to conduct experiments in schools (Fish, 2016). Future visits to informal learning environments depend on the quality of experience that learners and teachers have during their trip, thus the informal learning environments should implement all essential measures to guarantee that field trips are both educational and enjoyable.

Science centres as informal learning environments for learning are still underused by schools, particularly, in Turkey and this speculation may be true for South Africa (Sentürk, 2015). Therefore, it was important to conduct this study to understand

teachers' perceptions of teaching science in the science centre. The UNIZULU science centre was the informal learning environment chosen for this research.

2.5 UNIZULU Science Centre

2.5.1 The history of the UNIZULU Science Centre

The University of Zululand opened the UNIZULU Science Centre 36 years ago in 1986 within the deserted laboratory in the Zoology building (Fish, 2016). It was operated by the department of physics in the KwaDlangezwa Campus (Fish, 2016). The science centre used to be visited by 3000 learners per year, and at the time it was still at the KwaDlangezwa campus. According to Fish (2016), the science centre, boasting a collection of 130 exhibits, transitioned from its campus location to an unoccupied industrial facility in Alton Richards Bay and officially resumed operations on the 27th of February 1997.

The newly opened UNIZULU science centre has expanded in terms of the exhibits, and building and the number of learners visits exceeds 30 000 per annum, excluding teachers and parents (Fish, 2016). In November 2006, the UNIZULU auditorium which accommodates 200 people was extended and is used to present sound vibration experiments (Fish, 2016). The science centre has TRAC-Lab funded by South 32 Company in Richards Bay. During September 2011, an additional 600 m^2 structure was incorporated, designated as an early childhood development centre. This establishment marked Africa's inaugural dedicated children's museum (Fish, 2016). Presently, the UNIZULU science centre encompasses more than 200 interactive exhibits within 7 distinct exhibition zones, predominantly emphasising physical sciences. Sustained by the Department of Science and Technology, the science centre has received funding since 2008, with interns being deployed to provide assistance (Fish, 2016). It is for this reason that this study focused on teachers specialising in physical sciences or technical sciences.

2.5.2 UNIZULU science centre involvement with stakeholders

The primary purpose of the UNIZULU science centre is to provide support to science teachers and learners across KwaZulu-Natal schools that are situated in the vicinity of the University of Zululand. Extending its reach, the centre accommodates teachers and learners spanning from the Tugela River in the southern region to North Kosi Bay to the inland areas like Nongoma. This coverage encompasses three out of KZN's

twelve education regions, which encompasses approximately 550 secondary schools and over 1000 primary schools (Fish, 2016). Many of these secondary schools face dire challenges in terms of teaching resources, often lacking adequate equipment and numerous classrooms remain without electricity. The study's sample was drawn from the KwaMbonambi circuit, a region which is consistently identified in numerous surveys and studies as disadvantaged (Fish, 2016). This highlights the study's attention on teachers who are involved in teaching either physical sciences or technical sciences.

2.6 Benefits of teaching science in the informal learning environments

The literature shows that teachers take learners to different informal learning environments because of the numerous benefits. These benefits are motivating learners, enhancing curriculum, career awareness, social-emotional and development of life skills (Uludag, 2021). These benefits are discussed below:

Teaching that motivates learners by increasing interest and curiosity

The physical features, the materials, and the typical activities that are available in informal learning environments influence the teaching process by making the science concept easy to understand (Uludag, 2021). Moreover, the environment itself provides a stronger motivation for science learning to meet the growing demand for science and engineering jobs in a modern global economy (Watson et al., 2007).

The teaching strategies that involve observation and hands-on activities that are done in informal learning environments arouse the curiosity of learners (Gungor, 2021). Furthermore, teaching in these environments assist learners to relate science to everyday life situations (NRC, 2009).

Enhances the curriculum

Technical sciences and physical science are distinct branches of the broader scientific field, requiring teachers to effectively convey theoretical concepts and engage students in practical activities (Physical Science CAPS, page 14). Experiential learning in informal environments offers unique educational opportunities, allowing learners to acquire knowledge through hands-on experiences, fostering deeper understanding compared to traditional methods (Uludag, 2021).

This approach, highlighted by Albadawi (2021), introduces variety into the traditional classroom curriculum, cultivating a positive attitude toward educational activities. Moreover, incorporating real-world activities, as emphasised by Yigit et al. (2021), helps learners connect scientific ideas with practical life circumstances. Teaching science in informal settings not only develops science process skills but also provides concrete experiences through exhibits and visual learning materials (Walan & Gericke, 2021; Yigit et al., 2021), enabling learners to perceive and comprehend the natural world (Smith, 2020).

Contributing to the development of life skills

Informal learning environments offer a rich collection of instructional resources that are often either absent or more expansive than those available in schools (Albadawi, 2021; Smith, 2021). This abundance of resources in informal settings significantly contributes to the cultivation of problem-solving skills. Furthermore, learning in informal environments encourages both teachers and learners to develop creativity by embracing diverse teaching methodologies (Weeden et al., 2011; Yigit et al., 2021). The alignment between informal learning benefits and the objectives of teaching science is evident in the Physical Science and Technical Science CAPS documents. This document emphasises the importance of equipping learners with a range of critical skills, including the ability to design investigations, identify and control variables, and draw conclusions, all of which are foundational for scientific inquiry. As a result, the educational experiences provided by science centres complement and enhance the school science curriculum.

Career awareness

In informal learning environments, various science-related career education opportunities are provided, which introduce learners to diverse fields of science. This exposure to the world of science can serve as an incentive, motivating learners to opt for science as a subject not only in high school but also at higher educational levels (Zaca, 2018).

Social-emotional benefits

Participating in visits to informal learning environments fosters a deeper mutual understanding among learners. Field excursions often integrate team-building

exercises, enhancing collaboration among learners. Working together in a group, coupled with instructional materials, has been shown to boost learners' engagement in activities (Tasdemir et al., 2014). Importantly, conducting classes in informal learning settings contributes significantly to the development of cooperative skills among learners. This aligns with the goals of the National Curriculum Statement Grades R-12 which emphasises the importance of encouraging learners to work effectively both independently and as integral members of a team.

2.7 Challenges of teaching science in informal learning environments

Literature shows that there are challenges associated with teaching science in informal learning environments. These challenges include the lack of teacher training, limited time for teaching, inflexibility of curriculum, as well as transportation (Behrendt & Franklin, 2014; Keisel, 2005). These challenges are explained below:

Lack of teacher training

Teacher involvement is a key factor in planning a successful field trip. Lack of teacher training in planning out-of-school academic trips result in teachers dissociating themselves from learners in an informal learning environment (Keisel, 2005). In fact, allowing learners to form their own understanding of discovery experiences, without guidance leads to subject content misconceptions (Tran, 2007). Teachers' involvement in the informal learning environment plays an important role in reaching the intended objectives of their visit in an informal learning environment (Behrendt & Franklin, 2014). However, studies show that although teachers describe an informal learning environment as an important place to teach science, they are unable teach in these environments (Simsek & Kaplan, 2022). This study sought to explore teachers' perceptions of their role when visiting the science centre.

Limited time for teaching

It is believed that overcrowding of learners visiting informal learning environments contributes to less time for teaching (Bilankulu, 2018). The method of lesson presentation or teaching strategy used for a bigger group of learners is associated with the instructor rather than the facilitator (Zaca, 2018). This results in learners being unable to interact with exhibits on their own (Behrendt & Franklin, 2014).

The inflexibility of the curriculum

Some content lessons presented in informal environments are not aligned with the curriculum in the school (Behrendt & Franklin, 2014). Subsequently, this results in a wasted educational visit since learners cannot link the visit to the content learned in the classrooms (Zaca, 2018).

Moreover, Oliver and Herrington (2001) argue that science centres are often criticised for prioritising entertainment over education, leading to the perception that they are mere playgrounds for visitors. Consequently, if science centres emphasise fun and amusement too heavily, learners may prioritise enjoyment over actual learning.

Transportation to the informal learning environments

The locations of informal learning environments are mostly in largely populated cities which results in a travel expense for learners who live in rural areas (Tasdemir et al., 2014). As noted, in 2.4.2 the UNIZULU science centre is the only science centre within a large radius. Behrendt and Franklin (2014) record that teacher's feel that preparing for visits to informal learning environments is both time-demanding and costly. Planning a field trip requires the school to seek permission from parents as well as the contribution for transportation. Thus, teachers become frustrated, and as a result they avoid organising educational field trips for their learners (Behrendt & Franklin, 2014; Mosabala, 2014).

Furthermore, literature shows that teachers in schools face a lot of challenges in planning and preparing for visits to informal learning environments. However, those challenges do not prevent teachers from taking their learners to informal learning environments (Behrendt & Franklin, 2014). Therefore, this study sought to investigate how secondary school teachers perceived the process of teaching science in informal learning environments, given that they continue to take their learners to these venues.

2.8 Planning a successful visit to the informal learning environment.

Teachers should prepare learners to learn outside of the classroom since the novelty of a non-classroom setting might be distracting. Learners who are not used to attending academic field excursions or other non-classroom settings need teachers' guidance (Behrendt & Franklin, 2014). Sentürk (2015) recommends that any visitor's experience is shaped by his/her background, and interactions with their social and

physical environments. Teachers should know how to integrate these three contexts (personal, social, and physical) into a successful field trip experience (Behrendt & Franklin, 2014). Therefore, to plan a successful out-of-school learning, there are things that teachers need to consider before, during and after a visit to an informal learning environment.

2.8.1 Before the visit

Teachers should have a proper plan which includes a visit to an informal learning environment such as a science centre before taking learners to the site (Behrendt & Franklin 2014). The teachers' pre-visit to an informal learning environment is to familiarise themselves with the site and to arrange activities that are aligned with the classroom curriculum. It is also important that teachers prepare learners prior to the trip by familiarising them with the venue's layout (Kisiel, 2005). In addition, learners should be orientated about expected behaviour on the site and be informed about interacting with exhibits in the science centre. Moreover, learners should be taught the objectives of a visit to focus learners on the learning process (Behrendt & Franklin, 2014).

2.8.2 During the visit

Teachers should keep learners engaged in an informal learning environment (Mosabala, 2014). The staff in the informal learning environments should collaborate with the teachers to assist learners in making connections between the experience and the topics involved (Kisiel, 2005). A teacher's main objective should be to make field trips meaningful and inspiring for all learners. A teacher should actively participate in all phases of the field trip as well as fulfil a variety of tasks and responsibilities (Zaca, 2018). Additionally, learners learn in an authentic way such as doing hands-on activities usually in groups to achieve their objectives. Therefore, teachers should emphasise the need to supervise learners when they interact with exhibits for safety and to address their enquiries (Rebar, 2010).

2.8.3 After the visit

Teachers need to reflect with their learners after a visit to reinforce the curriculum connection which is made during a learning process in an informal learning environment (Mosabala, 2014). This can be done by asking questions formally or informally. Reflections on learning in an informal learning environment will contribute

to evaluation which is vital to the teaching and learning process (Department of Education, 2011). A successful experience and quality outside-classroom learning require teacher preparation, engagement, as well as a reflection (Behrendt & Franklin, 2014).

2.9 Teachers' motivations for visiting an informal learning environment.

Teachers' motivations are the reasons that drive teachers to organise and conduct teaching and learning that is outside the school setting (Ogbomo, 2010; Zaca, 2018). Literature shows that teachers mostly take their learners to informal learning environments because of the following reasons: 1) curriculum, 2) entertainment and 3) social. These reasons are elaborated in detail below:

Curriculum

Teachers conduct educational field trips mostly with the aim to promote lifelong learning, connecting curriculum with classroom theory and giving a different learning experience (Uludag, 2021). The teaching that happens in an informal learning environment improves learners' learning and motivates them as they experience experimental learning (Uludag, 2021; Tal & Steiner, 2006). Another reason for visiting an informal learning environment is to conduct experiments which are part of the formal science curriculum, especially, in schools that lack resources (Albadawi, 2021). The teachers bring their learners to informal learning environment with specific objectives in mind. However, if the learners perceive the trip primarily as a fun outing, it is unlikely that these objectives will be fulfilled (Eshach, 2007). Hence, it is crucial for teachers to explain the aims and objectives of the visit to their learners beforehand.

Entertainment

Teachers may organise field trips to excite their learners (Leatherbury, 2011). Kisiel (2005) revealed that one of the reasons teachers arrange school visits to informal learning environments is for entertainment purposes, where learners experience fun while learning.

Social

Learners are taken to informal learning environments to increase personal connection between learners and to help express themselves in a social setting (Uludag, 2021; Leatherbury, 2011). Informal learning environments provide learners with

opportunities to communicate and interact with each other, and that supports good relations when they are back in the classroom (Albadawi, 2021).

2.10 Schoolteacher practices in Informal learning environments

In an informal learning environment such as a science centre, schoolteachers' practices have a significant influence on learning and engagement level of learners (Zaca, 2018). According to Dewitt and Storksdiek's findings in 2008, one of the practices of schoolteachers is to create a memorable experience during a visit to an informal learning environment by actively engaging learners and facilitating the integration of their classroom knowledge with the content of the visit. Furthermore, Briggs (2009) emphasises the need for teachers to move throughout the trip to ensure that their expectations are being met.

Research suggests that teachers often utilise informal learning environments to teach subject matter that may be challenging to cover effectively within a classroom, possibly due to limited resources in their schools (Xulu, 2012). This practice serves as a means of complementing and supplementing classroom teaching, injecting variety into the learning experience, and exposing learners to valuable experimental resources (Anderson & Zhang, 2003; Kisiel, 2003). However, a study by Sonmez and Ozturk in 2022 revealed that, during museum visits, schoolteachers tend to concentrate more on learner management. Interestingly, the research also indicates that schoolteachers do not view informal learning environments as supplementary platforms for delivering science lessons. Instead, they often rely on science centre facilitators to take charge of lesson delivery, allowing the schoolteachers to focus solely on managing the learners (Xulu, 2012).

2.11 The science curriculum and teaching in the informal learning environments

Curriculum and Assessment Policy Statement (CAPS) is the current curriculum used in South African schools. CAPS is a guideline policy for all subjects listed in the National Curriculum Statement for Grades R – 12 (Department of Education, 2011). CAPS curriculum aims to capacitate learners with knowledge and skills in a way that provides meaning to learner's (Department of Education, 2011). Additionally, CAPS provides teachers with comprehensive instructions on what to teach and how to assess.

According to the Department of Education (2011), science is defined as a systematic way of seeking explanations using inquiry and investigations in connecting the ideas people have. Science is learned as a theory (scientific information) and experiments (hands-on activities) in school. Teachers may plan and prepare visits to informal learning environments to do experimental learning (Albadawi, 2021). The science curriculum is introduced in the natural science discipline in the senior phase. Natural science lays a foundation for secondary studies in more specific science disciplines such as physical sciences, technical sciences, life sciences and agricultural sciences.

The curriculum for both physical science and technical science shares common aims, focusing on enhancing learners' investigative abilities, including planning an investigation, analysing results, creating models, forming hypotheses, and problem-solving skills (DBE, 2011). Notably, technical sciences and physical sciences align in five knowledge areas and diverge in only one, while they both emphasise the same set of skills (Physical sciences CAPS, 2002;Technical science CAPS, 2014). Therefore, learning scientific knowledge, skills, and comprehending scientific concepts requires doing experiments. The CAPS curriculum is silent about school visits to learn science in informal learning environments. It is mandatory that teachers should conduct science experiments, however, teachers may improvise when the school does not have the equipment (NS CAPS, 2002).

Research has shown, however, that few schools in the country have laboratories that are equipped with equipment (Fish, 2016; Meier, 2003; Muwanga-Zake, 2007; Nandipha et al., 2023). Therefore, as they are unquestionably necessary for teaching science, the benefits of the experiments mentioned above are unquestionably compromised in these underprivileged schools.

According to Netshivhumbe et al. (2021), most teachers do not do hands-on activities with their learners in the laboratory due to a lack of resources. Additionally, due to a shortage of science resources in most South African schools, science teachers have adopted the traditional teacher-centred method of teaching science. Teachers are constantly under pressure to cover the curriculum and concentrate on the year-end assessments (Smith, 2020). Due to this, teachers must now use different methods to ensure that learners improve their performance. Different methods teachers use are

planning and preparing field trips and borrowing resources from informal learning environments such as a science centre (Fish, 2016).

This study focused on schoolteachers who were either teaching physical sciences or technical sciences, as they frequently take their learners to science centres that offers education in various science subjects (Insulander & Ohman, 2022).

Teaching science in informal learning environments

Learners are inherently curious beings, constantly seeking new knowledge and skills. Most of the search for knowledge involves science (Bell et al., 2009). Informal learning environments often aim to promote the use of unique physical and electronic objects that are focused on exploration and social interaction. The teaching of science is effectively supported by employing resources, demonstrations, and experiments that take place within these informal learning environments (Fish, 2016).

Teaching science in an informal learning environment should immerse learners in experiential learning, fostering the development of crucial laboratory skills like designing and conducting experiments while igniting a genuine interest in science (Leatherbury, 2011). These skills align with the learning objectives outlined in the physical sciences and technical sciences CAPS curriculum. The emphasis on small group learning encourages the sharing of exhibits and knowledge, promoting social learning. However, the research revealed that most schoolteachers poses challenges for teaching science in informal learning environments due to their inherently less structured nature, making effective planning and teaching more challenging (Sonmez & Ozturk, 2022). As the results science school teachers relay on science teachers for teaching and they provide with them their goals and objectives for visits.

In addition, an informal learning environment provides learners with the freedom to learn about the material that is presented to them (Albadawi, 2021). To accommodate learner's individual learning style teachers should place a high priority on integrating a variety of learning activities (Dipietro et al., 2008; Smith et al., 2018), thus informal learning environment does promote different teaching styles.

2.12 The Conceptual framework

The conceptual framework of this study was guided by the definition of an informal learning environment, what teachers need to know about informal learning

environments and the field trip inventory model (FTI). The informal learning environment definition has assisted in understanding the knowledge teachers should have about the informal learning environment. It was appropriate to examine what teachers need to know about informal learning environments since it has helped in exploring teachers' perceptions of teaching science in the science centre. Furthermore, the use of the FTI model has assisted in understanding how teachers should prepare for their visits to informal learning environments.

2.12.1 Definition of informal learning environments

An informal learning environment is a setting where teaching and learning occurs outside the classroom to achieve specific objectives (Coll & Coll, 2018). For the current study, the informal learning environment that was focused on was the science centre.

2.12.2 What do teachers need to know about teaching in an informal learning environment?

Informal learning environments are a centre of excellence that offers resources for learners and teachers to advance their understanding of science in teaching and learning (Smith, 2020). Teachers who plan and visit informal learning environments should be aware of the psychological needs of learners, the factors that influence teaching in an informal learning environment as well as characteristics of a successful learning experience in an informal learning environment (Patrick et al., 2013).

