EXPLORING ALTERNATIVE PEDAGOGIES FOR TEACHING GRADE 11 FURTHER EDUCATION AND TRAINING LIFE SCIENCES

By

Mr Zukisani Mkhanyiswa

Student number: 209212063

DISSERTATION

for

MASTER OF EDUCATION

in

SCIENCE EDUCATION

FACULTY OF EDUCATION

Supervisor: Dr Kwanele Booi

Co-supervisor: Dr Moses Moyo

September 2022

ABSTRACT

There has been a paradigm shift in the education landscape of South Africa since the introduction of the current Curriculum and Assessment Policy Statements (CAPS). The current curriculum emphasises the importance of employing learner-centred approaches that are linked to social constructivism theory when teaching Life Sciences. The study takes into cognisant that teaching of Life Sciences is dominated by traditional approaches that pride themselves on the transmission of knowledge and presentation of Life Sciences facts with no real-life situations with which learners can relate. The study used qualitative research methods, and participatory action research explored the enactment of teaching approaches to teach selected Life Sciences topics at a selected school in South Africa. Reference has been made to the teaching of photosynthesis and cellular respiration, which seem to be similar topics. Results included the researcher's narrative analysis of the approaches used and learner performance on the assessments given to learners to measure the extent of knowledge acquired as well as other skills gained during the learning process. Findings revealed that learners could not comprehend the content knowledge because of a lack of prior knowledge. Furthermore, there was little understanding of when the transmission approach was employed as opposed to when different approaches were integrated into the lesson. When learners were exposed to practical investigative work, more meaning was demonstrated. Furthermore, the integration of ICTs enhanced learners' understanding of concepts. When learners were assessed according to learning outcomes, poor performance was demonstrated. However, learners performed well when they were exposed to practical investigative activities. This study advocates for learner-involvement activities in knowledge construction. There should be the integration of ICTs when teaching Life Sciences since they play a significant role in assisting learners in understanding concepts better. Furthermore, when learners are exposed to practical work, they have opportunities to gain more conceptual knowledge and investigative skills linked to inquiry-based teaching approaches. Adherence to the CAPS document for Life Sciences is crucial because it guides how each topic should be taught.

KEY WORDS: **Alternative Pedagogies, Teaching strategies, Teaching methods, Life Sciences, Pedagogical Content Knowledge, Technological Pedagogical Content Knowledge.**

DECLARATIONS

I, Zukisani Mkhanyiswa, declare that the submission of the dissertation document with the title, **“Exploring alternative pedagogies for teaching FET Life Sciences”**, is entirely my own work. Where other sources were used, they were acknowledged and referenced in accordance with the Harvard system of referencing.

Name: Mr Zukisani Mkhanyiswa. Signed at Cape Peninsula University of Technology (South Africa).

Signature_ 

Date: 27 SEPTEMBER 2022

ACKNOWLEDGEMENTS

I would like to thank God for giving me the strength and courage to finish my dissertation. This endeavour would not have been possible without the guidance of my supervisors, Dr Booi and Dr Moyo, who invested their time and generously provided their knowledge and expertise to ensure that I gained much-needed knowledge in the study.

I would like to extend my sincere gratitude to every participant who agreed, out of their busy schedule to partake in the study. Without them, it would not be possible to complete the study.

Words are not enough to express my gratitude to my wife, Lakhanya, for her support throughout the journey. Her belief in me kept me going and motivated me throughout this journey.

Lastly, would like to thank everyone whom God used to assist me in any way.

GLOSSARY OF TERMS

CAPS	Curriculum Assessment Policy Statement
DBE	Department of Basic Education
DoE	Department of Education
ZPD	Zone of Proximal Development
FET	Further Education and Training
PAR	Participatory Action Research
WCED	Western Cape Education Department
PCK	Pedagogical Content Knowledge
ICT	Information Communications and Technology
LMS	Learning Management Systems
PK	Pedagogical Knowledge
CK	Content Knowledge
TPACK	Technological Pedagogical Content Knowledge
SA	Specific Aim

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

1.1 Introduction

There has been a paradigm shift in the education landscape of South Africa since the introduction of the current Curriculum and Assessment Policy Statements (CAPS). This current curriculum preaches the importance of employing a learner-centred approach which is linked with the use of social constructivism theory when teaching Life Sciences (Cronje, 2011; DoE, 2011). The CAPS curriculum for Life Sciences requires teachers to engage learners differently from traditional teaching practice (Mnguni, 2018). For example, learners should not be passive receivers of information but should be active participants throughout academic activities (Nwosu, 2019). Nwosu further asserts that learners who are active participants in academic activities can process information, interpret, explain, make a hypothesis, design their activities, and share research when engaging in learning content in class. According to Pozas, Letzel, and Schneider (2020), the performance of learners and the quality of teaching they get are primarily influenced by the teaching approaches employed by teachers. Therefore, if teaching approaches do not resonate well with the nature of the science disciplines, learners will be disengaged and lose interest. (Basu & Barton, 2010). Therefore, the shift in teaching approaches in South African schools is imminent.

The Department of Education stresses the need to move from traditional to learner-centred pedagogies to realise the aims of CAPS (DBE, 2011).

According to CAPS (DBE, 2011), among the aims of the South African curriculum is to produce learners who can:

- identify and solve problems and make decisions using critical and creative thinking;
- work effectively as individuals and with others as members of a team;
- collect, analyse, organise and critically evaluate information;
- use science and technology effectively and critically, showing responsibility towards the environment and the health of others; and

- demonstrate an understanding of the world as a set of related systems by recognising that problem-solving contexts do not exist in isolation.

In addition to the aforementioned aims, Preethlall (2015) states that CAPS has stipulated specific aims for Life Sciences that are intertwined with its aims as follows:

- Specific Aim 1 (SA1) – knowing Life Sciences (concepts, processes, phenomena, mechanisms, principles, theories, laws, and models) (DBE, 2011b).
- Specific Aim 2 (SA2) – doing science or practical work and investigations (DBE, 2011b).
- Specific Aim 3 (SA3) – understanding of the applications of Life Sciences knowledge in everyday life, as well as an understanding of the history of scientific discoveries and the relationship between indigenous knowledge and science (DBE, 2011b).

The realisation of the above aims and specific aims can only be achieved when effective teaching approaches cater for the needs of learners in the Life Sciences classroom (Pherson-Geyser, de Villiers, & Kavai, 2020). Furthermore, the competency of teachers, adequate teaching strategies employed by teachers that enable active participation of learners in a learning process, relevant subject content as well as the availability of necessary resources needed in the Life Sciences classroom also contribute to effective teaching (Dalton, McKenzie, & Kahonde, 2012). A study from Samaneka (2015) reveals that Life Sciences have been presented as an accumulation of facts with which learners must familiarise themselves. Consequently, learners are deprived of opportunities to develop creative and critical thinking.

For learners to develop scientific understanding, academic activities must be meaningful and integrate content knowledge, science processes and the nature of Life Sciences (Penn, Ramnarain, Kazeni, Dhurumraj, Mavuru, & Ramaila, 2021). This will ensure necessary opportunities such as critical thinking skills and expanding understanding of Life Sciences content and processes are created. However, there is little integration of content and knowledge in high schools due to the demands of keeping up with the Life Sciences pacesetter provided to teachers by Curriculum Advisors, which stipulates the exact time frame for each topic (Brownell & Tanner, 2012). Brough (2012) argues that there is a distinction in the level of science teaching at primary and high schools. Primary schools emphasise the processes of science while paying little attention to methods by which that knowledge must be imparted (Kazeni, 2012; Tabulawa, 2013).

While other teaching approaches have proven effective in teaching and learning Life Sciences, the traditional teaching approach remains dominant in most South African schools (Bray, Adamson, & Mason, eds., 2014). The traditional teaching approach can be equated to a one-man show because the teacher is the one who transmits knowledge. This is teacher-centred and rarely applies to real-life situations relating to science (Jensen, Kummer, & Godoy, 2015). Smetana and Bell (2012) suggest that traditional ways of teaching science do not enhance the development of learners in understanding scientific concepts. Traditional methods of teaching Life Science, which generally involve memorising concepts and calculations, are dominantly used at schools. As a result, most learners fail to understand some concepts that require critical thinking (Taasoobshirazi & Carr,2008). Therefore, according to these scholars, this approach results in poor problem-solving and limited comprehension of learnt concepts and ideas. Research from Onwu and Kyle (2011) has identified some weaknesses of traditional ways of teaching Life Science, making learners lose interest in learning Life Sciences. These include the following:

- They do not promote higher-order thinking skills.
- They make science education unpopular and irrelevant in the eyes of learners.
- They do not provide learners with the opportunity to see the link between science education and their day-to-day experiences.
- They lead to gaps between what learners want and what educators teach.
- They do not foster a sense of confidence in learners' ability to solve problems and make informed decisions about their daily experiences and needs.

As such, researchers in science education advocate for the move from traditional teaching strategies and that teachers familiarise themselves with various teaching approaches that would make them realise the aims of CAPS documents (DBE, 2011; Jackson, de Beer, & White, 2016; Osman, 2018).

The need to realise Life Sciences CAPS aims and objectives necessitated the study to explore different teaching approaches that are effective in the teaching and learning of Life Sciences in the Further Education and Training (FET) school curriculum. Furthermore, this study aims to suggest effective strategies that can be used in the teaching and learning of Life Sciences.

1.2. Research Problem

Science, in general, plays a pivotal role in technological and scientific developments necessary for the economic growth and well-being of South African people. A study conducted by Mavuru and Ramaila (2019) reveals that most South African learners demonstrate a low depth of Life Sciences knowledge, underperformance, and low level of engagement in the Life Sciences, which has been linked to teaching approaches adopted by teachers which are not aligned with CAPS. If appropriate teaching strategies are to be employed, learners would perform better in Life Sciences and be offered better chances to pursue further studies to build on the knowledge they received from the school.

The CAPS document aims to ensure that teaching strategies used in Life Sciences should make learners aware of their environment and equipped with investigative skills linked to physical and chemical phenomena. The CAPS document serves as a guideline for all subjects included in the National Curriculum Statement and advocates for the use of learner-centred approaches in the teaching of Life Sciences.

However, the current status quo of teaching and learning Life Sciences does not reflect what is ideally desired from CAPS documents (Nwosu, 2019). Teachers still present Life Sciences as a body of factual knowledge, emphasising expectations of the syllabus and memorising facts with no link to learners' prior knowledge and lived experiences (Cooper, Stowe, Crandell, & Klymkowsky, 2019). This has been associated with the use of traditional teaching approaches, which proved ineffective, disempowering, and limit learners in attaining cognitive skills such as critical thinking, problem-solving, communication and collaboration, which are important in knowledge gain (Aziz, Zannat, & Hena, 2021). Furthermore, the current Life Sciences traditional approaches do not engage learners in collaborative learning, which maximise their participation (Jeroen, Janssen & Wubbels, 2018). Therefore, this necessitates the need to explore different teaching strategies when teaching Life Sciences that would enable teachers to gain insight on teaching approaches that promote active participation of learners in the Life Sciences classroom.

1.3. Rationale of the study

The rationale for this research stems from personal experience as a Life Sciences teacher and contextual-based evidence. As a newly qualified educator, the researcher observed that most high school teachers train learners to memorise Life Sciences content through past examination papers with memoranda to enhance teaching and learning. Therefore, the researcher believes that the strategy mentioned above is ineffective since learners rely on memorization to pass their examination and progress to the next grade without understanding and knowing how to apply the content they have learnt.