Psychological needs of learners

According to Patrick et al., (2013), for field trips to be successful teachers should understand the psychological need of learners. Psychological needs are divided into six components. The six needs are (1) curiosity-learners expect to see something to arouse their interest. Things that they have not seen before; (2) confidence-learners anticipate feeling good about themselves. They expect to succeed and have confidence in their capacity to learn new skills when; (3) challenge-learners desire and anticipate being challenged. They anticipate encountering difficulties and participating in the resolution process, even though they desire to be successful; (4) control-learners anticipate feeling in charge in their learning; (5) play-learners expect to have fun in the informal learning environment and (6) communication-learners expect to have relaxed communication with their teachers and informal learning environment staff during their visit.

The factors that influence teaching in an informal learning environment

For teaching to take place in an informal learning environment, it is influenced by three factors (Davidson et al., 2010). These factors consist of a (1) personal context- which is a teacher or learner's prior knowledge, interest and experience that a visitor brings to the informal learning environment; (2) sociocultural context- which involves the potential for persons both inside and outside of the group to have an impact on learning in an informal learning environment; and (3) physical context- the informal learning environment itself, and the exhibits available to provide a great teaching aid for teaching (Falk & Dierking, 2000; Uludag, 2021).

Characteristics of a successful (teaching and learning) experience in an informal learning environment

Davidson et al., (2010) identified three characteristics of a successful learning experience in an informal learning environment such as science centre. The qualities include (1) planning and preparation; (2) visiting the informal learning environment; and (3) integrating learner and teacher-led learning (Davidson et al., 2010; Kisiel, 2014).

Planning and preparation

Planning and preparation are very important to avoid learning disruption in informal learning environments (Patrick et al., 2013). As part of teachers' preparation, teachers should organise activities that will increase learners' interest and knowledge (Zaca, 2018). Prior to the informal learning environment visit, it is the duty of teachers to explain to their learners the goal and schedule of the field trip (Kisiel, 2014).

Visiting the informal learning environment

It is the teachers' responsibility to plan and check activities that suit learners' age when visiting informal learning environments (Patrick et al., 2013). However, learning in an informal learning environment needs to include problem-solving skills and integrate the classroom curriculum (McLoughlin, 2004). Furthermore, pre-visiting the informal learning environment by schoolteachers help to support learning activities during the field trip (Coll et al., 2018; Kisiel, 2003).

Integrating learner and teacher-led learning

Teachers should allow learners to group themselves to promote team-building relationships among learners (Bätz et al., 2010). Furthermore, giving learners the freedom to select their own working groups helps them feel in control of their learning and increases learners' discussion (Coll et al., 2018).

2.12.3 Field trip inventory (FTI) model

The conceptual framework of this study was also based on the field trip inventory (FTI) model. Coll et al. (2018) explains that the FTI model has three educational components which are important when teachers plan for scientific field trips. These components are named cognitive, procedural, and social. The FTI model is used when guiding a successful use of informal learning environment experiences, particularly, a science centre for the context of this study. This model better fits this study because the researcher sought to explore how teachers prepare for their learners' visits to the science centre. The three components are elaborated in detail below.

Cognitive component

The cognitive component is divided into four stages: pre-visit activities, during-visit activities, post-visit activities, and problem-solving. Pre-visit activities involve teachers developing classroom exercises that align with the learning goals of the informal learning environment visit. These activities are carried out in the classroom setting to prepare the learners for their visit (Coll et al., 2018). During the visit, activities are designed to build upon the pre-visit preparation and enable learners to better understand scientific concepts during their visit (Coll et al., 2018). Post-visit activities are conducted after the visit to help learners reflect on and to apply what they learned in the informal learning environment to their classroom curriculum (Davidson et al., 2010). Problem-solving activities engage learners in critical, analytical, and creative thinking, encouraging them to interpret new information based on what they have learned in both the classroom and the informal learning environment (Coll et al., 2018).

Procedural component

The procedural component involves two key elements: facility staff and advance organisers. Before the visit, teachers are advised to contact and visit the informal learning environment to meet the facility staff (Storksdieck, 2001). This allows teachers to familiarise themselves with the environment and to understand the expertise of the

staff, which helps in planning the educational objectives for the visit (Coll et al., 2018). Advance organisers are pamphlets that provides learners with essential information about the informal learning environment. They include details such as the layout of the environment, notes on available exhibits, and the time allocation for each area (Coll et al., 2018). To ensure a well-organised visit, it is a teacher's responsibility to visit the facility prior to the school visit to liaise with an informal learning environment staff to inform them about their intended objectives of the visit (Coll et al., 2018).

Social component

Teaching in informal learning environments can be enriched when teachers provide opportunities for learners to choose their own groups, allowing them to enjoy each other's company and foster collaborative learning experiences (Patrick et al., 2013). Moreover, teachers who actively incorporate learners' suggestions during pre-visit planning empower learners to take ownership of their education, promoting a sense of responsibility and engagement in the learning process when they visit the informal learning environment (Storksdieck, 2001).

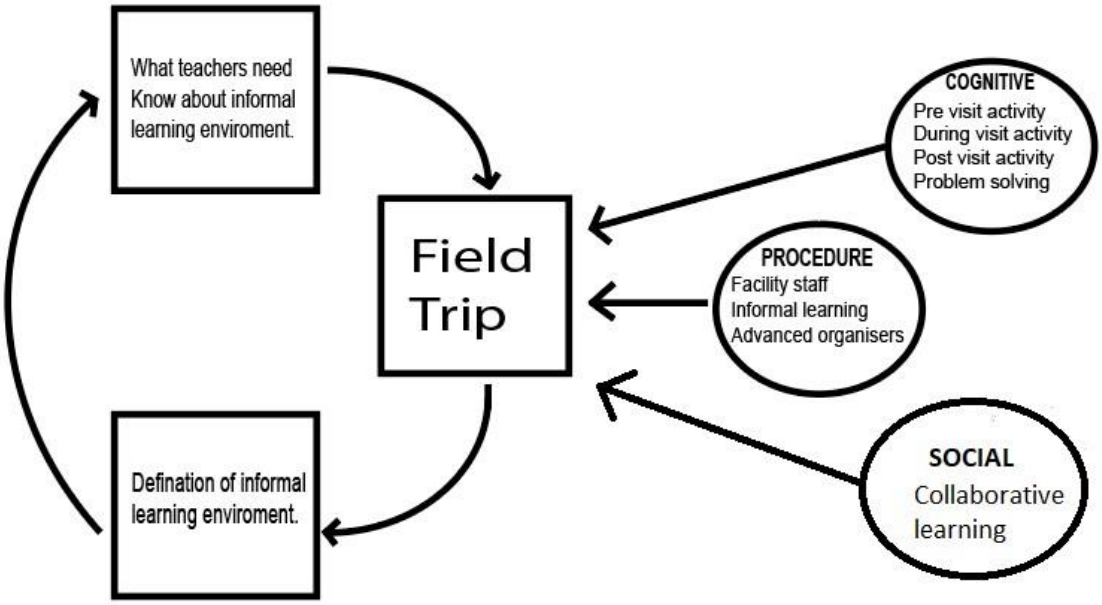


Figure 2.1 *A model that links the definition of an informal learning environment, what teachers need to know about informal learning environments and the field trip inventory (adapted from Patrick et al., 2013)*

2.13 Conclusion

This chapter began with defining the informal learning environment and examining the science centre as an informal learning environment. It then discussed the history of the UNIZULU science centre which was chosen as an informal learning environment. The chapter also highlighted the benefits and challenges of teaching science in an informal learning environment. It is also noted that a successful visit to an informal learning environment is enhanced by preparing learners' experiences before visiting an informal learning environment. Furthermore, curriculum and teaching in an informal learning environment were also reviewed. Finally, the conceptual framework of definition of an informal learning environment, the knowledge a teacher must have about the informal learning environment and the FTI model was reviewed. The next chapter discusses the methodology and sampling approach of this study.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Introduction

This study aimed to understand FET teacher's perceptions and practice the teaching of science in a science centre. To achieve this aim, this chapter presents the procedures used in this study. This entails the research methods, research design, sample strategy, as well as the paradigm that frames the research and its justifications. The chapter further discusses the data analysis that was used in this research. Lastly, the chapter concludes by presenting issues of trustworthiness and ethical considerations which were followed during the research process. Table 3.1 below outlines the summary of research methodology of this study.

Table 3.1 The summary of research methodology (adapted from Zaca, 2018:68)

Research focus area	Research discussion point
Research questions	Main question: ▪ How do FET teachers' view and practice the teaching of science in a science centre? Sub-questions: ▪ What is the extent of understanding regarding the teachers' knowledge of how and when to teach science in the science centre? ▪ How do teachers plan and prepare for a visit to a science centre? ▪ How do the science teachers facilitate teaching and learning in an informal learning environment such as a science centre?
Research paradigm	Interpretivist
Research approach	Qualitative
Research design	Case study
Sampling	▪ Purposive sampling
Data collection technique	▪ Semi-structured interviews ▪ Observations ▪ Document analysis

Data analysis	Content analysis

3.2 The research paradigm

McMillan and Schumacher (2014) define research paradigms as ideas and beliefs of researchers on how to interpret the data collected for research. Paradigms are guidelines for experienced researchers and beginners on how to work with the chosen method without getting confused in a study (Thanh & Thanh, 2015). There are four research paradigms according to Christiansen et al. (2010), namely: positivist, interpretivist, post-positivist, and critical paradigms.

The interpretive paradigm enables researchers to perceive the world from the perspective of individual participants (Zaca, 2018). Therefore, the interpretive paradigm was followed to develop, comprehend, and interpret meanings from participants. Moreover, it proves highly beneficial when researchers seek to gather valuable insights into participants' lived experiences through the utilisation of observational methods.

This study adopted an interpretivist paradigm, a framework that is commonly used in studies that focus on understanding of human and social interaction with the world around them (McMillan & Schumacher, 2014). Interpretivist researchers aim to grasp the contextual aspects of participants' settings by personally visiting the context, collecting data first-hand, and conducting thorough analyses (Kivunja, 2017). The data in this study were gathered through participant observation and semi-structured interviews, aligning with the interpretivist paradigm (McMillan & Schumacher, 2014). Furthermore, Van-Rensburg et al. (2011) agree that there are several ways of interpreting the same data and the understanding depends on the person doing the interpretation in the context in which they find themselves. The choice of this paradigm was based on the provided definitions, and the nature of the inquiry being investigated. This approach allowed a comprehensive understanding of schoolteachers' role in the science centre and how secondary schoolteachers teach science within the science centre setting.

3.3 Research approach

The research approach outlines the study's methodology. The goal of the research approach is to demonstrate how the researcher will use the research questions to

come to reliable and accurate conclusions (Creswell & Creswell, 2017). There are three different categories of research methodologies: mixed, qualitative, and quantitative (Maree, 2007). An approach to qualitative research was used in this study.

Qualitative research is a strategy for systematic collection, organising and interpreting textual information descriptively (McMillan & Schumacher, 2014). Aiming to understand how and why individuals think, act, and create meaning in the ways they do in their natural environments, qualitative research seeks to gain a thorough Misunderstanding of phenomena from small samples (McMillan & Schumacher, 2014).

The primary goal of qualitative research is to offer a comprehensive representation of the phenomenon under investigation (Maree, 2007). The researcher selected this research approach because it was appropriate for the study's goals and research questions. This study sought to investigate teachers' views of teaching science in science centre environment as well as understanding the participants' personal experiences. Additionally, the data collected was non-numerical (Thanh & Thanh, 2015). Moreover, the qualitative methodology is commonly employed in research that focuses on participants' perspectives within their authentic environments (Creswell & Creswell, 2009; Lincoln, 2011). McMillan and Schumacher (2014) outline three elements of qualitative research namely, 1) flexibility, 2) emergent design and 3) natural settings. The characteristic of qualitative approach further shows why the approach was suitable, this is elaborated below.

Flexibility

Qualitative research methods are flexible and enable greater spontaneity and modification in the interaction between the researcher and the participant. (Lincoln, 1985). Open-ended questions that were not always phrased the same for each participant were used in this study by the researcher. This was done to allow participants to react freely and in their own terms. As opposed to a simple "yes" or "no", these responses were semi-structured.

Emergent design

Qualitative research is flexible and always developing. This can mean that sticking to the original strategy is not a must. All stages of the research process may change once the researcher enters the field and starts to gather data. As long as the changes don't

interfere with achieving the research's objectives, which include learning more about the problem (McMillan & Schumacher, 2014). For example, in this study, a researcher collected pre-interviews in schools, observations and post-interview in the science centre. However, the original plan was to conduct post-interviews back in the participants' respective schools. Participants and a researcher agreed to a change of plan and the post-interviews were also conducted in the science centre after the observation phase. Furthermore, despite this deviation from the original plan, the researcher ensured that the adjustments were implemented while keeping the research objectives in focus.

Natural settings

The site where qualitative researchers collect data in the field is typically the place where participants experience the issues or topic under study (Creswell, 2009). They do not distribute questionnaires for people to fill out, as is customary in survey research. Instead, qualitative researchers engage with people directly and study their behaviour and actions in their surroundings to gather detailed data (Ormston, 2014). The researchers gradually engage in face-to-face interactions in the setting.

3.4 Research design

A case study design was used in this study. According to Creswell (2009), a case study design is a research method that is used in getting a thorough and multi-faceted understanding of a complex subject in its natural surroundings. Furthermore, a research design is a strategy that specifies how the study will be carried out to reach its research objectives (Creswell, 2009; Fenstermacher, 1986).

A case study design helps a researcher to conduct a comprehensive study systematically (Henning, 2004). A case study approach is suitable for addressing the “how” and “why” research questions without having to regulate participant behaviour (Bassey, 1999; Yin, 2009). A case-study design also acknowledges the distinctiveness and dynamic nature of situations while conducting a thorough investigation of human interactions in a particular situation (Yin, 2009). According to Lincoln and Guba (1985), there are several types of case studies. These case studies are stated in Table 3.2 below:

Table 3.2 The descriptions of different types of case studies (Lincoln & Guba, 1985)

Type of case study	Description
Explanatory case studies	Researchers are interested in investigating possible causes of specific events
Exploratory case studies	Researchers gather more data before formulating their research topics.
Descriptive case studies	Researchers start with a descriptive theory, and then they compare the information acquired from the observations to the prevailing theory.
Intrinsic case studies	A researcher conducts a study with a personal stake in the findings.
Instrumental case studies	These occurs happen when a person or group enables researchers to comprehend more than what is initially noticeable to observers.
Multiple-case (collective) studies	Researchers study a group of individuals in a certain environment.

The multiple (collective) case-study design was considered appropriate for this study because it allowed a researcher to engage with science teachers to know about their experiences in the informal learning environment (Maree, 2007). Every case was handled separately. Furthermore, a case study approach has the capacity to offer a significant amount of data that is essential to this research.

3.5 Research context

This section provides an overview of the study's research settings.

3.5.1 Research setting

The educational system in South Africa is divided into two distinct departments: the Department of Basic Education (DBE) and the Department of Higher Education and Training (DHET). The DBE oversees Grade R through Grade 12 education, whereas

the DHET is entrusted with the oversight of universities and post-school education and training. The DBE governs schools in the nine provinces of South Africa and those provinces are made of districts. KwaZulu-Natal as a province consists of twelve educational districts namely the iLembe, Amajuba, uMzinyathi, uThukela, Harry Gwala previously called Sisonke, uMgungundlovu, Umlazi, Pinetown, King Cetshwayo previously called uThungulu, uGu, uMkhanyakude, and Zululand. This study has conducted research in the King Cetshwayo district under the KwaMbonambi circuit. King Cetshwayo district is made up of five circuits (Umlalazi, Nkandla, Umhlathuze, Mthonjaneni and Imfolozi). Circuits are made up of wards, and the KwaMbonambi ward is one of the nine wards under Imfolozi circuits. The word circuit is used interchangeably with the word ward.

The researcher chose the KwaMbonambi ward usually called circuit because of its accessibility and convenience for data collection, since the researcher stays in the ward. Moreover, the presence of schools in the KwaMbonambi ward and the UNIZULU science centre within the area of Richards Bay offered a suitable environment for gathering the data for this study. Additionally, the proximity of these educational institutions made it simpler to coordinate and communicate with participants for the data collection process.

3.5.2 Population and Sampling

Participants are sampled from a population that is representative of that population, which is an important aspect of the research (McMillan & Schumacher, 2014). Zaca (2018) describes the population as the total number of people from which the participants will be chosen.

Sampling is defined as the process where a researcher chooses a small proportion of the population to represent the population in the study (Berndt, 2020). For this study, purposeful sampling was used to select participants. Purposeful sampling is used to gather information from people who have deep knowledge about a certain subject (Cohen et al., 2007). The participants of this study were four science teachers who were either teaching physical sciences or technical sciences in their respective schools because these two subjects are components of scientific subjects and are taught in the FET phase in all South African schools. Participants were from three different schools in the KwaMbonambi ward. Moreover, the participants were chosen

because they had plans to visit the UNIZULU science centre and were willing to participate in the study (Cohen et al., 2007; Hennings, 2004). For these reasons, the selected participants were able to give information on how and why they intend to visit the UNIZULU science centre. Likewise, it would save the researcher time and money, making the study more feasible (Creswell, 2009).

The criteria

In purposeful sampling, participants should meet the set criteria and be able to provide detailed information about the phenomenon under investigation (Mayaba, 2008). The criteria used to choose the sample are described in this section. It also discusses the steps that were taken to choose the cases.

The participants were teachers who were teaching in secondary schools from the KwaMbonambi circuit. The participants had to be science (Physical sciences and technical sciences) teachers in Grades 8 to 12. Furthermore, for this study, participants were chosen based on the schools that planned to visit the science centre and their willingness to take part in this research.

Four teachers were chosen to be participants from three different schools. The participants and school names were given pseudonyms. The pseudonyms given to participants and schools were Mrs R from school A, Mr O from school B, Mr S from school C and Mr E from school A.

3.5.3 Cases

The study focused on four participants from three secondary schools. The cases are described as follows:

Case 1: Mrs R from school A

School A is a public school in the rural KwaMbonambi area. It has 16 classrooms, one inactive science lab, and 3 workshop buildings for technical subjects. The school has one principal, two deputy principals, and five departmental heads. The total number of teachers in the school is 39 with 1195 learners. The school teaches Grades 8 to 12. Mrs R is one of the sciences (physical sciences and technical sciences) teachers and has 9 years of teaching experience in this school. During data collection, Mrs R was teaching physical sciences and technical sciences in Grades 10-12. Mrs R holds a

bachelor's degree in education with Natural science and Physical sciences specialisation. Her highest qualification is Honours in education.

Case 2: Mr E from school A

Mr E joined school A in 2015 where he taught Grade 11 Physical science and Grade 9 Mathematics. Since 2019 he has been teaching technical sciences in Grades 10-12. Mr E is in his late thirties and holds a bachelor's degree in education senior and FET with Physical sciences and Mathematics as majors.

Case 3: Mr O from school B

School B is situated in an anonymous village in the KwaZulu-Natal province. The school lacks adequate teaching materials and infrastructure. A total enrolment of 1205 learners, the school is notably without a dedicated science laboratory. The subject of physical sciences receives a modest allocation of three hours per week, each class spanning 60 minutes. It is important to note that instruction is conducted in English as the medium of communication. During data collection, Mr O was teaching Physical sciences in Grade 12, and Mathematics in Grade 8. He holds a bachelor's degree in Biochemistry and Microbiology, and a post-graduation certificate in education with Natural science and Life sciences specialisation.