Life Sciences include many abstract concepts which require some form of knowledge mixed from other sciences disciplines and that need to spiral as learners move from one grade to the other. Therefore, educators must demonstrate depth in content knowledge and knowledge of other disciplinary content knowledge that will enhance teaching and learning instead of relying on drill work and memorisation, as viewed by current researchers as limiting. Furthermore, the researcher observed that learners struggle to apply what they learned through memorisation when faced with higher-order questions.

1.4. Aim

To explore alternate pedagogies that can be employed for effective teaching of the FET Life Sciences school curriculum.

1.4.1. Research Objectives

1. To Identify different teaching approaches for teaching Life Sciences.
2. To investigate the level of effectiveness of each teaching strategy for teaching Life Sciences.

1.4.2 Main Research Question

What alternative teaching approaches can be employed to teach the FET Life Sciences school curriculum effectively?

1.4.3 Sub-questions

1. What are the possible alternative teaching approaches that can be used for adequate teaching of selected FET Life Sciences topics?
2. How effective is each strategy in improving teaching and learning Life Sciences topics selected from the CAPS curriculum?

1.5. Literature Review

Studies from Molefe, Stears, and Hobden (2016) and Willingham (2020) argue that Life Sciences have been taught as an accumulation of facts, especially in high schools, where learners are expected to familiarise themselves. (Molefe, Stears, & Hobden, 2016). This has been attributed to the frequent use of traditional pedagogies such as lecturing, where learners do not get enough opportunities that encourage critical thinking. Alemu, Stevens, and Ross (2012) emphasise that only active participation in the construction of knowledge will enable learners to acquire knowledge, which this study suggests is linked to the principle of the theory of constructivism.

Literature from Brown and Crippen (2017) and Sultan, Asim, and Khaskhely (2019) reveal that teachers often equate inquiry activities with highly structured activities with elements of the traditional approach, which involve the transmission of content from an educator or the textbook to the learners. Brown and Crippen (2017) further asserts that highly structured activities require learners to follow certain steps that only confirm the already established knowledge. In this way, learners are deprived of valuable inquiry skills that can enhance their thinking. Nyback (2013) adds that when a teacher always explains the steps to be followed in every activity, this serves as a purpose of memorising the scientific truths. From the perspective of proponents of constructivist theory, such practice is viewed as rigid and procedural. It, therefore, neglects the importance of learners' prior knowledge. Such activities are suggested as defeating the purpose of learning and emanating from incorrect strategies used to impart knowledge in a science environment since they do not afford learners opportunities for active engagement in the learning process (Nyback, 2013). Furthermore, structured activities do not allow learners to be independent thinkers since the teacher is the one who explains everything (teacher-centred), including assisting learners on how to answer questions (Alam, 2016). This practice is seen in this study as a copy-and-paste method as teachers themselves rely on the views of others to answer such questions.

A study from Kazeni (2012) suggests that the Science teaching method is different in primary school and high school. At the primary school level, Science teaching is student-centred, involves more practical activities, and has more freedom for investigation. In contrast, science teaching at the high school level is dominated by the "chalk and talk" teaching approach, learning abstract concepts, factual knowledge and cookbook practical lessons and demonstration (Mavuru, & Dudu, 2020). In most high school classes, it is a teacher who engages in solving problems, most often than not, using answers from past examination papers and performing practical demonstrations in some cases. Learners would only contribute by listening to the teacher and writing notes without asking questions or using inquiry-related learning strategies (Tabulawa, 2013). This is supported by Krahenbuhl (2016), who states that science teaching at the high-school level involves the transmission of knowledge from expert sources (educators and textbooks) to mainly passive recipients (the learners). Lyons used these words to describe this approach: "This is it, this is how it is, this is what you learn; it is like that, learn it because it is right, there is nothing to change; it is as it is, just accepts it. (Lyons, 2006: 591).

These words imply that learners see science as a collection of knowledge committed to memory, with no room for understanding and questioning. Furthermore, a study by Love, Hodge, Corritore, and Ernst (2015) reported that most learners in high school believe that Life Sciences teaching lacks a sense of community. They cannot relate socially to what is being taught; too much mimicking rather than inquiry-based learning does not provide a good overview of the subject, and there is little room for learners' engagement in learning the content taught. Brownell and Tanner (2012) have also pointed out that there is usually little active learning involvement when using traditional ways of teaching science, which frequently causes learners to become disengaged and demotivated.

There is an emphasis by Ültanir (2012) that the learning of science is an active process. It is something that learners do, not something that is done for them. He further stated that doing science involves students both in physical and mental processes, collectively known as scientific inquiry. Scientific inquiry demands active participation from learners, i.e., learners must be hands-on in Life Sciences activities.

It is important to note that factors such as poor infrastructure, lack of resources and competent science teachers, and pedagogies, also impact the teaching and learning of Science (Andrews, Leonard, Colgrove, & Kalinowski 2011). Kazeni and Onwu (2013) suggest that different pedagogies used by educators play an important role in the performance of a learner. Therefore, this shows that there is a link between teaching strategies and learner performance in science. Many studies suggest that there has been ongoing research around pedagogy in science classrooms from a much broader spectrum which entails an examination of pedagogical content knowledge in science and the competence of a science teacher (Abbitt, 2011; Duit, Gropengießer, Kattmann, Komorek, & Parchmann, 2012; Fauth, Decristan, Decker, Büttner, Hardy, Klieme, & Kunter, 2019).

This, again, demonstrates a gap in how Life Sciences are taught, thus warrants a need to explore alternative pedagogies that are effective for teaching Life Sciences. It is also necessary to compare the effectiveness of traditional teaching (teacher-centeredness) and other teaching approaches involving the acquisition of science inquiry skills, problem-solving and critical thinking, as stipulated in the South African curriculum (DoE, 2008). Since the concept of Pedagogy is broad, the study will focus mainly on alternative pedagogies that can be employed in teaching Life Sciences in the classroom to achieve the objectives of the CAPS curriculum (DoE, 2011).

1.5.1 Learning Styles in Life Sciences

There are many different teaching approaches in Life Sciences, and each approach can be effective based on understanding diverse learning styles as well as adapting to the context of the classroom (Stains & Vickrey, 2017). Naqvi (2017) posits that an approach that is consistent with the preferred learning style of a learner leads to better academic performance and the development of a positive attitude towards learning the discipline. On the other hand, if the teaching approach does not accommodate the preferred learning styles in the classroom, it could result in learners withdrawing from participating in the lesson and consequently resulting in a drop in academic performance (Roig, 2008). Therefore, it is important to create awareness of the role that learning styles play in improving learners, academic strengths and weaknesses. However, the research focus will not be on learning styles but on teaching approaches.

1.5.2 Theoretical Framework

Educational theory plays a significant role in building a plan that guides teaching and learning. Therefore, this research is underpinned by constructivist theory.

1.5.2.1 Constructivism

Constructivism is described as an epistemological and psychological theory that deals with how people learn using their past knowledge to negotiate the meaning of new information (Splitter, 2009). Constructivism views learning as building on internal cognitive structures, which are schemas consisting of information and the process of how this information is acquired. As new information is acquired through experiences, this information modifies, adds to, or changes the previous schema.

According to Mvududu (2005), since South African education is multicultural, there is a need to move to an approach that will include themes, activities and outcomes accommodating learners’ daily experiences and activities or examples that encourage learners to be actively involved in the learning process. This is referred to as social constructivism. Social constructivism allows teachers to use knowledge through social, cultural, and political processes. According to the Department of Basic Education (2011), learners should achieve three learning outcomes in Life Sciences. These outcomes include scientific inquiry and problem-solving skills, construction, and application of Life Sciences knowledge. These outcomes can only be achieved through social constructivist theory because it emphasises the importance of integrating inquiry-based and problem-solving teaching methods and activities using scenarios and examples familiar to learners’ social backgrounds to explain phenomena.

The constructivism theory describes learning as an active process where learners construct new ideas or concepts based on their current or previous knowledge (Booi, 2017). The researcher further state that the constructive theory model sees constructivism as a spiral with the students at the centre of learning. Wirth and Perkins (2008) state that as new experiences are linked with prior knowledge, deeper knowledge can be applied in different contexts.

Since prior knowledge is a focal point for learning, teachers need to identify and correct the existing misconceptions at the beginning of each lesson. Constructivism encourages learner-centred pedagogy, involving learners actively participating in the teaching and learning process rather than passively receiving information (Splitter, 2009).

Vygotsky (1978) came up with the idea of social constructivism, while Piaget (1972) founded the idea of constructivism (Nyback, 2013). Hmelo-Silver and Eberbach (2012) concluded that in social constructivism, learning is constructed in a social context and involves individuals engaging in problems in a social environment, while constructivism advocates that learning is constructed within the individual and involves prior knowledge.

1.5.2.2. Social Constructivism

McLeod (2007) posits that learning is regarded as a social process that is facilitated through social interactions and communication, which results in cognitive development. Social constructivism is underpinned by the Zone of Proximal Development (ZPD) concept, which is a phase of activity where learners are assisted by a teacher or more knowledgeable peers to fulfil activities they cannot accomplish alone (Vygotsky, 1978). Students cannot learn anything complicated to understand since that will not be in their zone of proximal development. Therefore, a shift in a zone of proximal development needs to occur so that a learner can attain his or her potential and then proceed to solve challenging problems. The ZPD concept assists teachers in identifying learners' strengths and weaknesses so that they can adapt their teaching to a meaningful learning experience guided by the needs of learners through various forms of scaffolding interventions. Furthermore, the application of ZPD enables teachers to mediate and provide instruction and feedback that enhances cognitive development, creating a learning environment that is valuable to learners (McLeod, 2012).

A study by Van Wyk (2013) reveals that there is an improvement in learners' performance when teachers use constructivist teaching approaches in their teaching. Constructivist teaching approaches include inquiry-based teaching approach, context-based teaching approach, environmental awareness teaching approach, facilitative teaching approach, Integrative approach, Dialogical Argumentation Instructional Model teaching approach and reflective Approach. The lessons must challenge learners' suppositions; for example, a teacher would introduce a lesson with what learners already know (context-based teaching approach). A teacher who uses a constructivist approach to teaching would also structure his or her lessons around big ideas, e.g., by allowing learners to interact with their environment (environmental awareness teaching approach). In constructivist-based teaching approaches, teachers must show their ability to impart content knowledge in many ways by giving activities that enable active engagement of learners during the lessons. The teacher, as a facilitator and a mediator between content knowledge and learners, will then guide learners as he moves around the classroom to address any question that might arise and check whether learners understand the activity and give guidance (scaffolding) where learners are struggling with understanding the activity that is done in the classroom.

1.6. Research Methodology

This section deals with the research methodology used in the study. It explains the research paradigm, research design, and research methods. Furthermore, it gives an insight into how data will be collected and analysed.

1.6.1 Research Paradigm

This study will be guided by the principles of interpretivist theory knowledge production. According to Alharahsheh and Pius (2020), interpretivism research paradigms are suitable for seeking different views, perceptions, and experiences of participants. This paradigm uses a qualitative data collection method involving qualitative research instruments, data presentation, and analysis. The rationale behind adopting this paradigm is to find out more about which teaching strategies can be effective in adequately teaching Life Sciences in the FET band. Using a variety of data collection will enable the researcher to collect and interpret data to formulate answers to the main research sub-questions.