Case 4: Mr S from school C

The school is a no-fee school, and it is situated in a rural area far north of KwaMbonambi ward. It is 33,1 km from Richards Bay town. The school has 22 teachers and 780 learners. The classroom average size is 60 learners. Mr S joined the school in 2015, where he teaches Natural sciences and Physical sciences. He has been teaching Physical science for 10 years. During data collection, Mr S was teaching Physical sciences in Grade 12, and Natural sciences in Grade 8. Mr S holds a bachelor's degree in Biochemistry and Microbiology which was completed in 2010, and a postgraduate certificate in education with Natural sciences and Life science specialisation.

3.6 Data collection techniques

McMillan and Schumacher (2014) explain data collection as the process of gathering information using different instruments to be evaluated by a researcher to address the research questions posed by the study. Studies indicate that researchers can evaluate

peoples' perceptions through interviews, observations, and reading documents (Berndt, 2020; McMillan & Schumacher, 2014). Therefore, in this qualitative study, the data was collected through interviews, observations, and document analysis.

Merriam (1998) emphasises that qualitative research revolves around pivotal activities such as making observations, engaging in analysis, and conducting interviews. It was considering these, therefore, that the researcher deemed it fit to use the interview tool to further probe the teachers' conceptions of teaching science in the science centre. Thus, this study employed a qualitative research method for data collection.

3.6.1 Interviews

Interviews are conversations with goals between a participant and a researcher (McMillan & Schumacher, 2014). McMillan and Schumacher (2014) categorise three types of interviews, namely: semi-structured, structured, and unstructured. Semi-structured interviews show less control, offer greater adaptability, and do not rely solely on the interviewer. Structured interviews are not flexible, and a researcher has predetermined agenda. Unstructured interviews are open-ended, and flexible such that they can turn to the unpredicted direction (Holidays, 2007).

In this study, the researcher adopted semi-structured interviews to determine rich descriptive data from the participants by allowing them to share their knowledge and experiences regarding the topic under study. Semi-structured interviews have open-ended questions which allowed a researcher to generate data from four sampled science teachers on how they perceive teaching science in the science centre (Grossoehme, 2014).

Interviews took place at participants' schools, and they were interviewed twice before, and immediately after observation of their visits to a science centre. The interview schedule used to guide the interviews was developed using open-ended questions. Face-to-face interviews that lasted 30 to 40 minutes each were conducted. Conducting a face-to-face interview provided thorough data gathering, and the opportunity to get a deeper understanding (Meier, 2018).

Using face-to-face interviews was applicable in this study since the researcher looked for detailed information on participants' experiences, and perceptions of teaching science in the science centre. Consent was requested from the participants to record

interview responses in audio format. Audio recording as well as field notes assist a researcher when transcribing data in preparation for analysis (Creswell, 2009). An audio recording was conducted using a smartphone, the researcher then transferred the audio record to a password-protected USB for confidentiality purposes. Interviews were transcribed in a form of verbatim (word to word). Some of the interview questions are illustrated in Table 3.3 below:

Table 3.3 Sample of some interviews' questions asked before and after the observation.

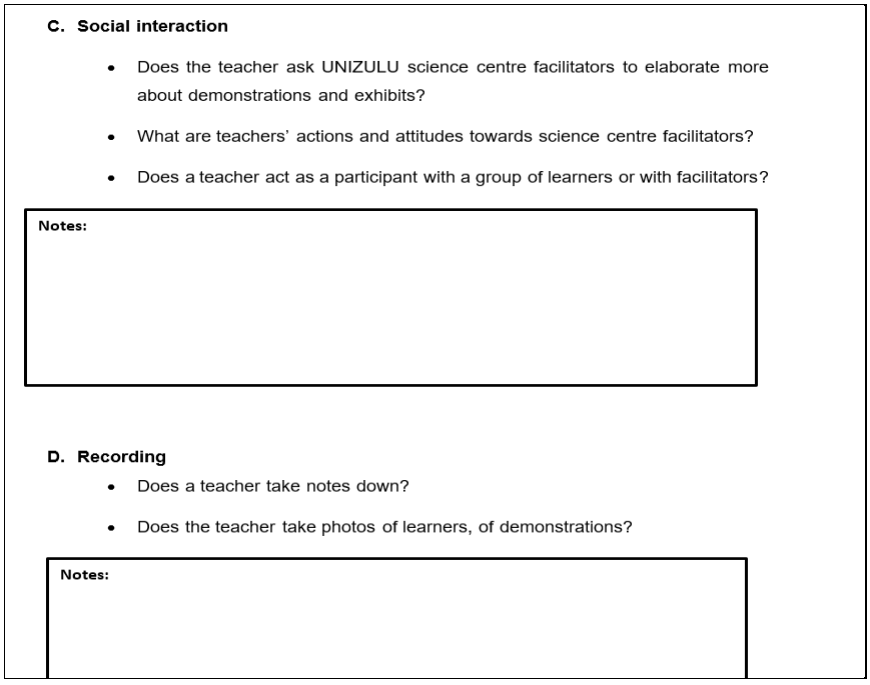
Before observation questions	After observation questions
• Which Grades and classes do you typically bring to the science centre? • Do you think learners learn when teachers teach at the science centre? • Do you visit the site (science centre) before you take the learners? • Are you presenting any lessons at the science centre? • What do teachers normally do when they get to the science centre?	• Were you able to achieve your goal of the visit? • Were you satisfied with the learning process at the science centre? • What were the benefits of taking learners to a science centre? • Will you visit the science centre again?

3.6.2 Observations

McMillan and Schumacher (2014) define observation as an act where a researcher watches people and events in the natural setting with an intention to collect data. There are four types of observation according to McMillian and Schumacher (2014). Firstly, as an incomplete observer, a researcher solely observes the situation without active participation. Secondly, the observer as participant involves a researcher entering the situation, while primarily focusing on their role as an observer. Thirdly, the participant as an observer approach, is when a researcher's role is disclosed to the participants. Lastly, the complete participant is when a researcher totally immerses themselves in the surroundings, and participants or people are unaware that they are being observed.

In this study, complete observer observations were employed to collect information, in which a researcher did not influence teaching and learning process in the science centre. According to Creswell (2014), by taking on the role of a complete observer, participants were given the ability to speak freely. Observations assisted the researcher in knowing the social roles of science schoolteachers in the science centre in which teaching and learning activities were performed (Grossoehme, 2014). According to Cohen et al. (2011), observation in research offers the advantage of gathering information in its natural context within a social institution.

The researcher observed four participants individually at the UNIZULU science centre. During observation at the UNIZULU science centre, the researcher assumed a non-participant observer role and participants were aware that they were being observed. This comprehensive observation lasted for three hours, comprising five distinct sessions: Career guidance, science demonstrations, exploration of exhibits, a lesson on safety at sea, and an experiment. The observation schedule was used to guide the observation process. The observations were recorded in field notes and transferred to a password-protected file on a memory stick (USB). These observations were aimed at comprehending the practical aspects of schoolteachers' teaching methods, drawing inspiration from Creswell (2014). Figure 3.1 below shows part of the templet used during the observations at the UNIZULU science centre.



C. Social interaction

- Does the teacher ask UNIZULU science centre facilitators to elaborate more about demonstrations and exhibits?
- What are teachers' actions and attitudes towards science centre facilitators?
- Does a teacher act as a participant with a group of learners or with facilitators?

Notes:

D. Recording

- Does a teacher take notes down?
- Does the teacher take photos of learners, of demonstrations?

Notes:

Figure 3.1 *Example of the document produced by the researcher.*

3.6.3 Document analysis

According to Bandi (2012), documents are an important source of data collection because they reveal what people can and cannot do. Document analysis has been part of research as far as 1993, and is still relevant in many studies (Bandi, 2012). In this study, the documents studied were those outlining the teachers' preparations for the visits to the informal learning environment, particularly, the science centre. Collected documents were lesson plan designed by schoolteachers, worksheets by schoolteachers and handout by UNIZULU science centre. These documents were studied to provide a more comprehensive description of teachers planning and preparation for a visit to a science centre.

3.7 Data analysis

Data analysis is the process of organising, classifying, and processing the collected data in a meaningful way by noting themes, categories, patterns, and consistencies (Henning, 2004). This study used inductive content analysis to analyse the data collected. Inductive content analysis is referred to as a research method that is used to analyse a written, verbal or visual communication (Creswell, 2009). In this method, researchers commonly employ coding and categories during data analysis, highlighting the approach's reliance on logical thinking that originates from concrete facts, ultimately leading to comprehensive conclusions (Bertram & Christiansen, 2014). The inductive content analysis was appropriate for this study because a researcher was analysing information from semi-structured interviews, observations and documents used by teachers in planning and preparation for their visit to science centre.

In this study, inductive content analysis was adopted, which integrated coding and category creation. The coding was initially developed based on the literature and the research questions. All interviews were recorded using a smartphone, and these audio recordings were transcribed verbatim to maintain fidelity to the spoken content. To enhance precision, the researcher reviewed and cross-checked the transcripts against the original audio, ensuring alignment with participants' words. The researcher then meticulously analysed the transcribed data, conducting a line-by-line examination in a way that aimed to discern recurring ideas and patterns within the text.

The transcribed interviews were analysed to understanding the teachers' knowledge of how and when to teach science in the science centre. Additionally, each document designed by schoolteachers was analysed to assess how FET teachers plan and prepare and whether they explicitly outline the purpose and learning objectives for organizing visits to the science centre. The analysis of observation data focused on identifying the teacher's role, and the connection established with the science centre.

These findings were then organised into categories that corresponded with the objectives of the study, as informed by the FTI model discussed earlier and the relevant literature. After categorisation, the researcher explored connections between the identified categories. This step was crucial for gaining insight into how FET teachers view and practice science teaching in a science centre. This approach aligns with the findings of Battiste (2016), emphasising the need to analyse and transcribe research data for readers to comprehend the results effectively.

3.8 Trustworthiness

In qualitative research, trustworthiness pertains to convincing the readers that the study's findings merit consideration, and that the research maintains a high standard of quality (Maree, 2012). This study used Merriam (2009) procedures of trustworthiness which includes credibility, dependability, authenticity, and transferability.

3.8.1 Credibility

Credibility is a method of assuring that the research findings correspond to reality, and that a reader trusts the research process' conclusions (Flanagin & Metzger, 2007). To ensure the credibility of this study, the interviews were audio-taped and transcribed in a form of verbatim. The use of several sources in the research is known as triangulation (Msweli, 2020). To increase the study's credibility, triangulation was adopted, and as a result used many methods (semi-structured interviews, observation, and document analysis) to collect data, and allowed for the inclusion of multiple points of view.

3.8.2 Dependability

Dependability is the period in which a reader may be satisfied that the researcher's findings occurred exactly as he or she claims (Maree, 2012). Lincoln and Guba (1985) expressed a similar viewpoint when they said that dependability is the method by

which the researcher assesses the entire data-gathering and processing procedure. It is challenging to guarantee dependability for qualitative work. However, in quantitative research, dependability is consistency. To ensure dependability, only science teachers who intended to visit the science centre were sampled as participants. In this study, science teachers were teachers who were teaching either physical sciences or technical sciences during a data collection.

3.8.3 Authenticity

According to Lehman et al. (2019), authenticity refers to the genuineness or truthfulness of a study. To ensure authenticity in this study, a detailed description of the research setting, and participants were provided. This allows readers to assess the transferability of the findings to other contexts and enhances the study's authenticity. Furthermore, direct quotations from the participants were used while presenting the data, to avoid the data being questioned and to ensure trustworthiness. The researcher wrote participants' words in italics to highlight that they were the participants' voices, and not the researchers.

3.8.4 Transferability

Transferability is the degree to which a study's conclusions can be extended and applied to other populations. Qualitative research, however, is more designed to offer in-depth insights into the phenomena being studied than it is to be generalisable (Creswell, 2014). Giving a thorough description will enhance the findings' transferability (Maxwell, 2021). By doing this, readers of this research can evaluate and determine whether the findings are comparable and applicable to other contexts or not. The results of this study are likely to have relevance for other science teachers who engage in teaching science within informal learning settings, such as science centres.

3.9 Ethical considerations

Ethical considerations are very important principles which govern the research on what is acceptable, or not acceptable when the researcher is engaging with the participant (McMillan & Schumacher, 2014). It was necessary to follow the principles of research ethics to protect the participants, promote values of truth and mutual respect for the research data to enhance the truth, or reduce inaccuracies (Resnik et al., 2015). Before the data was collected, the following ethical procedures were followed.

Permission was sought from relevant authorities, for instance, the KwaZulu Natal Department of Basic Education, school managers (principals), secondary science teachers, and science centres. This process was carried out after obtaining ethical clearance from the University of South Africa.

Participants were given a written consent form that explained the study and its objectives before the data was collected. The study was voluntary, and participants were made aware of their right to withdraw from this study anytime they felt like they did not want to participate anymore. The consent letters outlined the participants' voluntary and independence in their participation. The ethical standards as well as principles of informed consent were thus upheld. To participate in this study, the participants signed the consent letters. The study was also disclosed to the school principals and officials of the UNIZULU science centre, even though they were not participants.

The participant names and schools were given pseudonyms to maintain anonymity. The participants were assured of confidentiality by keeping the discussed information confidential and only used for research purposes. Field notes, audio recordings, and observation documents were handled professionally and were kept safe. Soft copies were stored in the cloud.

3.10 Conclusion

This chapter has outlined the research methodology which was used to collect data in this study. The chapter discussed the relevancy of using a case study design. The qualitative methods which were used to obtain the data such as population and sampling, data gathering procedure, and the research participants were all explained and justified. Furthermore, the process of data analysis (content analysis) and the ethical considerations were explained. The results of the study are presented in the next chapter.

CHAPTER 4

DATA PRESENTATION

4.1 Introduction

The previous chapter presented the methodology that was used to guide the study. This chapter provides the data that was generated through interviews, observations, and document analysis. The results are presented in four individual cases, as this study was conducted as a case study. The collected data aimed at responding to the following questions:

Main research question

How do FET teachers perceive and practice the teaching of science in a science centre?

Sub-questions

1. What is the extent of understanding regarding the teachers' knowledge of how and when to teach science in the science centre?

2. How do teachers plan and prepare for a visit to a science centre?

3. How do the science teachers facilitate teaching and learning in an informal learning environment such as a science centre?

4.2 Categories

Since this study used inductive content analysis, the collected data is presented using categories that emerged from the analysed data. These categories include:

- Teachers' knowledge of how and when to teach science in a science centre.
- Teachers planning and preparation for a visit to a science centre.
- Teachers' facilitation of teaching and learning in a science centre.

4.2.1 Category 1: Teachers' knowledge of how and when to teach science in the science centre.

Case 1: Mr O

Teacher's knowledge about teaching science at the science centre

Mr O expressed concerns about the teaching methods used in the science centre, stating that they may not align with the classroom curriculum. Although he acknowledged that the science centre can ignite learners' interest in science, he believed that the teaching does not effectively facilitate actual learning.

In addition, Mr O suggests that science centres can serve as valuable resources for career guidance. He explained that these institutions can provide learners with insights into various scientific fields, which can help them make informed decisions about their future career paths. He said that:

> *Researcher*: *Do you think learners learn when teachers teach at the science centre?*
>
> *Mr O: "No, but it's just to arouse interest because there are things that they see physically when they are at the UNIZULU science centre …what is offered by the centre is not correct or 100% in line with the curriculum in class or back at school, but it can direct them in terms of career choices".*

According to Mr O, the teaching strategies employed at the science centre effectively captured learners' attention and kept them engaged and energised. Mr O explained that the exhibits are designed to provide learners with hands-on experiences which fosters a deeper understanding of scientific concepts. The unfamiliar faces of the UNIZULU science centre facilitators also contributed to the learners' interest in learning as they brought a fresh perspective and new knowledge to the learners. He elaborated that:

> *"They become so active more than what you see in classes because of the visual things they see in the science centre and see new faces trying to explain some concepts to them".*

Which Grades should visit the science centre?

Mr O believed that the learners that should visit the informal learning environment such as the science centre should be learners who are in Grade 12. He believed that the science centre will be more beneficial to these learners since they are exiting high school and they are going to higher institutions. He commented that:

"Mostly it's the Grade 12 I take to the science centre because they are about to exit High School".

He further elaborated that the science centre was there as the career guidance institution. When the learners visited the science centre, they are there to be guided about careers so that they know what they can do after completing Grade 12. He believed that the science centre also prepared learners for the world outside high school. He specified that:

"…So, I need them to see for the career guidance part, so the exhibition is key to them for visual learning, so they know what is happening outside the world and can choose careers wisely".

Mr O explained that the school syllabus demand is the main factor that determined the frequency of visits to informal learning environments. He emphasised that these visits are an essential part of the educational experience as they provide a unique opportunity for learners to explore real-world situations and gain practical knowledge. Mr O further explained that visits to informal learning environments could take place once or twice a year, depending on the school's syllabus. He said:

Researcher: How frequently are learners taken to the scientific centre?

Mr O: *"… mostly it would be once or twice a year, depending on the demand of what is required by the curriculum".*

The benefits of teaching in the science centre

Mr O expressed that the science centre has a role in enhancing the teaching of science subjects, but he also believed that it may only be partially relevant to the school curriculum. He noted that one of the advantages of visiting the science centre is that it can stimulate learners' curiosity about the subject of science. He stated:

"The benefit calls back to arousing interest … brief explanations done by the officers at the science centre. I won't say they don't gain anything, they do gain, even if it's partially irrelevant to what is offered by the school curriculum".

Mr O noted that the science centre can help to enhance learners' content knowledge of science subjects, such as chemical reactions and the motion of bodies. Being able to see and interact with these phenomena in a person can deepen learners'

understanding and appreciation of the subject matter. Moreover, Mr O highlighted that the utilisation of technology within the science centre proves to be an asset in aiding learners to comprehend difficult scientific concepts. He explained that:

> *Mr O: "Through the science centre, learners can gain a better understanding of scientific concepts such as chemical reactions and the motion of bodies. The videos they watch in the centre can help to engage their interest and foster a deeper appreciation for the subject".*

Mr E believed that learners have the capacity to learn, but there may be situations where they are not motivated or willing to learn. Mr E provided an example of a specific class where some learners display a negative attitude towards learning, resisting active participation, consequently impeding their capacity to acquire knowledge efficiently. He said:

> *Researcher:* Do you think learners learn when teachers teach at the science centre?
>
> *Mr E: "Yes, they learn, sometimes, but not always, for instance, there is a class where the learners refuse to learn themselves whereby, they are being taught and the attitude made them refuse to be able to learn".*

Case 2: Mr E

Teacher's knowledge about teaching science at the science centre

Mr E added that teaching science in an informal learning environment, such as a science centre, can be highly effective in promoting learners' interest in science-related careers and beyond. Furthermore, the teaching that takes place in science centres can help bridge a gap between the school syllabus and real-life situations, making science more engaging and relevant to learners. He explained that:

> *"I think science centres are highly productive and impactful for teaching and learning environments because they provide learners with more than just knowledge about a specific subject. Learners can also gain valuable insights into life and the choices they can make".*

Which Grades should visit the science centre?