1.6.2 Research Design

The proposed study will employ a qualitative research design using the Participatory Action Research approach (PAR).

1.6.2.1. Qualitative Research

According to McMillan and Schumacher (2006), a researcher using qualitative methods gives a detailed description of the situation, events, attitudes, and thoughts of the participants. Furthermore, Creswell and Creswell (2017) state that qualitative research gathers descriptive and explanatory data for a deep understanding of the phenomenon being studied through learning from the participants in real-life situations. Therefore, this method will give answers to my research questions. During Qualitative research studies, data collection occurs through observations and in the form of a write-up or visuals (Opie, 2004). Opie (2004) further stressed that qualitative research is more concerned with the process rather than a product. For example, in his research Opie (2004) explored how people use data collection to make sense of their practices and emphasise interpreting patterns and identifying themes that emerge from data instead of numbers (quantity). De Villiers (2005) further states that qualitative research is a naturalistic, interpretive science that involves methods such as case studies, interviews, observation, and textual analysis, which provide insights into cultural aspects, organisational practices and human interactions. Mogashoa (2014), on the other hand, explains qualitative research as human actions taking place within a structure of social rules wherein, they have meaning. In the context of this study, the structure of social rules would refer to a Life Sciences classroom where teaching takes place.

1.6.2.2. Participatory Action Research approach

The researcher will use the Participatory Action Research (PAR) approach to collect his data. According to Moffitt and Vollman (2004), PAR is an approach to research that involves persons being studied in any research that affects them. The PAR approach allows the researcher and participants to deviate cognitively from familiar routines of learning and forms of interaction to question and rethink situations and strategies that are already established (Reitan & Gibson, 2012). In addition, PAR allows the researcher to be a facilitator, committed participant and learner in the research process. In essence, to gain a deeper insight into the contextual structuredness of meaning and different social actions, it is necessary to employ a Participatory Action Research approach. Participants are not passive in PAR but actively engaged in finding information and ideas that will be helpful for future actions. This approach will be crucial in this research as it will allow the researcher to work with learners and understand which methods work best when teaching Life Sciences. Furthermore, as a reflexive practitioner, the researcher will reflect on his experiences while conducting the study.

1.6.3. Research Method

1.6.3.1. Study Site

The area for research is a high school located in Circuit 5, in the Cape Winelands Education District in the Western Cape. The school is a mathematics and Science school and falls under quintile 1 (a no-fee under-resourced school). The school is selected because it is where the researcher is currently teaching, and this will be an opportunity to explore other teaching approaches since the researcher teaches Life Sciences. Researching the school will also help other Science teachers to look at alternative methods to enhance teaching and learning at the school.

1.6.3.2. Participant selection

A sample is a group of subjects or participants from whom the data are collected (McMillan and Schumacher (2006). The sample is purposive, which represents a qualitative research feature. According to McMillan and Schumacher (2006), purposive sampling is a sampling that allows the researcher to choose small or large groups who are likely to have knowledge and information about the subject of interest. An argument might arise that the researcher has used a small sample size, but it is reasonable because the study is not a survey, which would normally require a large sample size. Furthermore, the researcher does not want to generate broad generalisations required in large samples.

The research will focus specifically on Grade 11, where three classes will be used for this study. The researcher teaches Life Sciences in Grade 10 and 11 at the school the study will be conducted. There are a total of 43 learners from three Life Sciences classes who will be participants because they form part of the Life Sciences classes. The participants were learners and a teacher(researcher). Grade 11 learners are chosen for the study because the researcher teaches them at the school, and they are ones affected by the traditional pedagogies used. They will be able to give the researcher an insight into which pedagogy can be employed when teaching certain sections in Life Sciences. In addition, the grade 11 learners, as the preferred grade to participate in the study, will be able to provide the researcher with valuable information on how they respond to each teaching approach employed during the lesson. The teacher will be the one who initiates lessons guided by the CAPS document.

1.6.4. Data Collection

The data will be collected qualitatively through participant observations, document analysis and assessments. These various methods would provide the research with rich data for analysis and enable the researcher to see which teaching approach is most effective for teaching and learning FET Life Sciences topics in the school curriculum.

1.6.4.1 Participant Observation

Studies from Brophy (2006) suggest that the use of observational methods gives important information to a researcher as the research is in progress. According to Cohen Morrison and Manion (2011), there is more to observation than just looking. Cohen *et al*. (2011) allude to this by stating that observations offer an opportunity for a researcher to gather live data from a naturally occurring situation, which is the presentation of a lesson in the classroom or any educational setup.

Participant observation involves a coordinated noting and recording of behaviour and events in the social setting using thorough and comprehensive field notes (Takyi 2015). Takyi (2015) further states that participant observation is an innovative qualitative research method that is a rich source of data collection and is mostly used in PAR. Participant observation allows the researcher to research subjects in a social situation. It captures the context of the social setting in which individuals' function by subjectively and objectively recording human behaviour. This enables the researcher to be part of the learning process that is observed through hearing, seeing, and experiencing the reality of the social situation with the participants. Therefore, the researcher, as a participant-observer, would not only observe Life Sciences activities unfolding, but also engage in activities to get a deeper insight into which teaching approach works best and in which setting. The researcher initiated learning opportunities using different resources such as media, PowerPoint presentations, and handouts. As the teaching and learning unfolded, the researcher recorded how learners responded to each form of teaching approach. The interest shown by learners during the lesson was monitored to make it easy to tell when learners find it difficult to understand what is taught through their responses during the lesson.

1.6.4.2. Document Analysis

The Life Sciences CAPS document would be used as a guideline for achieving a learner-centred approach to teaching and learning Life Sciences. The document will be analysed in the context of literature and educational theories adopted by the study. This document will enable the researcher to critically zoom in on important aspects one needs to consider when teaching Life Sciences using a certain approach. Furthermore, the CAPS documents will guide the researcher on how to plan each lesson for different teaching approaches like argumentation, practical work (inquiry-based learning), traditional approaches, and data management exercises to encourage learners to use a synthesis of data, evaluation of data and other learner-centred approaches.

1.6.4.3. Assessments

Assessments play an integral role in teaching and learning. They play a crucial role in how teachers teach, learners learn and the motivation behind teaching and learning (Dudu & Samuel, 2017). In the school context, assessment refers to a variety of approaches or strategies that teachers can use to measure, document, and evaluate learning progress, acquisition of skills, as well as academic gaps and educational needs of learners (Aikens & Dolan, 2014). In essence, the assessments aim to inform the teacher about learners' level of understanding of the concepts taught in the classroom. The main purpose of assessments is for teachers to do an introspection of their teaching style as learning patterns from learners are informed by teaching approaches employed by the teacher and by the outcomes of learning in the whole process. Assessments will play a major role in this study because they will clearly indicate which teaching approach works best based on the results. These assessments involve formal and informal assessments such as practical demonstrations, practical exams, formal exams, classwork, excursions, practical laboratory work, and group work. With the above-stated forms of assessments, the researcher will be able to deduce which teaching approach is effective in the adequate teaching and learning of Grade 11 FET Life Sciences.

1.6.5. Data Analysis

As indicated previously, the data will be collected through participant observation, document analysis and assessments. The data obtained from these sources of evidence will then be analysed through the development of themes. All data collected will be analysed within the framework of the qualitative research methods. Discussion and interpretation of themes from participant observation, assessments and document analysis will be informed by literature that was provided within the context of the research questions of the study.

1.6.6. Trustworthiness

A triangulation of participant observation, assessments and document analysis will be employed in the study to ensure the credibility and transferability of the research findings. These different methods of data collection will enhance the validation of research and capture different views of the subject investigated. Furthermore, using these data sources will also help to identify contradictions and weaknesses of data produced by each source of evidence, thus enhancing the trustworthiness of the research. In essence, triangulation will assist in analysing differences and similarities that may be found among data collected, and this will enhance credibility through a convergence of evidence attained.

1.6.7. The Researcher's position in the study

As the initiator of the research, the researcher will be a participant-observer and a facilitator in the study since he is also teaching the subject being investigated. Although the researcher is a Life Sciences teacher where the study will take place, he will not alter findings by any means as this will jeopardise the validity of the data. Instead, the researcher will take an objective stance during data collection to minimise biases by making sense of what transpired in different lessons through the CAPS document. The CAPS document has a detailed sequence on what role a teacher should play when teaching any topic in Life Sciences. In this way, any reflection will be made in the context and expectations of the CAPS document, particularly on the Specific aims of Life Sciences. He will be subjective during the discussion of results because he believes that his own opinions and feelings need to be heard since being involved in the research as a participant-observer, and he will also narrate what transpired throughout the data collection stage.

1.6.8. Ethical Considerations

According to Sikes (2004), research ethics deals with the application of moral principles to avoid harming and affecting other people's lives in the process of doing research. For the ethical requirements of the research, the research will apply for ethical clearance from the Cape Peninsula University of Technology. Furthermore, the researcher will seek permission from the Western Cape Education Department to conduct research at the school. The researcher will liaise with the principal of the school via email to request permission to conduct his research. Consent from learners and their parents for learners to participate in the study will be obtained. They will be told about the research and notified that they could choose to decline participation. The names and responses of the participants will be kept anonymous to guarantee their confidentiality. Pseudonyms will be used to conceal the identity of participants.

1.7 Contribution of the study

The study will contribute to the body of knowledge by raising awareness of the need to consider a variety of teaching strategies that are aligned with CAPS objectives and the needs of the topics that are taught in the Life Sciences classroom. Alternative pedagogical approaches that enable learner-centeredness and provide opportunities for optimum learning and guarantee success in knowledge impartation will be highlighted.

1.8. **Definition of term used in the study**.

Pedagogies- refers to how strategies of how educators teach in practice and theory. It is shaped by teaching beliefs of teachers and interplay between culture and various teaching methods (Shirke, 2021). Pedagogy emphasises on the educators’ understanding on how learners learn when they present the subject content to the student. Therefore, pedagogy assist teachers to understand the best teaching approaches used in presenting the subject content to learners so that they benefit (Baker, 2023)

Teaching strategy- refers to a generalized plan for a lesson which includes structure, instructional objectives and an outline of planned tactics, necessary to implement the strategies (Issac, 2010).

Teaching method – refers to the mechanism that is used by the teacher to organize and implement a number of educational means and activities to achieve certain goals (Hoque, 2016).

Teaching approaches- Hoque (2016) defines teaching approach as a “set of principles, beliefs, or ideas about the nature of learning which is translated into the classroom”. In this, pedagogy has been used to refer to the teaching methods and learning activities that teachers adopt as well as approaches and strategies used to accomplish the educational outcomes that each topic seeks to achieve.

1.9 Structure of the dissertation

The study is organised into five chapters, as shown in the diagram.