Mr E believed that the Grades that should visit the science centre are Grades 10 to 12. He commented that:

> *"We bring grades from Grade 10, Grade 11, up to Grade 12…Not frequent enough, below average, maybe once a year".*

The benefits of teaching science in the science centre

Mr E pointed out that traditional teaching methods in schools tend to be more focused on theoretical concepts and textbooks. As a result, the benefit of teaching in a science centre lies in the opportunity to explore a more visual and hands-on learning experience. By engaging in interactive and experiential learning activities, learners can develop a deeper understanding of scientific concepts and gain practical skills that can be applied in real-world situations. This approach to learning can also help to spark interest and enthusiasm for science and encourage learners to pursue further education and careers in science-related fields. He elaborated that:

> *"The benefit is they see things at a practical level, and whereby opposed at school everything is done theoretically, its only books, but when they come to the science centre, they see more practical things rather than theoretical"*.

Case 3: Mr S

Teacher's knowledge about teaching science at the science centre

Mr S held the belief that the science centre provides an informal learning environment where learners can acquire various science-related skills, including conducting experiments, participating in demonstrations, and developing scientific awareness. In addition, Mr S emphasised that the science centre also plays a crucial role in exposing learners to potential career opportunities within the scientific field. He explained that:

> *Researcher: Do you think learners learn when teachers teach at the science centre?*
>
> *Mr S:* "*Yes, a lot. If you take learners at the science centre, UNIZULU science centre facilitators help learners with graphs, they do demonstrations and experiments, and they teach them more about their careers".*

Mr S stated that the teaching that happens in the informal learning environment such as the science centre assists learners in understanding science knowledge and developing an interest in the subject. He elaborated that:

> *Researcher: What are your thoughts on teaching at the science centre?*
>
> *Mr S: "Through teaching learners get help and they get interested towards their subjects and careers when they are in the science centre".*

Mr S explained that learners tend to be more excited and engaged when they visit unfamiliar places like science centres, likely, because they spend more time at school than outside of school. He also noted that viewing exhibits and other interactive displays can inspire learners to further explore and pursue science-related topics. Mr S discussed that:

> *Researcher: What do learners normally do when they get to the Science centre?*
>
> *Mr S: "Spending most of their days in the same place can cause learners to become overly excited when they visit a new environment, such as a science centre. Seeing various exhibits and displays based on scientific principles can further increase their enthusiasm. In turn, receiving assistance in the subject of science can be particularly beneficial to these learners".*

Which Grades should visit the science centre?

Mr S stated that it is depended on the Grade he teaches in the year, for example, he currently teaches Grade 9, Grade 11, and Grade 12. He indicated that:

> *Researcher: Which grades do you usually bring to the science centre?*
>
> *"This year it will be Grade 9 and Grade 12" (Mr S).*

In addition, Mr S also said that they focus on visiting informal learning environments once a term.

The benefits of teaching science in the science centre

Mr S believed that the science centre fosters teamwork among learners and promotes collaborative relationships between learners and teachers. He explained that:

> *Researcher: What are the benefits of bringing learners to the science centre*?

“Learners-to-leaner relationships get stronger, and they also connect more with their teachers” (Mr S).

Mr S further said that when learners are exposed to a teacher who employs a different teaching strategy, they may develop a better understanding of the subject matter. He expanded that:

“In the science centre, learners get more understanding on their subject because they get to hear different sides of topic explanations by UNIZULU science centre facilitators”.

Case 4: Mrs R

Teacher’s knowledge about teaching science at the science centre

During an interview with Mrs R, she shared her thoughts on the importance of taking her learners to informal learning environments such as a science centre for learning science. She explained that exposing learners to different environments is essential as it gives them the opportunity to experience and engage with the environment. Mrs R emphasised that this exposure helps learners to better understand scientific concepts and theories and helps to make learning more meaningful and enjoyable. She described that:

“...The environment and exposure, the adventure of being in a lab teach them a lot. To be in a science centre alone is an experience on its own”.

Mrs R emphasised that the teaching that takes place at the science centre is incredibly valuable for learners. She explained that due to a lack of resources at the school, many learners struggle with handling the apparatuses used during science experiments, which in turn limits their knowledge and understanding of scientific concepts. However, by taking learners to the science centre, they are given the opportunity to become familiar with these important tools and gain valuable knowledge that will benefit them even after they leave school and pursue further education. She explained that:

"For me, the experience of working in a science laboratory can shape learners' future prospects, whether they decide to pursue a science major or work in a field that involves laboratory work. Being in a laboratory setting allows them to

gain valuable insights and explore a wide range of scientific concepts. Additionally, it provides an opportunity for them to become familiar with using equipment that may not be available in their school laboratory. However, due to the limited resources in our school, learners don't get the chance to engage in hands-on learning experiences".

Mrs R saw science centres as a crucial resource for learners, one that can play a key role in inspiring the next generation of scientists and science enthusiasts. By exposing learners to new ideas, providing them with a supportive learning environment, and helping them develop a love for science, science centres can truly make a difference in the lives of learners, both now and in the future. She said:

"Normally they get excited because they are not used to this, especially the ones that want to pursue careers that are related to science, it motivates them to be in a science centre".

According to Mrs R, the teaching that takes place at the science centre is highly complementary to the school syllabus, particularly, when it comes to the practical aspects of the science curriculum. She explained that conducting science experiments is an integral part of the curriculum and a key component of the formal assessment process. By providing learners with access to well-equipped laboratories and knowledgeable instructors, the science centre can enhance their practical skills and enable them to perform better in their formal assessments. She elaborated that:

Researcher: How does teaching in the science centre links to classroom learning?

Mrs R: "Mostly in classroom we teach the theory part, then in the science centre they get the practical part of it, which helps them a lot because mostly in science, there are marks which are in theory, and some are in practical. Then they gain a lot to be in a science centre because they will improve their marks which are allocated for practical part for the science".

Which Grades should visit the science centre?

Mrs R believed that learners who visit the science centre should be in manageable numbers, and for her, this typically means Grade 12 learners. She explained that taking smaller groups of learners allows for a more personalised learning experience

and helps to ensure that each learner can engage with the material in a meaningful way. When asked about how often learners visit the science centre, Mrs R explained that it typically occurs about twice a year.

The benefits of teaching science in the science centre

Mrs R said that teaching in the science centre help learners to gain an understanding of science concepts. She believed that learners are taught laboratory safety rules, they see science apparatus used when one conducts a science practical.

Mrs R believed that teaching science in a science centre is important for helping learners to understand scientific concepts through hands-on laboratory work. She emphasised the importance of laboratory safety rules to create a safe learning environment and expose learners to various scientific apparatuses to develop their experimental science skills. She sees science teaching as critical for success in academic and professional pursuits and believes it can inspire a lifelong love of science. She elaborated that:

> *Researcher: What are the benefits of bringing learners to the science centre?*
>
> *"To gain knowledge, to be well vast with the equipment, to note so many things about the laboratory precautions and the dangers in the laboratory. They need to know all those things. The principles, most of the time in the lab, we go science centre to know things that relate to the curriculum" (Mrs R).*

4.2.2 Category 2: Teachers planning and preparation for a visit to a science centre.

Case 1: Mr O

Teacher preparation

Mr O visited the UNIZULU Science Centre beforehand to assess its operations, confirm available dates, and meet with facilitators to plan the lessons that will be delivered during the visit. He stated that:

> *Researcher: Do you visit the site (science centre) before you take the learners?*

Mr O: "Yes, you check for the availability of the officers, and how safe it will be when your learners arrive at the science centre, and so you check the functionality of the science centre"

According to Mr O, the initial step in planning and organising out-of-school teaching is to establish the goals and objectives of the lesson. He emphasised the significance of discussing these objectives with his learners to establish clear expectations prior to their science centre visit, as doing so can promote levels of engagement. He said:

"Firstly, before you take learners for the visit, you must identify a need first of taking them there, you want to address a certain concept".

Mr O stated that when he is preparing for a visit to the science centre, he informed the school management team about the excursion. Once the school has been informed, he completed the form and then submitted it to the circuit manager for approval. He mentioned that he communicated with learners' parents for transport contribution, and elaborated that:

"You must organise with the parents, firstly the SMT of the school, you have to report about the excursion you fill-up the form, you involve the parent because they have to support financially their children, you organise transport then you have to submit to the circuit manager about your planning".

According to Mr O, he planned that he was going to provide his own learning material for the learners, and he believed that the facilitators at UNIZULU science centre would meet him halfway. Mr O's response was as follows:

Researcher: Are you expecting the science centre facilitators to give you and the learners anything such as worksheets?

Mr O: "*Not necessarily the worksheet but the contribution by teaching, I will bring my own worksheet"*.

The teacher's goal for visiting the science centre

Mr O stated that his Grade 12 learners are exiting high school education, so it is important that he familiarise his learners with the science laboratory before they get to post-school education. This is what he said:

Researcher: What is the goal of visiting the Science Centre?

Mr O: "The goal of visiting the centre is just to give my learners that exposure, since they are about to exit high school, I wish them not to just see things when they get to the university that those things become new to them, at least they must have that little knowledge about them".

Mr O also wanted to take learners to the science centre because he wanted his learners to be exposed to different science experiments when they were in the science centre. In addition, he wanted his learners to be able to see different apparatuses that are used during an experiment. In this case, he specifically mentioned a titration experiment. Mr O elaborated that:

"…the aim is to be able to conduct this experiment titration, the mechanism within this experiment which is titration and be able to handle the equipment".

Documents analysis

There was no lesson that was conducted for learners before the visit to the science centre. Therefore, there was no worksheet before. Two documents (a worksheet and career handout) were used during the visit to the science centre. Career handouts were designed by UNIZULU science centre facilitators to be used by all learners who are doing Grade 10 to Grade 12 during a visit to the science centre. The worksheet that was prepared by Mr O reflects his intention to guide his learners in conducting a titration science experiment, which, while being a formal assessment component, allowed for an informal learning experience in this particular case. The worksheet serves as a guide for learners, encompassing various essential elements. It begins with an introduction providing context for the experiment, followed by definitions of key terms to ensure learners understand the terminology involved. The stipulated procedures section outlines the specific steps and instructions for learners to follow during the experiment. Table 4.1 below shows how the worksheet content was designed.

Table 4.1: The outline of the worksheet designed by Mr O

Worksheet activity	Learner's expectations
Introduction about titration	Learners were expected to read the introduction about titration
Definitions of terms used in the worksheet	Learners were expected to read and know the used term in the titration experiment such as standard solution and burette
Stipulated procedures for learners.	Learners were expected to read and follow the stipulated procedures during the experiment.
observations	Learners were expected to fill in the information they observed during the experiment and complete the worksheet at home.
conclusion	They were then required to submit the completed worksheet to their teacher at school.

Career handout

During their visit to the science centre, Mr O and his learners participated in a career exploration session facilitated by a UNIZULU science centre staff member. The session included the distribution of Grade 10-12 career quest questionnaire handouts to the learners. The facilitator directed the learners to utilise the books available on the shelves that ranged from different career paths to research information and to complete the handouts.

Throughout the session, the career handouts were used to guide the learners in their exploration of potential career paths, and the facilitator provided guidance and support as needed. The handouts themselves included spaces for the learners to fill in the information, and Table 4.2 below provides an outline of the contents of these career handouts that were issued by the science centre facilitators.

Table 4.2: The outline of the career handout

Career handout activity	Learners' expectations
Name of a career	Learners were to write their three careers
Description of the career	Learners were expected to use provided books in the science centre about careers and describe the above-mentioned careers
Subject compulsory or recommended	Learners were expected to fill in the subjects recommended with respect to their careers

Qualification and duration of the study	Learners were to fill in the duration of the study
Employment (where one can work after completing studies)	Learners must research and find out the possible workplaces after completing the qualification.

Case2: Mr E

Teacher preparation

Mr E indicated that he did not visit the informal learning environment before taking his learners to the site. Mr E elaborated that he is familiar with the UNIZULU science centre and has recently been in the place, therefore, he does not see a need to do a pre-visit. He explained that:

> *Researcher: Do you visit the site which is the science centre before taking the learners?*
>
> *Mr E: "No, I haven't visited this science centre recently because I am already familiar with it and have visited it before."*

Mr E elaborated that before taking learners on a trip to the science centre, he makes several preparations. The first step is to brief the learners about the upcoming trip, explaining the purpose and expectations for the visit. Next, the headmaster and HODs of the school must also be notified about the trip to ensure that it aligns with school policies and guidelines. This helps avoid any potential issues and ensures that the trip runs smoothly.

Thirdly, Mr E writes letters to the parents, informing them of the trip, its purpose, and the necessary arrangements. This helps to ensure that parents are aware of their child's participation and can provide necessary permissions and support.

Finally, the teacher organises transportation for the learners, ensuring that the driver is well-informed about the location of the science centre and the route to take. He elaborated that:

> *Researcher: What do you do before taking learners to a science Centre visit?*
>
> *Me E: "First, you have to brief the learners that they are going to go, then you have to write a letter to the parents, to let them know about the visit. Let the*

headmaster of the school know and the HODs know of the trip to the science centre. You then have to organise transport that's going to take the kids to the science centre, including the driver, he has to be well-known and well-informed about the location of the science centre".

The preparations of Mr E were not limited to logistical matters because he designed the worksheet for educational activities to be used by his learners during the visit. He explained that:

Researcher: Are you expecting the science centre facilitators to give you and the learners anything such as worksheets?

Mr E: "I am not expecting it at all because I will bring my own worksheet".

The teacher's goal for visiting the science centre

Mr E's goal for organising the visit to an informal learning environment (the UNIZULU science centre) was to allow the learners to gain different approaches to science knowledge as well as to conduct the science experiments which form part of the school syllabus for formal assessments. He pointed out that:

"The goal is for the learners to learn on knowledge and assessments, a practical task for this year".

Documents analysis

Mr E and his learners were also given the same career handout which was given to Mr O's learners during the visit. Mr E designed his own worksheet for his learners to be used during and after conducting the science experiment in the science centre. Unfortunately, Mr E's learners did not have a chance to conduct or watch a presentation based on the science experiment because they left the science centre and returned to school. As a result, Mr E did not hand out worksheets to learners. The reason for taking learners to school was that learners were disturbing science centre facilitators during the lesson presentations. The worksheet remained with Mr E. Mr E gave the researcher his prepared worksheet during the post-interview. Table 4.3 below outlines the worksheet designed by Mr E that was supposed to be used at science by his learners.

Table 4.3: The outline of the worksheet designed by Mr E

Worksheet activity	Learner's expectations
Instructions	To read and fully understand the instructions provided
Aim	To comprehend and gain knowledge on the topic of the experiment
Apparatus and method	To familiarise themselves with the apparatus and follow the method
Learner Information	To fill in their name and grade
Rubric assessment	• Identify and handle apparatus (2 marks) • Collect, record and present data (2 marks) • Observe precautions (2 marks)
Questions	To answer the questions provided
Recordings	Learners were to record their results

Case 3: Mr S

Teacher preparation

According to Mr S, he prepared his learners for their visit to the science centre by briefing them on the environment and the expected behaviour. He provides an overview of the exhibits that they will encounter at the centre. Additionally, Mr S communicates with the parents of his learners to report on the planned visit and request funds for transportation and food expenses. Mr S elaborated that:

> *"I tell learners at school about the science centre, prepare them by telling them about what they are going to see and their expected behaviour at the science centre. I also talk to the parents, and they contribute especially towards food and transport fees because the school is very far from the science centre".*

Mr S believed in the importance of thorough preparation before taking his learners on an educational trip to the science centre. He pointed out that the science centre provides a variety of programs which are specifically designed for teachers. These programmes offer valuable opportunities to learn and interact with other teachers. Moreover, during his pre-visit to the science centre, Mr S familiarised himself with the layout of the centre, ensuring that he could navigate his way around with ease when he brings in his learners.

Researcher: Do you visit the science centre before taking your learners there?

Mr S: "Yes, we do. The science centre offers various programs for teachers, so we go there for a pre-visit before taking our learners. This helps us familiarise ourselves with the environment and prepare accordingly".

Mr S indicated that he is expecting teaching material from the UNIZULU Science centre as part of his preparation for teaching science during the visits.

The teacher's goal for visiting the science centre

Mr S stated that his primary objective for taking his learners to the science centre was to provide them with a unique and enriching educational experience that would enhance their learning through interactive and engaging science demonstrations. When he was asked what his goals were, he revealed:

"It's to build a learner, maybe the learners will understand another person when they are explaining a concept, especially when they demonstrate it practically".

Documents analysis

Mr S did not prepare any worksheet, handout, or lesson plan for teaching in the science centre. Additionally, it was noted that both Mr S and his learners were given the same career handout which was also provided to Mr O's learners during their visit. The career handout was used during the career guidance session, but it was observed that the handouts were not retrieved from the learners after the session.

Case4: Mrs R

Teacher preparation

Mrs R explained that she always does a pre-visit to the science centre before taking her learners. This is to help her to familiarise herself with the environment, identify potential safety concerns, and plan the visit effectively. By doing this, she believed she can ensure a smooth and productive learning experience for her learners. She highlighted that:

"It is very important for a teacher to go there beforehand so that you accustom yourself to the rules and expected behaviour so that when you come with your learners you are familiar with everything".

Mrs R emphasised that she takes the time to inform her learners about how to behave in the science centre before each visit to the science centre. This includes discussing laboratory safety rules, emphasising the importance of following instructions, and setting clear expectations for behaviour and academic performance. Once she has done this, she explained that she plans and prepares the work to be covered during the teaching sessions at the science centre. This involves setting specific objectives for a visit. She elaborated that:

> *Researcher: What do you do before taking learners for a visit to a science centre?*
>
> *Mrs: "I think you need to plan what it is that you are taking them to the science centre, what you need them to acquire, you need to have objectives so that you know when you arrive there what you expect your learners to gain from the science centre. You need to plan; it must not be too much work. You need to prepare learners and their behaviour and tell them what is expected of them when they get to the science centre".*

According to Mrs R, it is important to design her own teaching materials when planning to teach outside the school environment, such as at the science centre. She believes that this allows her to tailor her approach to the specific needs and abilities of her learners, while also aligning the content with the school syllabus.

> *Researcher: Are you expecting the science centre facilitators to give you and learners the worksheets?*
>
> *Mrs R: "No because it might not be related to the curriculum. I normally prepare the handouts before so that you know what question you need to be answered for your learners and the facilitators might help you, therefore, you need to have your own".*

The teacher's goal for visiting the science centre

The goal of Mrs R's visit to the science centre was to provide her learners with an opportunity to conduct science practical's, which are a crucial component of the school syllabus. According to Mrs R, her school does not have sufficient apparatus to conduct some of these science experiments, which can limit the learners' ability to fully engage with and understand scientific concepts. By organising a trip to the science centre, Mrs

R hoped to give her learners access to a wider range of equipment and resources, allowing them to conduct experiments and develop practical skills that they might not otherwise have had the chance to acquire. She explained that:

> *Researcher: What is the goal of visiting the science centre?*
>
> *Mrs R: "It is to do the practical part of it…resources are limited in our school; thus, learners don't get to know the practical part of their science subject. That's the reason we take them to the science centre because other resources are not there. In my school, our lab is not well equipped".*

Document analysis

It was noted that no lesson was observed prior to the visit, there were no related documents. However, the science centre facilitators provided career handouts to Mrs R's learners, which were like those in case 1 (Mr O). Additionally, Mrs R had prepared a lesson plan for teaching at the science centre, even though there was no teaching on her side. Mrs R created a lesson plan to use in the science centre. Table 4.4 below displays the framework of her lesson plan.

Table 4.4: The outline of Mrs R's lesson plan

Required information on the lesson plan	Mrs R's Responses
Topic and grade	Chemical reaction Grade 12
Term **Duration** **subtopic**	3 60 minutes Titration
Terminology/ Vocabulary	Indicator; Burette; standard solution
Prior knowledge	Titrations and indications should be taught to learners so they have the underlying knowledge needed.
Resources	Burette, dropper, burette stand and clamp, Erlenmeyer flask, white paper, beaker, funnel, pipette
Misconceptions	Wrong reading of meniscus in the burette
Methodology	Demonstration
Teachers' activities	Demonstrate to learners and monitor learners when doing the practical

Learners' activities	Read instructions, takes notes and conduct their own titration experiment.
Assessment	Practical (informal assessment)

4.2.3 Category 3: Teachers' facilitation of teaching and learning in a science centre.

Case 1: Mr O

The teacher's role at the science centre

Mr O clarified that his role during the visit to the science centre is not to act as a teacher but rather to serve as a manager and monitor for his learners. This involves overseeing the behaviour and engagement of his learners, as well as monitoring the lessons and activities presented by the science centre facilitator to ensure they align with the school curriculum.

> *Researcher: Are you presenting any lessons at the science centre?*
>
> *Mr O: "No, I will not present any lesson at the science centre, but I will be observing the activities and content being presented to ensure that we don't go away or divert from what is required by the curriculum".*

The researcher asked Mr O what other teachers do when they get to the science centre. This question was asked to get Mr O's understanding of teachers' role when in an informal learning environment such as science centre. Mr O stated that he noticed that when teachers are in the science centre, they do not teach or monitor their learners. Consequently, all work such as teaching and managing learners are left to the science centre facilitators. He explained that:

> *"Normally what I've observed, is when the teachers get to the science centre, they become so inactive, they take all the work to officers that are working at the science centre, forgetting that they need to be in control of what is taking place because these are their learners, they understand them more than any individuals, so they need to give that brief guidance".*

Observation

On August 19th, 2022, Mr O and thirty-one Grade 12 learners visited the UNIZULU science centre. Upon arrival, Mr O went to the reception to receive an overview of the visit from the science centre facilitators. The facilitators informed Mr O that the visit would be divided into multiple sessions, which included career guidance, science demonstrations, exhibit exploration, sea safety, and experiments.

During the observation, Mr O played an active and supportive role in facilitating his learners ' learning experiences during the visit. This was evident when he actively engaged with his learners throughout various activities. In the career guidance session, he monitored and assisted learners in filling out information provided by the science centre facilitator. During science demonstrations, he sat with the learners and encouraged their participation. Unfortunately, his group couldn't participate in the safety in the sea lesson. During the experiment session, Mr O introduced the titration experiment, provided worksheets, and handed over to the science centre facilitator to proceed with teaching. He summarised the experiment, encouraged learners to complete the worksheets, and instructed them to submit them on the following Monday. Table 4.5 below shows a detail description of what happened.

Table 4.5: Mr O's observation report in different sessions

Sessions	Observations report
Career guidance (30 minutes)	During my observation, I noted that Mr O was actively engaging with the learners. I observed Mr O standing at the back of the room while the science centre facilitator was explaining the different colours related to career choices in science and engineering. Mr O was seen moving around the room, checking if the learners were filling in the information on the handouts provided by the facilitator. Additionally, I noticed that the science centre facilitator did not collect the handouts at the end of the session. Instead, learners were allowed to take the handouts home with them.
Science demonstrations (45minutes)	Mr O was observed sitting with his learners when the science centre facilitator demonstrated an activity about balancing chemical reactions. Science centre facilitators handed calculators, and pencil bags along with period tables, to praise participating learners. At

	the end of the session, Mr O instructed his learners to proceed to the exhibition centre.
Exhibits exploration (30 minutes)	Mr O instructed his learners to explore exhibits in groups. Mr O was observed exploring with the learners effectively but did not take pictures of his learners. At the end of the session, Mr O told his learners to move to the next activity which was doing the experiment.
Safety in the sea lesson (30 minutes)	Mr O's group did not participate in the session as it was not available on the day of their visit.
Experiment (40 minutes)	Mr O introduced the titration experiment and handed out his own designed worksheets to his learners. He instructed the science centre facilitator to begin the experiment. Mr O sat with his learners in the auditorium while the facilitator played a video of the titration experiment. The interaction between the facilitator and Mr O was good, and they were able to respond to the learners' questions. Mr O summarised the experiment and encouraged learners to complete the worksheet during the weekend. Lastly, he told them to submit the worksheets on the following Monday.

Case 2: Mr E

The teacher's role at the science centre

Mr E stated that he was planning to present a lesson to his learners at the science centre. He said: *"Yes, I am presenting a lesson".*

Mr E further indicated that his role was to monitor learners' behaviour in the science centre. He also believed that science centre facilitators are there to teach learners. He explained that:

> *Researcher: What do teachers normally do when they get to the science centre?*
>
> *"My understanding is to mainly manage the kids, so they behave because the science centre has people to take care of the kids and teach them. So, my main role is to make sure the kids behave" (Mr E).*

Additionally, he had planned to teach alongside the science facilitators at the centre and to explore the science centre with his learners. He elaborated that:

Researcher: Are you going to be a participant with the group of learners or are you going to teach with the facilitators?

Mr E: "Both, sometimes I facilitate and sometimes I participate with the kids because I will be watching the videos with them".

Observation

On August 23, 2022, Mr. E, accompanied by a group of seventy-six Grade 11 learners, visited the UNIZULU science centre. Throughout the visit, Mr E played a pivotal role in managing learner behaviour and ensuring their engagement, while also addressing challenges as they arose. His responsibilities included distributing career questionnaires and making efforts to maintain order during a career guidance session. During the safety in the sea lesson, Mr. E actively participated by sitting with his learners and involving two of them in a practical demonstration. However, during the science demonstrations, disruptive behaviour within the group prompted Mr E to make the decision to terminate the learning activities and coordinate transportation for the learners' return to school. Table 4.6 below gives a full description of Mr E' role in guiding and supervising the learners during their visit to the science centre.

Table 4.6: Mr E's observation report in different sessions

Sessions	Observations report
Career choices (30 minutes)	Mr E was observed asking learners to be quiet. He instructed his learners to make a queue so that they would be assisted at the door. Mr E together with two UNIZULU facilitators handed out a career questionnaire to learners. Learners were making noise and talking to each other, the science centre facilitator and Mr E requested that they keep quiet. The science centre facilitator presented a short presentation on different types of careers and summarised the content due to the noise level. Mr E was observed standing at the back busy with his phone. The science centre facilitator continued with a career presentation to a noisy group, Mr E left the room for about 10 minutes. While learners were busy researching careers using the books available in the centre in order to complete the given handout. I observed Mr E moving around his learners he was still having his phone. At the end of the session, Mr E instructed learners to move out to the next presentation about safety in the sea.

Safety in the sea lesson (30 minutes)	During a practical lesson on resuscitating a drowning person at the UNIZULU science centre, Mr E was seen sitting in the front row while his learners occupied other rows in the auditorium. The facilitator's presentation was disrupted by some learners who were asking irrelevant and humorous questions. To maintain focus and engage his learners, Mr E selected two of them to perform the practical demonstration. At the end of the session, the facilitator asked questions based on the presentation, and the learners responded correctly.
Science demonstrations (45minutes)	Mr E and his learners were seated in the auditorium room, with Mr E sitting in the front row. The two science centre facilitators introduced the activities that were to be presented, including the use of aluminium, and balancing chemical reactions through practical applications. Some of Mr E's learners were listening attentively, while others were disruptive by talking and asking irrelevant questions. Mr E intervened by kindly asking them to be quiet and those who did not want to participate in learning were asked to wait outside the auditorium. None of the learners chose to leave. Mr E then asked to meet with the learner representatives outside, and when they returned, he announced that they would no longer be continuing with the learning activities. Mr E cited that in the previous session (career guidance), some learners were causing noise, and the situation had only worsened during the current session. As a result, Mr E called for taxis to take them back to school, and the science centre facilitators concluded the presentation. The taxis arrived shortly after and took the learners back to school.
Exhibits exploration (30 minutes)	The learners did not participate (they went back to their school). Therefore, no observation.
Experiment (40 minutes)	The learners did not participate (they were taken back to school). Therefore, no observation.

Case 3: Mr S

The teacher's role at the science centre

According to Mr S, learners tend to get overwhelmed or excited when they are in a different environment, such as the science centre, outside the traditional school

classroom setting. To ensure that the learners remain focused and on-task during their visit, he believed that it is important for him to take an active role in managing their behaviour. Specifically, Mr S saw it as his responsibility to ensure that the learners are well-behaved and attentive, while also allowing them to explore and learn in a safe and controlled manner. It is worth noting, however, that Mr S also recognised the important role played by the science centre facilitators, who are primarily responsible for teaching learners during their visit. He elaborated that:

> *"We follow instructions from the people in charge of the science centre and listen to them about what we must do in order to prepare our learners. We also control learners because when they get to places, they are not used to, they behave in different ways, so our job is to make sure that learners behave well while science centre teachers teach our learners"*.

Mr S further indicated that his role during a visit to the science centre is not that of a traditional teacher who delivers a structured lesson or lectures to the learners. Rather, Mr S planned to participate actively with both the science centre facilitators and his learners, engaging in interactive and hands-on learning experiences.

Observation

On August 24, 2022, Mr. S and twenty Grade 12 learners visited the UNIZULU science centre. During their visit, they participated in various sessions, including career guidance, science demonstrations, exhibit exploration, safety in the sea, and experiments. Mr S took on multiple roles to enhance the learners' experience, ensuring their engagement throughout the visit. Notably, he provided assistance during the exhibits exploration and facilitated smooth transitions between activities by directing learners to sessions. Table 4.7 below shows a detailed result of the observation.

Table 4.7: Mr S's observation report in different sessions

Sessions	Observations report
Career choices (30 minutes)	Upon arriving at the science centre, the learners were given a handout by the science centre facilitators at the entrance. Once inside, I observed Mr S standing at the back of the room, appearing to be occupied with his cell phone. However, his learners were fully engaged and paying attention to the science centre facilitator who was presenting on various career options. The facilitator then instructed the learners to move around the room and utilise the

	available books to complete the required information about different careers. Despite the individual nature of the activity, the learners carried out the task with minimal disruption. Mr S was seen moving around the learners, checking on their progress and offering assistance as needed. The session concluded with Mr S informing his learners that it was time to move on to the next activity, which was an exhibition exploration. Overall, it was observed that Mr S allowed the science centre facilitator to take the lead in presenting the material and facilitating the activity. However, he was involved in ensuring his learners remained focused and engaged throughout the session.
Science demonstrations (45minutes)	In this session, learners were engaged in a lesson on aluminium and balancing chemical reactions. The science centre facilitators provided a demonstration of how to balance chemical equations. Mr S was observed sitting alongside his learners, keenly observing the lesson. After the demonstration, Mr S led his learners to the next session. Throughout this session, Mr S played the role of an observer and a guide, ensuring that his learners were focused and engaged in the activities.
Exhibits exploration (30 minutes)	Mr S organised his learners into groups of 5 or 6 so that they could explore the exhibits together. While Mr S's learners were exploring the exhibits, they attempted to solve an exhibit involving balancing three sticks and placing a pot on top. However, they encountered difficulty, so Mr S raised his hand to call the attention of the science centre facilitator, who came over to assist them. I observed Mr S taking videos and pictures of his learners as they explored the exhibits using his cell phone. After some time, Mr S directed his learners to move to the next session, which focused on safety in the sea.
Safety in the sea lesson (30 minutes)	Upon arrival at the next auditorium, Mr S greeted the science centre facilitator who presented a lesson on safety in a practical and engaging manner. While the facilitator interacted with the learners, I observed Mr S sitting at the front of the auditorium, but he appeared preoccupied with his phone. Nevertheless, the learners were actively engaged in the safety observation, and at one point, the science centre facilitator asked one learner to come to demonstrate how to resuscitate a person using a provided doll. After the safety lesson, Mr S led his learners to the next session.
Experiment (40 minutes)	During the session, the science centre facilitator played a video demonstrating a titration science experiment. Mr S was observed

	sitting with his learners and paying close attention to the video. After the video, learners asked questions, and both Mr S and the science centre facilitator worked together to provide answers. No handouts or worksheets were provided to the learners during or after the session.

Case 4: Mrs R

The teacher's role at the science centre

Mrs R stated that she was not going to conduct teaching, but she has asked science centre facilitators to teach her learners. She mentioned that:

> *Researcher: Are you presenting any lessons at the science centre?*
>
> *Mrs R: "There are times when you need another person to explain to your learners so that they can see what you say in class may be simplified by someone else. Sometimes I ask a facilitator to explain to my learners some of the stuff".*

Mrs R believed that her role is to accompany her learners during the visit to the science centre and facilitate their learning experience. She is responsible for observing and controlling her learners' behaviour, ensuring that they are following the appropriate safety procedures and behaving appropriately in the science centre environment. Additionally, Mrs R planned to explore the exhibits with her learners, to provide them with additional context and clarification where needed. Furthermore, she believed her role also includes coordinating with the science centre facilitator to ensure that the teaching duration and content knowledge are aligned with her learners' needs and the school syllabus. She described that:

> *"As a teacher, you organise learners, plan and arrange your activities on time, I will also monitor learners' behaviour and their involvement in the practical and explain to the learners exhibits available in the science centre" (Mrs R).*

Observation

On August 18, 2022, Mrs. R, accompanied by sixty-two Grade 12 learners, visited the UNIZULU science centre. Upon their arrival, Mrs. R engaged in discussions with the science centre facilitators to familiarize herself with the visit's schedule. Throughout the visit, Mrs. R played various roles to enhance the learners' experience. She

assumed the role of a guide, providing direction to her group and ensuring they were on track with the planned activities. In some sessions, she acted as a monitor, actively moving around to check if all learners were actively engaged with the exhibits. During the science demonstrations, Mrs. R primarily observed. Notably, in certain instances, she stepped into an assistant facilitator role, as evident in the detailed observations provided in Table 4.8.

Table 4.8: Mrs R's observation report in different sessions

Sessions	Observations report
Career choices (30 minutes)	During the visit to the UNIZULU science centre, I observed Mrs R instructing her learners to form a queue upon arrival. Science centre facilitators handed out career handouts to each learner at the entrance of the venue. Mrs R then directed her learners to sit on the floor and listen to the presentation on science and engineering career guidance. Throughout the session, Mrs R moved around the learners, ensuring that they were following the facilitator's instructions. The learners displayed discipline and active engagement in the session. Mrs R concluded the session by calling her learners to follow her to the next session, which focused on exhibits in the science centre.
Exhibits exploration (30 minutes)	Mrs R was observed walking around the learners who were exploring exhibits. Mrs R took pictures of her learners using her phone. I observed Mrs R discussing with the science centre facilitators about some of the exhibits. The session concluded with Mrs R instructing the learners to move with her to the next session which was the science demonstration.
Science demonstrations (45minutes)	During the science demonstration, Mrs R was sitting at the back of the room, watching her learners' reactions and behaviour. The two science centre facilitators conducted the demonstration, showing the learners how to balance chemical reaction equations. Mrs R occasionally asked her learners questions to gauge their understanding, engagement and encouraged them to ask the facilitators any questions they had. The learners were attentive and showed a genuine interest in the demonstration. None of the learners asked question to the science centre facilitators.

Safety in the sea lesson (30 minutes)	Mrs R and her learners attended a lesson on how to resuscitate a person using a doll. Mrs R was observed sitting in the front row with her learners occupying other rows in the auditorium room. The science centre facilitator conducted the demonstration while Mrs R was observing with her learners. At the end of the demonstration, the facilitator asked questions based on the presentation, and the learners were able to answer them correctly. Mrs R expressed her appreciation to her learners for their participation and instructed them to move to the final session, which was the experiments.
Experiment (40 minutes)	Upon entering the auditorium, Mrs R warmly greeted the science centre facilitator before instructing her learners to listen attentively as the presentation was part of their formal assessment. Mrs R positioned herself beside the learners, keenly observing learners' participation. During the session, both Mrs R and the facilitator were seen assisting each other in responding to learners' questions, demonstrating a collaborative and supportive approach to teaching. The learners appeared to benefit from this partnership, with many actively participating in discussions and asking insightful questions. The questions were about the titration experiment presented to them through a video. The session ended with Mrs R asking her learners questions related to the titration video presented by the facilitator. Overall, the session was a success, with Mrs R's attentive supervision and the facilitator's engaging presentation helping to create a favourable, conducive learning environment for the learners.

4.3 Conclusion

This chapter presented the results pertaining to four teachers who taught physical sciences or technical sciences and visited the UNIZULU science centre with their learners. The results were gathered through a combination of pre and post interviews, observations, and document analysis. The next chapter conclude the study by presenting the findings of this research.

CHAPTER 5

DISCUSSION OF FINDINGS AND CONCLUSION

5.1 Introduction

This chapter aims to report the findings of this study which meant to explore how FET teachers view and practice the teaching of science in a science centre. The research questions that guided the study serve as the basis for organising the discussion of the results. Along with a summary of the findings, the chapter also includes an overview of the study's limitations, recommendations, and suggestions for future research. To contextualise the findings, the chapter relates them to the existing literature and the conceptual framework that informed the study. Finally, the conclusion is presented.

5.2 Discussion of Findings

In this section, the findings of this study are discussed in cases because the aim of qualitative research is to gain a deep understanding of each case from its perspective. The discussion is structured around the three sub-questions that guided this study and linked the findings to the literature review where applicable. The research questions were as follows:

Main research question

How do FET teachers perceive and practice the teaching of science in a science centre?

Sub-questions

1. What is the extent of understanding regarding the teachers' knowledge of how and when to teach science in the science centre?

2. How do teachers plan and prepare for a visit to a science centre?

3. How do the science teachers facilitate teaching and learning in an informal learning environment such as a science centre?

5.2.1 What is the extent of understanding regarding the teachers' knowledge of how and when to teach science in the science centre?

Case 1: Mr O

The findings of this study showed that Mr O believed that teaching science in the science centre is not perfectly aligned with the school curriculum, however, he recognises the potential benefits of utilising demonstrations and activities which are used as teaching strategies in the science centre. Research has demonstrated that science centre experiences can have a positive impact on learners' interest and engagement in science, despite not aligning perfectly with formal school curricula (Roche et al., 2020). For instance, Domenici (2022) found that science centre visits can enhance learners' interest and foster positive attitudes towards science. Similarly, Uludag (2021) found that informal learning environments such as science centres can be effective in engaging learners and promoting science education. The results of this study also highlighted the insights provided by Mr O, who emphasised the benefits of organising field trips for learners. According to Mr O, these outings offer valuable opportunities for learners to engage in science experiments within a real-world environment.