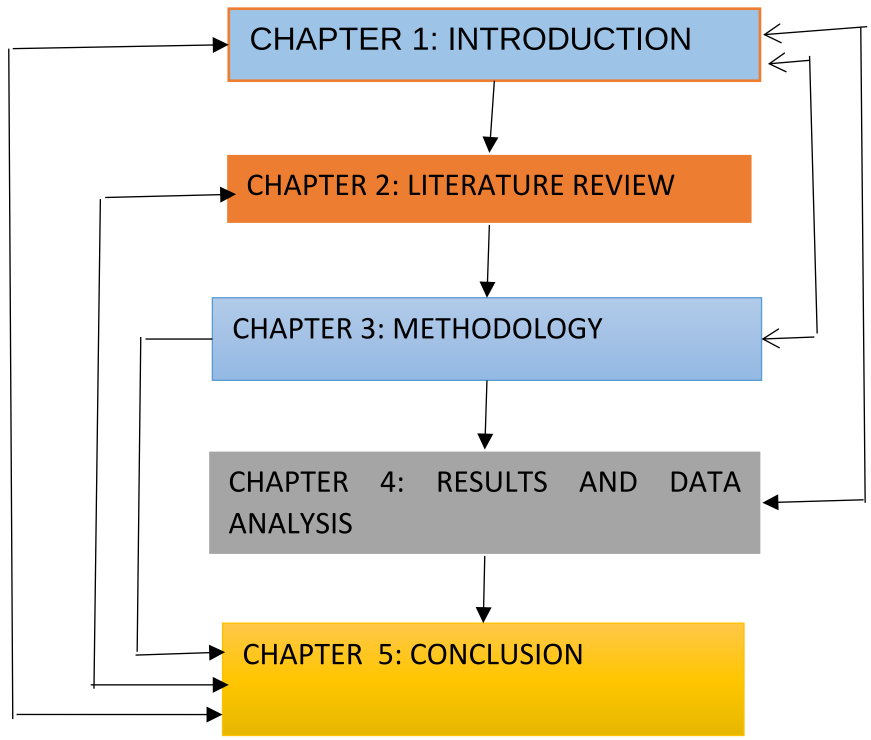


Figure 1.1: The structure of the research study

Chapter 1 presented the background of the problem, problem statement as well as research questions for the study. Chapter 2 looks at scholarly ideas underpinning the study. The research design and methodology needed to conduct the study systemically are described in Chapter 3. Chapter 4 is the empirical part of the study; it looks at data analysis, presentation interpretation and discussion of results. Finally, Chapter 5 provides conclusions, limitations, and recommendations of the study.

1.10 Summary

In this chapter, the problem of the study, on how the subject of Life Sciences is taught in high school, was introduced in the background and described in the problem statement. Furthermore, the aim, research questions, and preliminary literature review were provided to understand the nature of the problem. The chapter proceeds to outline the research design and methodology used for the study. The next chapter is on the important aspect of the study, the literature review.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The study aimed to explore alternative pedagogies for teaching FET Life Sciences. The problem pursued by this study has been described in Chapter 1. The purpose of this chapter is to present a detailed literature review on the teaching and learning of Life Sciences using different pedagogical approaches. It assesses how the use of teaching methods and learning activities could be a contributing factor depriving learners of learning opportunities in Life Sciences. Furthermore, this chapter elucidates the theories and frameworks that underpin the study. The rest of the chapter is organised into respective subsections.

2.2 Literature review

Life Sciences have been presented as a subject that prides itself on facts that learners need to memorise (Berwick, Finkelstein, & Academic Medicine 2010; Titsworth, McKenna, Mazer, & Quinlan 2013; Willingham 2020). This has subsequently led to the full embracement of traditional methods of teaching, such as lecturing and the presentation by teachers, depriving learners of an opportunity to develop critical thinking skills needed in the subject. Bond (2020) and Brown and Crippen (2017) observe that there is always little active learning involved when using traditional methods of teaching sciences because they demotivate learners who subsequently disengage in learning activities. It has become a norm in most high school Science lessons that teachers engage in solving problems, using past examination papers, and performing practical demonstrations while learners just passively sit and listen to teachers or write notes (Ferreira, 2011). Similarly, Nyback (2013) adds that in traditional classes, the steps to be followed in every activity are a priority of the teacher, which serves as a purpose of memorising the scientific facts without giving learners the expected learning experiences, and there is little learning in that regard.

Literature from Motallebzadeh, Kafi and Kazemi (2016) illustrates that those teachers often associate inquiry activities with structured activities underpinned by a traditional approach which entails direct transmission of content from a teacher or textbook to the learners. Highly structured activities have established steps to be followed to arrive at a predetermined answer (Motallebzadeh, Kafi & Kazemi, 2016; Sultan, Asim & Khaskhely, 2019). In this regard, learners will have limited exposure to valuable inquiry skills that will edify their thinking. In addition, structured activities do not allow learners to be independent thinkers since the teacher is the one who explains everything (teacher-centred), including assisting learners on how to answer questions. The traditional approach is regarded as a copy-and-paste method because teachers will rely on the views of others to answer such questions (Sultan, Asim & Khaskhely 2019)**.** The approach is rigid and procedural because it neglects the important aspects of learning, such as prior knowledge, emphasised by the constructivist theory of learning (Esanu & Hatu, 2015). Any teaching approach or practice that ignores learners' knowledge about the content disadvantages them because it treats them as passive recipients of knowledge (Gurvitch, & Lund, 2014; Esanu & Hatu, 2015). The constructivist theory of learning encourages the use of learners' prior knowledge in all learning situations. Therefore, appropriate teaching approaches should acknowledge learners' prior knowledge in various learning situations.

The National Research Council (2011) highlights the existence of a gap in how Science is taught in primary and high schools. At the primary school level, Science teaching is learner-centred because it involves more practical activities, and there is more freedom for investigation (Brough, 2012; National Research Council, 2011). On the contrary, high school science teaching is dominated by the "chalk-and-talk" teaching approach, learning abstract concepts, factual knowledge, and cookbook practical lessons and demonstrations (Kazeni 2012; Brough 2012). The same issues have been raised by Kidman (2012) and Tabulawa (2013), who observed that Science teaching at the high school level involves the transmission of knowledge from expert sources (educators and textbooks) to passive recipients (the learners). Brownell and Tanner (2012) argue that most learners in high school believe that the teaching of Life Sciences lacks a sense of community; is devoid of real-life experiences, as it entails too much mimicking compared to inquiry-based learning; does not provide a good overview of the subject and has little room for learners' engagements in the learning of the content taught.