However, it is important to note that not all studies have shown consistently positive results. For example, Efe and Umdu Topsakal (2022) found that science centre visits do not have a significant impact on learners' understanding of scientific concepts or attitudes towards science. There are several authors who reported that informal learning environments such as the science centre have been shown to be effective in promoting science education and enhancing learners' understanding of scientific concepts, even if they do not perfectly align with formal school curricula (Busch et al., 2023; Gupta et al., 2010; Yacoubian & BouJaoude, 2010).

Case 2: Mr E

The findings of this study revealed that Mr E recognises that teaching learners in an informal learning environment helps them in making connections between science and their daily lives. Additionally, the findings showed that Mr E understood classroom teaching as primarily reliant on textbooks, while visiting the science centre provides practical applications of scientific concepts, thereby, serving as a valuable complement to classroom teaching. This observation aligns with the study conducted by Grimus (2017), which revealed that many teachers in Sub-Saharan Africa still rely on teacher-centred methods, employing traditional teaching approaches such as

chalk, blackboards, and textbooks, even in subjects such as sciences that benefit from a more hands-on, practical approach.

The literature suggests that teachers who face the challenge of finding additional strategies and diverse learning opportunities to effectively teach science can utilise informal learning environments as one strategy to enhance learners' interest in the subject (Simsek & Kaplan, 2022; Walan & Gericke, 2021).

Case 3: Mr S

The findings of this study revealed that Mr S understood teaching science in an informal learning environment as a teaching strategy that supplements formal education in schools (Sonmez & Ozturk, 2022). However, it was observed that Mr S did not conduct any teaching during the visit. Mr S emphasised the significance of science centre facilitators in providing learners with hands-on learning experiences. He acknowledged the science centre facilitators' role in coaching learners about science and engineering careers.

Furthermore, the findings revealed that Mr S believed in organising visits to informal learning environments to promote stronger connections among learners, both with their peers and the surrounding environment. Organising visits to informal learning environment motivate his learners, especially, considering that most of their learning takes place within the confines of school classrooms, according to Mr S. This finding is consistent with the study by Albadawi (2021), which reports that informal learning environments offer learners the chance to engage in communication and interaction with one another. This interaction fosters positive relationships among learners which can then carry over to the classroom setting (Albadawi, 2021).

Case 4: Mrs R

The finding of this study indicated that Mrs R uses the visits to informal learning environments to complement classroom teaching, and this observation is similar to Mr S's findings. Mrs R's understanding behind this practice was to provide learners with hands-on and practical learning experiences which in turn enhances the meaningfulness and enjoyment of their education.

This finding aligns with the research conducted by Anand and Dogan (2021), which emphasises the benefit of science centres in offering learners' hands-on experiences.

Such experiences assist in establishing connections between scientific concepts and their real-world applications. Similarly, Walan's study (2020) highlighted the importance of utilising well-equipped laboratories and knowledgeable instructors to facilitate effective science education.

However, it is worth noting that certain studies have identified limitations in teachers' knowledge and experience regarding the utilisation of informal learning environments, such as science centres to enhance science education (Köseoğlu et al., 2020). DeWitt and Archer (2015) shed light on this issue, revealing that teachers may possess limited pedagogical knowledge and skills required for effectively integrating science centre experiences into their classroom teaching practices.

5.2.2 How do teachers plan and prepare for a visit to a science centre?

Case 1: Mr O

The results of the study showed that Mr O did a pre-visit to the site before taking his learners and prepared the learners on objectives about the visit to the informal learning environment. These findings indicate that Mr O did prepare and plan for his learners educationally when they visit the science centre. These results are consistent with the study of Chebrat et al. (2019). In their study, the science centre facilitators advised that it is beneficial for schoolteachers to make a prior visit to the site, and subsequently prepare their learners for the logistics of the venue and the educational concepts that they would encounter. The study also revealed that Mr O involved the school management team, learners' parents, and a circuit manager in the planning process. A study by Uludag (2021) found that teachers involve parents in the planning process for a science museum visit, and that this increased parent engagement with their children's learning.

Furthermore, the study findings indicated that Mr O prepared a worksheet for learners to use during and after the science experiment. This finding aligns with previous research by Kisiel (2003) and Rennie (2007), who highlighted the use of worksheets by teachers to support learners in focusing on experiments and comprehending specific concepts, particularly, in informal learning environments.

However, it is important to note that the effectiveness of worksheets as a teaching tool is a subject of ongoing debate. In a study conducted by Belin (2018), they discovered

that providing learners with pre-prepared worksheets did not yield significant improvements in their understanding of science concepts compared to teachers who did not employ worksheets. While Mr O's use of a worksheet may have had some benefits, it is crucial to consider alternative teaching methods that might be more effective for certain learners.

Additionally, it is essential for teachers to be aware that providing materials alone does not guarantee improved learning outcomes (Vergara, 2019). The quality and relevance of the materials provided are crucial factors to consider (Mupa & Chinooneka, 2015). Therefore, teachers should carefully select and design instructional materials that align with the learning goals and needs of their learners to enhance their overall learning experience during teaching in an informal learning environment.

Case 2: Mr E

The findings of this study indicated that Mr E partially prepared for the visit to the science centre. In this study, Mr E's primary focus was on logistical preparations such as notifying the school principal, parents and organising transport for learners. While these are important aspects of planning a field trip, it is also essential to consider educational goals and activities. This finding contrasts with Saihu (2020) study, which found that involving school administrators in the planning process for field trips increased schoolteachers' support for these activities and contributed to their success. Contrary to Saihu (2020) study, where school administrators were responsible for logistic preparations such as organising transport and notifying parents, in this study, the teacher takes on these tasks.

Conversely, the findings revealed that Mr E did not visit the science centre prior to taking his learners, relying solely on his previous knowledge of the site. This approach may have impacted his ability to effectively plan the visit, as he may not have been aware of any changes or updates to the facility. The study by Zaca (2018) highlighted that teachers who are accustomed to visiting the same educational site, such as a science centre, may overlook essential preparatory activities, leading to negative impacts on the teaching process.

The research findings revealed that Mr E has designed his own worksheet for his learners to use during the visit, indicating a positive approach to planning educational

activities. However, the group did not have a chance to use those worksheets due to unruly learners who disrupted the teaching, and which resulted in their early return to school. This may be due to poor preparation since the study by Chebret et al. (2019) confirmed that insufficient preparation for field trip leads to a range of issues including problems with teaching, behaviour, interest, and safety.

Case 3: Mr S

The results from the semi-structured interviews revealed several notable practices employed by Mr S in preparing for the visit to the science centre with his learners. Firstly, he provided a briefing to his learners regarding the environment and expected behaviour before the visit. Secondly, Mr S communicated with the parents to arrange the necessary funds for the trip. This finding is incongruent with the study conducted by Koseoglu et al. (2020), where they noted that the majority of teachers' preparations for their visits to science centres primarily focus on technical aspects such as transportation, obtaining permissions, and addressing the learners' food requirements during the trip. Lastly, Mr S visited the science centre before taking his learners there to familiarise himself with the environment layout. These findings showed that Mr S did plan for his learners educationally when they visited the science centre. These results are consistent with the research conducted by Behrendt and Franklin (2014), which emphasised the importance of teachers briefing their learners about the location and arrangement during the orientation, before a field trip. The finding also supports Behrendt and Franklin's (2014) suggestion that teachers should go to informal learning environments settings beforehand as part of the preparations.

Case 4: Mrs R

The study findings revealed that Mrs R does make educational plans for her learners when they visited the informal learning environment. This was evident by her prior visit to the science centre which enabled her to familiarise herself with the environment and identify any potential safety concerns (Coll & Coll, 2018). Additionally, Mrs R ensured that her learners were well-informed about appropriate behaviour in the science centre and clearly outlined the lesson objectives before the visit. These findings align with the research conducted by Roche et al., (2016), who emphasised the benefits of pre-visits to science centres by teachers. Such pre-visits enabled teachers to plan and design more effective learning activities that align with their curriculum objectives.

Furthermore, the study findings revealed that Mrs R organised a visit to the science centre for her learners to conduct science experiments because her school lacked apparatus. This approach is similar to that reported by Mudulia (2012) in his study conducted in Kenya, which examined the relationship between availability of teaching/learning resources. Mudulia (2012) discovered that the shortage of science equipment and materials in South African schools hindered the effective teaching and learning of science. Consequently, many schools had to rely on science centres to provide learners with access to necessary equipment and materials for science experiments (Xulu, 2012).

5.2.3 How do the science teachers facilitate teaching and learning in an informal learning environment such as a science centre?

Case 1: Mr O

The finding of this study showed that Mr O perceived his role as a monitor and manager for his learners, rather than a teacher. This is in line with Chebret's et al., (2019) statement that teachers have a responsibility to oversee and actively engage in monitoring the learning process in informal learning environments. Based on the study's findings, it was determined that Mr O had the responsibility of ensuring that his learners were actively involved and that they behaved appropriately. It was observed that Mr O did not engage in any teaching during the science centre visits. The observation is consistent with the study of Uludag (2021) who showed that many teachers lack confidence in their capacity to teach in informal learning environments due to their insufficient training and experience. In a comparable manner, this study revealed Mr O's belief that his expertise is limited to classroom settings.

Case 2: Mr E

Based on the data obtained from the semi-structured interviews, they revealed that Mr E believed his duties were to determine and suggest the lesson that will be presented by the facilitators and manage the behaviour of learners. Notably, Mr E did not personally conduct any formal educational sessions during the visit, only the science centre facilitators were teaching the learners. These results were consistent with earlier studies by Brahms and Wardrip (2016), who highlighted that teachers often perceive informal learning environments, such as science centres, as places where learners can be guided by teachers who possess specialised training in teaching.

School teachers typically consider their primary responsibility to be delivering instruction within the classroom, while science centre facilitators are viewed as being responsible for providing engaging and educational experiences in informal learning environments (Boeve-De Pauw et al., 2022).

Case 3: Mr S

Based on the research findings obtained through semi-structured interviews, it was discovered that Mr S perceived himself as a behavioural manager for his learners during their visit to the science centre (Sonmez & Ozturk, 2022). The findings of this study showed that Mr S closely collaborated with the science centre facilitators while they were teaching his learners, primarily, due to the learners' unfamiliarity with the environment. This view is rooted in the understanding that his learners may face challenges in navigating the novel setting and require support and guidance to effectively engage with the exhibits. This finding is consistent with the observations made by Huang et al. (2016), who highlighted that learners may encounter difficulties in adjusting to the novelty of the environment and, therefore, need assistance and direction to fully benefit from the exhibits.

The study's results further indicated that Mr S perceived his role as a field trip organiser, working in coordination with the school team. This implies that he took responsibility for organising the visit to the science centre and ensuring that it was a well-coordinated and meaningful experience for his learners (Koseoglu et al., 2020).

Case 4: Mrs R

The findings of this study revealed that Mrs R perceived her role within the science centre as a guide and monitor for her learners, rather than a teacher. This observation is similar to Mr O’s findings. The results indicated that Mrs R relied on the science centre facilitators to deliver the lessons while providing additional context and clarification to her learners as necessary. This finding aligns with a study conducted by Boeve-De Pauw et al. (2022) which similarly found that schoolteachers often depend on science centre facilitators to deliver lessons during visits to science centres.

Contrary to the findings of Chebret et al. (2019), who reported that science centre facilitators perceive schoolteachers as uninvolved in guiding their learners, this finding

revealed a different perspective. The results demonstrate that most teachers were actively managing their learners during the visit.

5.3 Summary of findings

This section summarises the findings of this study. The findings are presented in line with the research objectives, and they are linked to the conceptual framework of this study. This study's conceptual framework was shaped by three primary components: the definition of an informal learning environment, the necessary knowledge that teachers should possess about informal learning environments, and the employment of the FTI.

5.3.1 Understanding the teachers' knowledge of how and when to teach science in a science centre

The majority of the science teachers who took part in this research understood informal learning environments as locations where teaching and learning occurs outside of traditional classrooms. Their understanding was supported by this study's conceptual framework, which defines informal learning environments as spaces where learning occurs beyond the confines of a classroom setting to achieve specific goals (Coll & Coll, 2018). Teachers believed that science centres are places for experimental learning. According to the conceptual framework of this study, one of the teaching strategies which contributed to effective teaching in the science centre is the use of exhibits. These exhibits assist learners in connecting science to real-life situations (Kisiel, 2005).

The findings of this study highlighted that most science teachers organised visits to science centres with the specific purpose of exposing their learners to the science centre environment (Anderson & Zhang, 2003). These visits were aimed at providing learners with hands-on experiences as they approached the end of their secondary school education, as outlined in the conceptual framework of this study. As per the findings of Patrick et al. (2013), for informal leaning environments to be effective, teachers need to consider the psychological needs of the learners. These psychological needs can be categorised into six components, one of which is learner curiosity. Learners expect to encounter something that arouses their interest when visiting informal learning environments. Engaging in hands-on experiments or

encountering exhibits for the first time can effectively stimulate learners' curiosity (Uludag, 2021).

5.3.2 Teachers planning and preparation for a visit to a science centre

The study findings indicated that a significant majority of teachers (75%) involved in this research, also engaged in pre-visit preparations which highlighted their strong commitment to ensuring successful teaching experiences in science centre. The findings also revealed a correlation with the FTI model of the conceptual framework used in this study. This model emphasised the significance of teacher preparation for visits through elements such as pre-visit, during-visit, and post-visit activities, as well as a focus on problem-solving (Coll et al., 2018). Significantly, most teachers took an extra step by developing worksheets for their learners to utilise during and after their visit to the science centre. These findings resonate with the study's conceptual framework and the existing literature, which emphasises the importance of planning and preparation for a visit to informal learning settings. In line with these findings, Sonmez and Ozturk (2022) also highlight that creating teaching materials tailored for informal learning environments, in harmony with specific curriculum goals, proves to be an effective strategy. This approach enhances teachers' capabilities in planning visits that not only align with curricula but also influence the educational opportunities offered by informal learning environments.

According to Patrick et al. (2013), adequate planning and preparation are essential to minimise disruptions during teaching sessions in informal learning environments. In support of this notion, one teacher in the study who neglected pre-visit preparation encountered disruptive behaviour from learners, which resulted in the suspension of the visit. This highlights the serious role of teachers in explaining to their learners the purpose of going to informal learning environment prior to visiting the site, as emphasised by Kisiel (2014). Additionally, the outcomes of the study indicated that most of the teachers did indeed communicate the learning objectives of the science centre visit to their learners, with the primary objective being the execution of a science experiment.

5.3.3 Teachers' facilitation of teaching and learning in a science centre

The study revealed that most teachers identified themselves as guides during field trip visits. They recognised the importance of facilitating learners' learning by providing

guidance and support throughout the experience (Sonmez & Ozturk, 2022; Koseoglu et al., 2020). Teachers saw themselves as mentors, encouraging learners to explore, ask questions, and make connections with the exhibits and activities in the science centres. Teachers also acknowledged their responsibility as trip organisers. They took charge of logistical aspects, such as planning the trip, coordinating with the science centre staff, ensuring learner safety, and managing administrative tasks. This organisational role allowed teachers to have a structured and favourable setting to facilitate effective learning throughout the field trip.

In addition to guiding learners, teachers perceived themselves as monitors and behavioural managers during field trip visits. They maintained a watchful eye on learners, ensuring their safety and well-being. Moreover, teachers actively promoted positive behaviour, encouraged respectful interactions among learners, and addressed any disciplinary issues that arose.

Interestingly, the study highlighted that despite the interactive and experiential nature of the science centre environment, none of the teachers viewed the science centre as an environment for delivering formal lessons. Instead, they perceived it solely as a supplementary educational setting that supports classroom teachings. Consequently, they missed opportunities to thoroughly involve learners in practical activities and capitalise on the resources available in the science centres.

5.4 Limitations of the study

The participants in this study were limited to four science teachers from the KwaMbonambi circuit. Therefore, the findings and implications derived from this research might not entirely be applicable to all physical sciences and technical sciences teachers across South Africa. It's crucial to recognise that qualitative research aims to attain a comprehensive understanding of the distinct context and individuals involved, rather than striving for broad generalisation.

Additionally, the study was carried out in a single UNIZULU science centre, which may not be representative of the experiences of teachers visiting other science centres. It is important to note, however, that the study's use of a variety of data collection techniques, such as interviews, observations, and document analysis, helped to mitigate some of these shortcomings. By triangulating the data from various sources,

this multi-method approach helped to increase the validity and dependability of the conclusions.

5.5 Recommendations

The study's recommendations are grounded in its findings. Although the findings cannot be generalised to the broader population, it is recommended that:

- Science teachers (physical sciences and technical sciences teacher) and science centre facilitators need to communicate to understand each other's roles and duties in educating learners more clearly. This can help to ensure that learners are receiving consistent and effective instruction in science, both in the classroom and in informal learning environments such as science centres.
- It may also be beneficial for science teachers to obtain training or professional development on how to effectively incorporate visits to science centres into their lesson plans and curricula to ensure that learners receive consistent and integrated science instruction across different learning environments.
- The teaching of science within a science centre heavily relies on the significance of resources and exhibits. Therefore, science centre's available in communities should conduct trainings to equip science teachers with available exhibits so that teachers can help their learners during the exhibit exploration sessions.
- Teachers should actively involve their learners in the planning and preparation process for teaching in informal learning environments, and engage them in activities before, during, and after a visit to ensure a meaningful and memorable learning experience.
- Teacher Reflection: Teachers should engage in reflective practices to critically evaluate their instructional strategies and perceptions during field trips. Self-reflection can promote awareness of biases and help teachers adapt their practices to create more learner-centred and immersive learning experiences.

5.6 Contribution of the study

This research has shed some light on the views of science teachers towards teaching science in informal learning environments such as science centres, along with their behaviours within science centres. The results revealed that science teachers

understood the informal learning environment as a setting outside the traditional school context.

This study focused on the teachers' roles, their views and planning for science centre visits, the study identified that while the participants demonstrated sufficient knowledge in planning and preparation, they did not actively deliver lessons to the learners during the visits. This finding highlighted an area for improvement in teacher practice.

The study's findings can be utilised by science teachers as a resource when planning and preparing for visits to science centres. The insights can inform teachers about best practices in teaching science in such environments and provide guidance on maximising the learning potential during visits.

The results should also be of interest to science subject advisers, who can use them to promote opportunities for teachers to engage in professional development, particularly, in teaching science in settings like science centres. This study emphasises the need for additional support and training in this situation, serving as an opportunity for subject advisors to consider and promote the significance of the teachers' role in the science centre.

5.7 Conclusion

This chapter summarised the findings of this study. It discussed the findings pertaining to teachers' knowledge about teaching science in an informal learning environment, their views of their role while at the science centre, and their planning and preparations for science centre visits. The findings indicated that teachers possess an understanding of the informal learning environment, recognising it as a context outside the school. Additionally, most teachers believed that science centres offer learners an opportunity for experimental learning. During the science centre visits, teachers primarily assumed the role of being learners’ monitors and guides. Notably, it was observed that none of the schoolteachers delivered formal lessons to the learners during these visits.

Furthermore, the study revealed that science teachers do engage in planning and preparation prior to science centre visits. Some teachers designed worksheets, while others developed lesson plans with clear objectives for the visit. However, it is

essential to conduct further investigation to fully comprehend the underlying reasons why teachers do not actively engage in teaching activities during science centre visits. This knowledge gap creates a chance for upcoming research to determine the challenges faced by teachers in this context and to explore potential strategies to overcome them.

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APPENDICES

APPENDIX A: ETHICS CLEARANCE LETTER

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2022/06/08

Ref: **2022/06/08/56206097/21/AM**
Name: Ms LP Gumede
Student No.:56206097

Dear Ms LP Gumede

Decision: Ethics Approval from 2022/06/08 to 2025/06/08

Researcher(s): Name: Ms LP Gumede
E-mail address: Gumedelungile5@gmail.com
Telephone: 0817358388

Supervisor(s): Name: Mrs P Photo
E-mail address: photop@unisa.ac.za
Telephone: 079 181 8165

Title of research:

Exploring secondary school teachers' perceptions of science learning in informal learning environment: A case study from KwaMbonambi circuit

Qualification: MEd Natural Science Education

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2022/06/08 to 2025/06/08.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2022/06/08 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.
2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.

Open Rubric

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
8. No field work activities may continue after the expiry date **2025/06/08**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:
The reference number **2022/06/08/56206097/21/AM** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

Prof AT Motlhabane
CHAIRPERSON: CEDU RERC
motlhat@unisa.ac.za

Prof Mpine Makoe
ACTING EXECUTIVE DEAN
qakisme@unisa.ac.za

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APPENDIX B: PERMISSION LETTER FROM DBE

KWAZULU-NATAL PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

OFFICE OF THE HEAD OF DEPARTMENT

Private Bag X9137, PIETERMARITZBURG, 3200
Anton Lembede Building, 247 Burger Street, Pietermaritzburg, 3201
Tel: 033 392 1051
Email: Phindile.duma@kzndoe.gov.za

Enquiries: Mrs B.T. Ntuli
Ref.:2/4/8/7319

Ms Lungile Philisiwe Gumede
P.O. Box 3911
MANDENI
4490

Dear Ms Gumede

PERMISSION TO CONDUCT RESEARCH IN THE KZN DoE INSTITUTIONS

Your application to conduct research entitled: **"EXPLORING SECONDARY SCHOOL TEACHERS' PERCEPTIONS OF SCIENCE LEARNING IN INFORMAL LEARNING ENVIRONMENT: A CASE STUDY FROM KWAMBONAMBI:"**, in the KwaZulu-Natal Department of Education institutions has been approved. The conditions of the approval are as follows:

1. The researcher will make all the arrangements concerning the research and interviews.
2. The researcher must ensure that Educator and learning programmes are not interrupted.
3. Interviews are not conducted during the time of writing examinations in schools.
4. Learners, Educators, Schools and Institutions are not identifiable in any way from the results of the research.
5. A copy of this letter is submitted to District Managers, Principals and Heads of Institutions where the Intended research and interviews are to be conducted.
6. The period of investigation is limited to the period from **27 July 2022 to 31 March 2025**.
7. Your research and interviews will be limited to the schools you have proposed and approved by the Head of Department. Please note that Principals, Educators, Departmental Officials and Learners are under no obligation to participate or assist you in your investigation.
8. Should you wish to extend the period of your survey at the school(s), please contact Miss Phindile Duma at the contact numbers above.
9. Upon completion of the research, a brief summary of the findings, recommendations or a full report/dissertation/thesis must be submitted to the research office of the Department. Please address it to The Office of the HOD, Private Bag X9137, Pietermaritzburg, 3200.
10. Please note that your research and interviews will be limited to schools and institutions in KwaZulu-Natal Department of Education.

Mr GN Ngcobo
Head of Department: Education
Date: 27 July 2022

APPENDIX C: INTERVIEW QUESTIONS

TEACHERS

INTERVIEW TEMPLATE

Theme: Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study

Interview **BEFORE** a visit to UNIZULU science centre

Section A (Introduction)

1. Before I begin, do you have any questions?

Section B (Educational background and teaching experience)

This section deals with the background information of the participant.

1. Please tell me about your educational background, where did you study and for how many years?
2. What subjects are you teaching?
3. How long have you been teaching the subject that you are currently teaching?
4. What Grade do you teach?

Section C (Teachers' knowledge about learning at the science centre)

This section deals with teachers' knowledge about learning science at the science centre

1. Which grades and classes do you typically bring to the science centre?
2 How frequently are learners taken to the scientific centre?
3 What are your thoughts on learners learning at the science centre?
4 What do learners normally do when they get to the science centre?
5 What are the benefits of bringing learners to a science centre?
6 Do you think learners learn when teachers teach at the science centre?

Section D (Teacher's preparation)

This section deals with teachers' preparation for visiting the science centre.

1. What do you do before taking learners to the science centre visit?
2. Do you visit the site (science centre) before you take the learners?
3. Are you expecting the science centre facilitators to give you and learners anything such as worksheets?
4. What is the goal of visiting the science centre?

Section E (Teachers' role)

This section deals with teachers' perceptions of their role at the science centre.

1. Are you presenting any lessons at the science centre?
2. What do teachers normally do when they get to the science centre?
3. Are going to be a participant with a group of learners or with facilitators?

Interview **AFTER** UNIZULU science centre visit

Section F (Post interview)

This section is to check developments from pre-interview

1. Were you able to achieve your goal for the visit?
2. Were you satisfied with the learning process at the science centre?
3. Will you visit again?

Thank you for participating

APPENDIX D: OBSERVATION SCHEDULE

OBSERVATION TEMPLATE

Observation date and time _____

Participants' School_____

A. Behaviour

- Does the teacher gives directions to learners?
- Does the teacher stimulate attention to learners by relating content to classroom lessons?
- Does a teacher motivate learners by encouraging learner involvement or by praise during the learning process?

Notes:

B. Interaction with the environment

- Does the teacher explain based on prior knowledge to link what was learned at school with current learning at the science centre?
- Does the teacher summarise what was told by the science centre facilitator?

Notes:

C. Social interaction

- Does the teacher ask UNIZULU science centre facilitators to elaborate more about demonstrations and exhibits?
- What are teachers' actions and attitudes towards science centre facilitators?
- Does a teacher act as a participant with a group of learners or with facilitators?

Notes:

D. Recording

- Does a teacher take notes down?
- Does the teacher take photos of learners, of demonstrations?

Notes:

E. Concluding the visit

- How was the visit concluded?

Notes:

APPENDIX E: INFORMED CONSENT LETTER TO THE CIRCUIT MANAGER

Title: Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

Date: 03 March 2022

The circuit manager

King Cetshwayo District

Kwazulu-Natal Department of Education

Dear Sir/Madam

I, Lungile Philisiwe Gumede, am doing research under the supervision of Ms P Photo, a lecturer in the Department of Science and Technology Education. I am working towards my master's degree in education at the University of South Africa. There is no funding involved in this study. I am requesting written permission to use the schools that will be interested to participate in the study entitled Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

The aim of the study is to gain an understanding of how teachers perceive teaching science in informal environments. The study will also investigate how science teachers plan and prepare for their visit to the informal environment (science centre) in the KwaMbonambi circuit.

Your circuit has been selected because the main objective of the study is to explore how FET teachers view teaching science and understand their practices within UNIZULU science centre, specifically in the KwaMbonambi circuit and this objective can only be realised within your circuit. The study will request consent of science teachers from KwaMbonambi circuit to participate in this study, prior to interviews and observations, participants' permission will be requested, a recording device will be used. Upon the granted permission from the participants to take part in the study, I will then work with them throughout the research process. In this study four schools will be selected to participate and will be observed and interviewed.

The benefits of this study will be for all schools situated in the KwaMbonambi circuit even the neighbouring ones. The study will help the science teachers to improve their knowledge of

teaching science in informal learning, bring insight into how other teachers prepare for learners' visits to the informal environments and their role when in the science centre and further provide solutions thereof.

There are no known risks associated with this study. Confidentiality will be maintained by not disclosing the names of schools and participants. The data that will be collected from the participants will be kept confidential and will be strictly used for research purposes.

Participants will not be reimbursed or receive any incentives for participating in this study. Upon request, participants will receive a summary of the research findings.

For more information regarding the study, please contact me on 073 799 8751 or email: gumedelungile5@gmail.com and my supervisor Ms P Photo can be reached at 079 539 7066 or email: photop@unisa.ac.za

Yours sincerely

_____

Lungile Philisiwe Gumede

Researcher

APPENDIX F: INFORMED CONSENT LETTER TO THE UNIZULU SCIENCE CENTRE

Title of the research: Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

Date 03 March 2022

The UNIZULU science centre manager

Tel: 035 979 3204

Dear Sir/Madam

My name is Lungile Philisiwe Gumede and I am doing research under the supervision of Ms P Photo, a lecturer in the Department of Science and Technology towards a Master of education at the University of South Africa. We are inviting you to participate in a study entitled Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

The aim of the study is to gain an understanding of how FET teachers view teaching science in informal environments such as science centre.

Your science centre has been selected because it is responsible to support school education.

The study will entail observing science teachers during their visit to the centre.

This study should help the science teachers to improve their knowledge of teaching science in the science centre and understand their role in the science centre.

There is no risk involved in this study and there will be no reimbursement or any incentives for participation in the research.

Feedback procedure will be discussed with the participants at the end of the study before the paper is published.

Yours sincerely

……..

Lungile Philisiwe Gumede

Researcher

APPENDIX G: INFORMED CONSENT LETTER TO THE SCHOOL PRINCIPAL

Title: Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

Date: 03 March 2022

The Principal

Dear Sir/Madam

I, Lungile Philisiwe Gumede, am doing research under the supervision of Ms P Photo, a lecturer in the Department of Science and Technology Education. I am working towards my master's degree in education at the University of South Africa. There is no funding involved in this study. I am requesting written permission to use the schools that will be interested to participate in the study entitled Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

The aim of the study is to gain an understanding of how FET teachers perceive teaching science and explore their practices within an informal environments. The study will also investigate how science teachers prepare for their visit to the informal environment (science centre) in the KwaMbonambi circuit.

Your circuit has been selected because the main objective of the study is to investigate how FET science teachers view teaching of science and explore their practices in the science centre specifically in the KwaMbonambi circuit and this objective can only be realised within your circuit. The study will request consent of science teachers from KwaMbonambi circuit to participate in this study, prior to interviews and observations, participants' permission will be requested, a recording device will be used. Upon the granted permission from the participants to take part in the study, I will then work with them throughout the research process. In this study, four science teachers will be selected to participate and will be observed and interviewed.

The benefits of this study will be for all schools situated in the KwaMbonambi circuit even the neighbouring ones. The study will help the science teachers to improve their knowledge of teaching science in informal learning, bring insight into how other teachers prepare for learners' visits to the informal environments and their role when in the science centre and further provide solutions thereof.

There are no known risks associated with this study. Confidentiality will be maintained by not disclosing the names of schools and participants. The data that will be collected from the participants will be kept confidential and will be strictly used for research purposes.

Participants will not be reimbursed or receive any incentives for participating in this study. Upon request, participants will receive a summary of the research findings.

For more information regarding the study, please contact me on 073 799 8751 or email: gumedelungile5@gmail.com and my supervisor Ms P Photo can be reached at 079 539 7066 or email: photop@unisa.ac.za

Yours sincerely

_____

Lungile Philisiwe Gumede

Researcher

Response of Principal:

I _____ (full names of principal) hereby confirm that I understand the contents of this document, the nature of the research and I grant the researcher permission to distribute/conduct the relevant data collection instruments among/to the science teachers.

_____ _____

Signature of Principal Date

APPENDIX H: INFORMED CONSENT LETTER TO THE TEACHER

Date: 09 May 2022

Title: Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

DEAR PROSPECTIVE PARTICIPANT

My name is Lungile Philisiwe Gumede and I am doing research under the supervision of Ms P Photo, a lecturer in the Department of science and technology towards a Master of education at the University of South Africa. We are inviting you to participate in a study entitled Informal science education practices and views of Further Education and Training (FET) teachers: a UNIZULU science centre case study.

This study is expected to collect important information that could be beneficial to the educational community as it will enable teachers to come up with strategies that they can implement to ensure that they develop a greater understanding of teaching science in an informal environment, to make an informed decision when planning informal learning visits by ensuring sustainable development. The study should also assist the policy developers to look at the contributions of the science centre when developing the school curriculum.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because your of involvement and the interest you have shown in science education at the science centre.

I obtained your contact details from your school principal where I asked teachers teaching science in his school. Please note that four participants have been selected for this study.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study involves audiotaping, semi-structured interviews, and observation. You will be observed when in the science centre. You will be interviewed on knowledge about learning science and informal learning. The first interview will be done before you visit the science centre and the second interview will be done after the science centre visit. Each interview will last for approximately 30 minutes.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent adult form. You are free to withdraw at any time and without giving a reason. All the information given in the study will remain anonymous.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

This study is expected to benefit both the participants and the science centre on knowledge of informal learning in science education by reviewing the practices of teachers at the centre.

It will also assist the science community with a better way of learning science at the science centre.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

Since the research involves the familiar task (visiting the science centre) of the participants there are no negative consequences for participating in this research project.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research OR Your name will not be recorded anywhere and no one will be able to connect you to the answers you give. Your answers will be given a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you give permission for other people to see the records.

All the information gathered in this study will remain anonymous and cannot be traced to your name.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filing cabinet at the College of Education, Unisa for future research or academic purposes. Electronic information will be stored on a password protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. Hard copies will be shredded, and electronic copies will be permanently deleted from the hard drive of the computer using a relevant software program.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

No payment will be given to any participant

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of Unisa science education Department. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Lungile Philisiwe Gumede on 073 799 8751 or email gumedelungile5@gmail.com

Should you have concerns about the way in which the research has been conducted, you may contact Ms P Photo at photop@unusa.ac.za.

Thank you for taking time to read this information sheet and for participating in this study.

Thank you.

_____

Lungile Philisiwe Gumede

CONSENT/ASSENT TO PARTICIPATE IN THIS STUDY (Return slip)

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits, and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree to the recording of the classroom observation and the semi – structured interview.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print) _____

_____ _____

Participant Signature Date

Researcher's Name & Surname (please print) _____

_____ _____

Researcher's signature Date

APPENDIX I: MR O INTERVIEW TRANSCRIPT

PRE-INTERVIEW

SECTION A (Background)

Researcher: Please tell me about your educational background. Where did you study and for how many years?

Mr O: I studied at the University of Zululand and I hold a Bachelor's Degree in Mathematics, Science and Life Sciences, so I am a full Science educator, it was a 4 year degree.

Researcher: What subjects are you teaching now?

MR O: Currently, I am specializing in Physical Sciences, if I talk about Physical Sciences, within physical sciences we talk of also Chemistry.

Researcher: How long have you been teaching the subject that you are currently teaching?

Mr O: I have a 12-year experience on the subject.

Researcher: What grade do you teach?

Mr O: I teach Grade 10, Grade 11 and Grade 12 Physics and I also do NS which grade 8 and 9 sometimes.

SECTION B (Teachers' knowledge about informal learning environment)

Researcher: Which grade or classes do you typically bring to the science centre?

MR: Mostly it's the grade 12 I take to the science centre because they are about to exit High School. So, I need them to see… for the career guidance part, so the exhibition is a key for visual learning, so they know what is happening outside the world and can choose careers wisely.

Researcher: How frequently are learners taken to the scientific centre?

MR O: To go to the science centre, mostly it would be once or twice a year, depending on the demand of what is required by the curriculum.

Researcher: Do you think learners learn when teachers teach the at science centre?

MR O: No, but it's just to arouse interest because there are things that they see physically when they are at the UNIZULU science centre because what is offered by the centre is not correct or 100% in line with the curriculum in class or back at school, but it can direct them in terms of the career choices.

Researcher: What are your thoughts on learners learning at the science centre?

Mr O: Through the science centre, learners can gain a better understanding of scientific concepts such as chemical reactions and the motion of bodies. The videos they watch in the centre can help to engage their interest and foster a deeper appreciation for the subject.

Researcher: What do learners normally do when they get to the science centre?

Mr O: They become so active more than what you see in classes because of the visual things they see in the science centre and see new faces trying to explain some concepts to them.

Researcher: What are the benefits of bringing learners to a science centre?

Mr O: The benefit calls back to arousing interest, and they start to love the subject more.

SECTION C (Teacher's preparation)

Researcher: What do you do before taking learners to the science centre visit?

Mr O: Firstly, before you take learners for the visit, you must identify a need first of taking them there, you want to address a certain concept, you must organise with the parents, firstly the SMT of the school, you have to report about the excursion you fill-up the form, you involve the parent because they have to support financially their children, you organise transport then you have to submit to the circuit manager about your planning.

Researcher: Do you visit the site (science centre) before you take the learners?

Mr O: Yes, you check for the availability of the officers, and how safe it will be when your learners arrive at the science centre, so you check the functionality of the science

centre first so that you know, you'll be held accountable for whatever incident that can take place.

Researcher: Are you expecting the science centre facilitators to give you and the learners anything such as worksheets?

Mr O: Not necessarily the worksheet but the contribution by teaching, I bring my own worksheet I need them to meet me halfway because they are not dealing with the curriculum that is taking place at schools.

Researcher: What is the goal of visiting the Science Centre?

Mr O: The goal of visiting the centre is just to give my learners the exposure, since they are about to exit high school, I wish them not to just see things when they get to the university that those things become new to them, at least they must have that little knowledge about them.

To be specific about the goal, the equipment for titration they need to understand it. The aim is to be able to conduct this experiment titration, the mechanism within this experiment which is titration and be able to handle the equipment.

SECTION D (Teachers' role)

Researcher: Are you presenting any lessons at the science centre?

Mr O: No, I will not present any lesson at the science centre, but I will be observing the activities and content being presented to ensure that we don't go away or divert from what is required by the curriculum

Researcher: What do other teachers do when they get to the science centre?

Mr O: Normally what I've observed, is when the teachers get to the science centre they become so inactive, they take all the work to officers that are working at the science centre, forgetting that they need to be in control of what is taking place because these are their learners, they understand them more than any individuals so they need to give that brief guidance.

Researcher: Are you going to be a participant with a group of learners you going to be a participant with the officials which are facilitators at the science centre?

Mr O: I'll be with the learners.

POST INTERVIEW

Researcher: Were you able to achieve your goals for this visit?

Mr O: Partially I have achieved the goals of my visit with the science centre for exhibition part, yes that was 100% achieved. For my intention of doing the titration experiment which is part of the curriculum, it was never reached according but at least I can say 40% of it because there was a display on a video so now my learners, they have a clue of what is happening when we are conducting the experiment, yet they never had a physical touch on the equipment for this particular experiment.

Researcher: Were you satisfied with the learning process at the science centre?

Mr O: I am not satisfied with the learning process in a case of… it still shows what is happening at the classroom, because the practical part of it is not there. So having a facility like the science centre I was expecting something that will show or that will help my learners to have an experience on the practical part of this kind of setting, so for me I have that particular part of it that is not satisfied. If such a facility is not well equipped such that the learners have a room and they have a chance to be hands on the experiment that had to be conducted.

Researcher: Will you visit again?

Mr O: I can only visit for exhibitions but the experiments I won't come again for the experiments but I can come for exhibitions so maybe if I want to arouse interest so that the learners can pick correctly their careers but not for practical issues.

APPENDIX J: MR E INTERVIEW TRANSCRIPT

PRE INTERVIEW

SECTION A (Background)

Researcher: Please tell me about your educational background. Where did you study and for how many years?

Mr E: I study at Walter Sisulu University which is located at Mthatha, TRANSKAI the Eastern Cape. I did my BED for math and science, I did for a period of 4 years, and my degree was 4 years. After 4 years I was lucky I was able to get work at School A. So, I have been teaching at school A since 2015.

Researcher: What subjects are you teaching now?

Mr E: I am only teaching Technical Science.

Researcher: How long have you been teaching these subjects that you are currently teaching?

Mr E: I have been teaching Technical Science since 2019

Researcher: What Grade do you teach?

Mr E: I am teaching grade 10 and grade 11.

SECTION B (Teachers' knowledge about informal learning environment)

Researcher: Which grades do you typically bring to the Science Centre?

Mr E: We bring grades from grade 10, grade 11, up to grade 12

Researcher: How frequently are learners taken to science centres?

Mr E: Not frequent enough, below average, maybe once a year.

Researcher: Do learners learn at the science centre?

Mr E: Yes, they learn, sometimes, but not always, for instance, there is a class where by the learners refuse to learn themselves whereby, they are being taught and the attitude made them refuse to be able to learn.

Researcher: What are your thoughts on learners learning at the science centre?

Mr E: I think science centres are highly productive and impactful for teaching and learning environments because they provide learners with more than just knowledge about a specific subject. Learners can also gain valuable insights into life and the choices they can make.

Researcher: What are the benefits of bringing learners to the science centre?

Mr E: The benefit is, they see things at a practical level, and whereby opposed at school everything is done theoretically, its only books, but when they come to the science centre, they see more practical things rather than theoretical.

SECTION C (Teachers' preparation)

Researcher: What do you do before taking learners to a science centre visit?

Mr E: First, you have to brief the learners that they are going to go, then you have to write a letter to the parents, to let them know. Let the headmaster of the school know and the HODs know of the trip to the science centre. You then have to organise transport that's going to take the kids to the science centre, including the driver, he has to be well known and well informed about the location of the science centre.

Researcher: Do you visit the site which is the science centre before taking the learners?

Mr E: No, I haven't visited this science centre recently because I am already familiar with it and have visited it before

Researcher: Are you expecting the science centre facilitators to give you and the learners anything such as worksheets?

Mr E: I am not expecting it at all

Researcher: What is the goal of the visit to the science centre?

Mr E: The goal is for the learners to learn on knowledge and assessments, practicals that they are doing at the moment and that year.

SECTION D (Teachers' role)

Researcher: Are you presenting any lessons at the science centre?

Mr E: Yes, I am presenting a lesson.

Researcher: What do teachers normally do when they get to the science centre?

Mr E: My understanding is to mainly manage the kids, so they behave because the science centre has people to take care of the kids and teach them. So my main role is to make sure the kids behave.

Researcher: Are you going to be a participant with the group of learners or are you going to be a participant with the facilitators?

Mr E: Both, I will facilitate and sometimes I will participate with the kids because I will be watching the videos with them.

POST INTERVIEW

Researcher: Were you able to achieve your goals for this visit?

Mr E: No, I was not able to achieve my goal, because of the misbehaviour of my learners that I teach. So, I was unable to reach my goal because of some of the things that we were to do at the science centre we were unable to do them especially what I requested and sent which is the pre-assessment I was unable to meet my goal because the kids were unable to do the experiment.

Researcher: Were you satisfied with the learning process at the science centre?

Mr E: No, again due to the misbehaving of learners.

Researcher: Will you visit again?

Mr E: Yes, I will visit whereby I will find better learners, learners that are willing to learn, that is when I will visit the science centre.

APPENDIX K: MR S INTERVIEW TRANSCRIPT

PRE INTERVIEW

SECTION A (Background)

Researcher: Please tell me about your educational background. Where did you study and for how many years?

Mr S: I firstly studies at the University of Zululand, doing BSc in Biochemistry and Microbiology for 3 years, I finished at the year 2010 and then I went to UNISA where I did my PGCE in Natural Science and Life Sciences for 1 year and I finished it on the year 2015. In total, I studied for 4 years.

Researcher: What subjects are you teaching?

Mr S: I am teaching Math, Natural Sciences and Physical Sciences.

Researcher: How long have you been teaching the subjects that you are currently teaching?

Mr S: I have been teaching these subjects for the past 10 years. I started teaching in 2011.

Researcher: What Grade do you teach?

Mr S: I am teaching grade 9 Natural Science, Grade 9 Math and Physical Science grade 11 and Grade 12.

SECTION B (Teachers' knowledge about informal learning environment)

Researcher: Which grades do you typically bring to the Science Centre?

Mr S: This year its Grade 9 and Grade 12

Researcher: How frequently are learners taken to Science centres?

Mr S: We don't do it much, maybe once a term.

Researcher: Do learners learn at the science centre?

Mr S: Yes, a lot. If you take learners at the science centre, UNIZULU science centre facilitator helps learners with graphs, they do demonstrations, experiments, and they teach them more about their careers.

Researcher: What are your thoughts on teaching at the science centre?

Mr S: Through teaching learners get help and they get interested towards their subjects and careers when they are in the science centre.

Researcher: What do learners normally do when they get to the Science centre?

Mr S: Spending most of their days in the same place can cause learners to become overly excited when they visit a new environment, such as a science centre. Seeing various exhibits and displays based on scientific principles can further increase their enthusiasm. In turn, receiving assistance in the subject of science can be particularly beneficial to these learners.

Researcher: What are the benefits of bringing learners to the science centre?

Mr S: Learner-to-learner relationships get stronger and they also connect more with their teachers. In the science centre, learners get more understanding on their subject because they get to hear different sides of topic explanations by UNIZULU science centre facilitators.

SECTION C (Teacher's preparation)

Researcher: What do you do before taking learners for a science centre visit?

Mr S: I firstly tell them at school about the science centre, prepare them by telling them about what they are going to see and their expected behaviour at the science centre. I also talk to the parents and they contribute especially towards food and transport fees because the school is very far from the science centre.

Researcher: Researcher: Do you visit the science centre before taking your learners there?

Mr S: Yes, we do. The science centre offers various programs for teachers, so we go there for a pre-visit before taking our learners. This helps us familiarise ourselves with the environment and prepare accordingly.

Researcher: Are you expecting the science centre facilitators to give you and the learner worksheets?

Mr S: Yes, yes, I am expecting it.

Researcher: What is the goal of visiting the science centre?

Mr S: It's to build a learner, maybe the learner will understand another person when they are explaining a concept, especially when they demonstrate it practically.

SECTION D (Teacher's role)

Researcher: Are you presenting any lessons at the science centre?

Mr S: No, there is no lesson that I am presenting

Researcher: What do teachers normally do when they get to science Centres?

Mr S: teachers follow instructions from the people in charge of the science centre and listen to them about what we must do in order to prepare our learners. We also control learners because when they get to places, they are not used to they behave in different ways so our job is to make sure that learners behave well while science centre teachers teach our learners.

Researcher: Are you going to be a participant with a group of learners or the facilitators?

Mr S: I am going to do both

POST INTERVIEW

Researcher: Were you able to achieve your goals for this visit?

Mr S: Yes I did achieve my goals, my learners got very big help here. Then Number two, part of the experiment they did the video, it was so very helpful to them.

Researcher: Were you satisfied with the learning process at the science centre?

Mr S: Yes, 102% satisfied.

Researcher: Will you visit again?

Mr S: 100times, yes, I'd visit again.

APPENDIX L: MRS R INTERVIEW TRANSCRIPT

PRE INTERVIEW

SECTION A (Background)

Researcher: Please tell me about your educational background. Where did you study and for how many years?

Mrs R: I studied at the University of Zululand popularly known as Ungoye, I did Bachelors of education degree for 4 years, I currently hold an honours degree in Education majoring in natural science and physical science.

Researcher: What subjects are you currently teaching?

Mrs R: I Teach Grade 12, Technical Science and Physical Science

Researcher: How long have you been teaching the subject that you are currently teaching?

Mrs R: I have been teaching physical science for 9 years. Technical science for 3 years.

Researcher: What grade do you teach?

Mrs R: Grade 12

SECTION B (Teachers' knowledge about informal learning environment)

Researcher: Which grade or classes do you typically bring to the science centre?

Mrs R: Normally I take the grade 12s, because the numbers of the classes are manageable

Researcher: How frequently are learners taken to the scientific centre?

Mrs R: Roughly twice a year.

Researcher: Do learners learn at the science centre?

Mrs R: Yes, the environment and exposure, the adventure of being in a lab teaches them a lot. To be in a science centre alone it's an experience on its own.

Researcher: What are your thoughts on learners learning at the science centre?

Mrs R: For me, the experience of working in a science laboratory can shape learners' future prospects, whether they decide to pursue a science major or work in a field that involves laboratory work. Being in a laboratory setting allows them to gain valuable insights and explore a wide range of scientific concepts. Additionally, it provides an opportunity for them to become familiar with using equipment that may not be available in their school laboratory.

Researcher (Follow up Question): Does your school have a fully equipped laboratory?

Mrs R: Not really, resources are limited in our school, thus learners don't get to know the practical part of their subjects. That's the reason we take them to the science centre, because other resources are not there. In my school, our lab is not well equipped.

Researcher: What do learners normally do when they get to the science centre?

Mrs R: Normally they get excited because they are not used to this, especially the ones that want to pursue careers that are related to science, it motivates them to be in a science centre.

Researcher: What are the benefit of bringing learners to a science centre?

Mrs R: To gain knowledge, to be well vest with the equipment, to note so many things about the laboratory precautions and the dangers in the laboratory. They need to know all those things. The principles, most of the time the lab, we go to the science centre to know things that are related to the curriculum.

Researcher: How does teaching in the science centre link to classroom learning?

Mrs R: Mostly in the classroom we teach the theory part, then in the science centre they get the practical part of it, which helps them a lot because mostly in science, there are marks which are in theory and some are in practical. Then they gain a lot to be in a science centre because they will improve their marks which are allocated for practical part for the science.

SECTION C (Teacher's preparation)

Researcher: What do you do before taking learners for a visit to a science centre?

Mrs R: I think you need to plan what it is that you are taking them to the science centre, what you need them to acquire, you need to have objectives so that you know when you arrive there what you expect your learners to gain from the science centre. You need to plan; it must not be too much work. You need to prepare learners and their behaviour, and tell them what is expected of them when they get to the science centre.

Researcher: Do you visit the site which is the science centre before you take your learners to the science centre?

Mrs R: It is very important for the teacher to go there beforehand so that you must accustom yourself with the rules and expected behaviour so that when you come with your learners you are familiar with everything.

Researcher: Are you expecting the science centre facilitators to give you and the learners' worksheets?

Mrs R: No because it might not be related with the curriculum. I normally prepare the handouts before so that you know what question you need to be answered for your learners and the facilitators might help you therefore you need to have your own.

Researcher: What is the goal of visiting science centre?

Mrs R: It is to do the science experiment.

Researcher: What did you consider before taking your learners to the science centre?

Mrs R: It was to check booking availability, arrange the transport and food because it was going to take the whole day, and arrange the worksheets for the activities to be done at the science centre.

Researcher: What were the learner's activities when they were at the science centre?

Mrs R: I was to write notes, choose careers which are in line with science, since they are doing science and do activities which were expected of them and explore the exhibits.

SECTION D (Teacher's role)

Researcher: Are you presenting any lessons at the science centre?

Mrs R: There are times when you need another person to explain to your learners so that they can see what you say in class may be simplified by someone else. Sometimes I ask a facilitator to explain to my learners some of the stuff.

Researcher: What do teachers normally do when they get to science centres?

Mrs R: As a teacher, you organise learners, plan and arrange your activities on time, I will also monitor learners' behaviour and their involvement in the practical and explain to the learners the exhibits available in the science centre.

Researcher: What did you do when you were at the science centre, your activities?

Mrs R: It was to monitor my learners during learning. To move around with learners to explain some of the exhibits and to group my learners during collaborative activities such as choosing careers.

Researcher: Did you present any lesson today or did the staff of the science centre present the lessons?

Mrs R: I think we worked hand in hand with the facilitator, some of the stuff I presented to my learners and some of the stuff was explained by the facilitators.

Researcher: Did you or learners receive any worksheets from the facilitators?

Mrs R: Not really because I came with my own worksheets so I did not receive any from the facilitators

POST INTERVIEW

Researcher: Were you able to achieve your goals for this visit?

Mrs R: No, What I wanted to achieve was for my learners to have a hands-on practical, to be accustomed to the resources that were there in the science centre, it's not what I was expecting.

Researcher: Did the learners learn at the science centre?

Mrs R: Yes, they did, even though they did not do the hands-on practicals. Learners had a video and that video was educative.

Researcher: Were you satisfied with the learning process at the science centre?

Mrs R: Not really, because I was expecting my kids to have a hands-on practical yet only to find when we arrive there, they show my learners a video. Yes, I appreciate it because we don't have that video in my school but it's not what I was expecting at the science centre.

Researcher (follow-up question): What was the reason for not doing the activities or practicals?

Mrs R: I think it was due to COVID 19, they were still recovering from it because during COVID 19 they were not able to do the practical because the hands-on, it will need a lot of people who will touch so many things and so on. They gave me that reason, that's why they showed us the video instead of having a hands-on practical.

Researcher: What were the benefits of taking your learners to this science centre?

Mrs R: An outing, to explore new things, was an adventure on its own to be in another environment, It motivates a learner to be in a different environment. And familiarise my learners with the equipment which is there at the science centre.

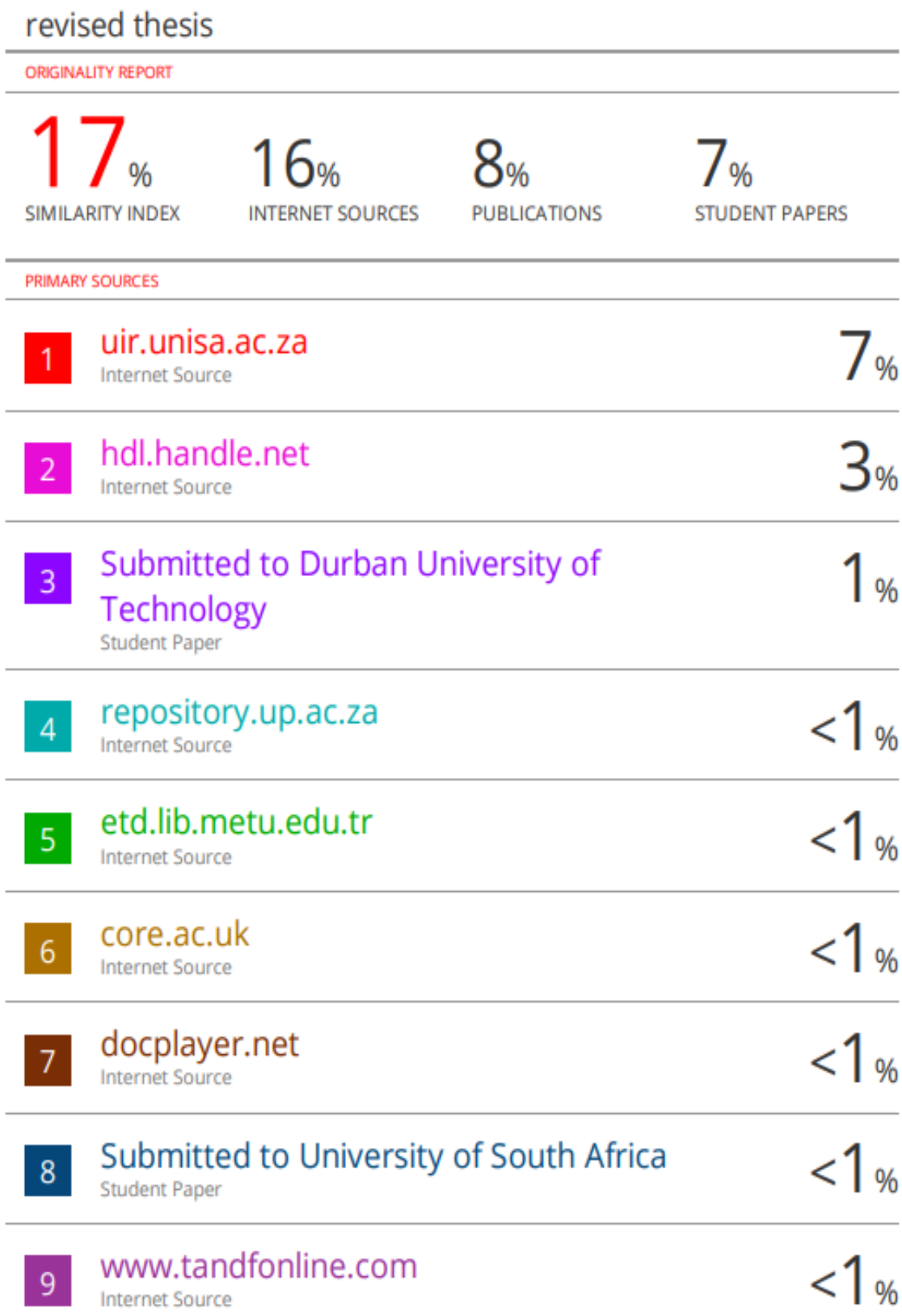
Researcher: Did you participate with the group of learners or facilitators?

Mrs R: I can say both, I did participate with the group of learners so I will explain some of the exhibits and also with the science centre facilitators.

Researcher: Will you visit the science centre again?

Mrs R: Most definitely, yes, because of what I said, it's an adventure on its own, it motivates learners, even though it's not what I expected but there are one or two things that they learned so I can take them again.

APPENDIX M: TURNITIN REPORT



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APPENDIX N: LANGUAGE EDITING CERTIFICATE

01 September 2023

TO WHOM IT MAY CONCERN

Dear Sir/Madam

Re: Editorial Certificate

This letter serves to prove that the thesis listed below was language edited for proper English, grammar, punctuation, and spelling, as well as the overall layout and style by myself, proprietor of Dr Thesis (Pty) Ltd.

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Author: LUNGILE PHILISIWE GUMEDE

The research content or the author's intentions were not altered in any way during the editing process. However, the author has the authority to accept or reject my suggestions and changes. I, the editor can guarantee the quality of my editing and mentorship abilities, however, I cannot guarantee that the examination board will accept the thesis with a pass. This will depend on the hard work, persistence and amount of effort put in by the mentee.

Should you have any questions or concerns about the edited document, I can be contacted at the listed telephone numbers or email addresses.

Yours truly,
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