The literature suggests that the performance of the learners in the Life sciences classroom is linked to the teaching strategy that is used. Hence there is a need to explore different pedagogies that are adequate for teaching Life Sciences (Coil, Wenderoth, Cunningham, & Dirks, 2010; Cleveland, Olimpo, & DeChenne-Peters, 2017; Guzey, Ring-Whalen, Harwell, & Peralta, 2019). It is necessary to look at the effectiveness of traditional teaching methods and learning activities, and other teaching approaches that cater to the acquisition of science inquiry skills, problem-solving and critical thinking as enshrined in the South African curriculum (DoE, 2008).

It is important to note that numerous factors influence the teaching and learning of Life Sciences, and some of these factors are associated with learners, teachers, schools, and families (Andrews, Leonard, Colgrove, & Kalinowski 2011; Farooq, Chaudhry, Shafiq & Berhanu, 2011). These factors entail school climate, teaching and learning support material, availability of well-equipped sciences laboratories, and competent Life Sciences teachers (Berhanu *et al*., 2011).

2.2.1 Teaching and learning of Life Sciences

Several studies discuss effective teaching and learning in general and few in Life Sciences (Abell, Appleton, & Hanuscin, 2007; Abell, 2013; Muijs, & Reynolds, 2017). However, the term teaching and learning is loosely defined, making it difficult to have a standard definition. This is supported by Devlin and Samarawickrema (2010), who posit that there is no consensus meaning of effective teaching and learning in the context of the classroom. Several scholars define effective teaching and learning based on measurable teaching outcomes that involve required academic performance (Devlin, & Samarawickrema, 2010; Gettinger & Kohler, 2013; York, Gibson & Rankin, 2015). Similarly, Calderón, Slavin, & Sanchez (2011) argue that the purpose of effective teaching is to improve learners' outcomes needed for their future ambitions. This implies that teaching is effective when it brings about an improvement in the performance of learners being taught. However, there are limitations to the definition given by Calderon *et al*. (2011). Firstly, it ignores the context in which teaching, and learning occur (Schunk, 2012). Secondly, it has been found that the assessment of learners' performance may not fully reveal the range of the outcomes that might denote desirable knowledge and skills being sought in the education system (Katsiyannis, Counts, Popham & Ryanand, 2018). Lastly, the definition seems to ignore essential factors, such as socioeconomic status or learners' backgrounds, teaching practices, teaching and learning support materials, parental support, competence in the language of teaching and learning, teacher's subject content knowledge, and teachers' Pedagogical Content Knowledge (PCK) (Ferreira 2011**;** Nwuso, 2019). These facets are important in effective teaching and learning and need to be considered. Despite all the aforementioned factors, learners' academic performance may be used to measure the effectiveness of a teaching method (Stronge, Ward & Grant, 2011; Komarraju, Karau, Schmeck, & Avdic, 2011).

From a constructivist perspective, effective teaching is a learner-centred approach teachers use in a learner-friendly environment with deliberate learner assessment strategies for enhancing teaching and learning (Nwuso 2019**;** Vygotsky 1978). This definition of effective teaching is relevant to the study as it advocates for a learner-centred approach and emphasises the role of the teacher as a facilitator of teaching and learning as opposed to an instructor in a teacher-centred approach. For teaching and learning to be effective, Beard and Wilson (2006) suggest practices that teachers can use, namely:

i. The promotion of collaborative work where learners work in groups to complete given tasks in the class.
ii. Integration of multiple teaching and learning support materials for fruitful learning in addition to textbooks.
iii. Creation of opportunities where learners pose questions while others give detailed explanations to their respective answers.
iv. Demonstration and explanation, underpinned by a sound Pedagogical Content Knowledge

v. Timely use of local languages and code-switching during lessons.
vi. Thorough planning of lessons that are adaptable based on learners' academic needs.

Equally, Hackling and Prain (2005) listed five characteristics of effective teaching and learning of Life Sciences:

i. Curriculum that is relevant to learners' experiences and interests.
ii. Classroom science is linked with the broader community.
iii. Learners actively engage with inquiry in which ideas and evidence are challenged to develop and extend meaningful conceptual understandings.
iv. The assessment facilitates learning and focuses on outcomes that contribute to scientific literacy.
v. Information and communication technologies are exploited to enhance the learning of science.

As effective teachers cater meaningful learning experiences, it is crucial to also zoom in on the features of effective teachers. In this regard, the Centre for High Impact Philanthropy (2010) claims that effective teachers:

i. Positively influence student learning and development through a combination of content mastery, command of a variety of pedagogical skills, and communications or interpersonal skills.
ii. Become life-long learners in their subject areas, show dedication, and reflect on their teaching practice.
iii. Are very fervent about teaching and providing meaningful learning experiences through good communication, assessment skills, and sound understanding of cultural differences; knowledge about their learners and their learning styles.
iv. Have the ability to use a range of teaching approaches to accommodate different learning styles.
v. Have high expectations of their learners and facilitate learning using a range of pedagogical approaches and available resources inside and outside the classroom.

2.2.2 Learning Styles in Life Sciences

Although Life Sciences have different teaching approaches, the efficacy of each approach depends on understanding diverse learning styles as well as adapting to the context of the classroom (Chen, Hsieh, Jang, & Hwang, 2011). Furthermore, Naqvi and Naqvi (2017) point out that an approach that is consistent with the preferred learning style of a student results in better academic performance and the development of a positive attitude towards learning the discipline. Equally, if the teaching approach does not suit learning styles in the classroom, it could result in learners withdrawing from participating in the lesson and consequently resulting in a drop in academic performance (Aragon & Johnson, 2004). Creating awareness of learning styles is important since learners can identify their academic strengths and weakness, which can improve their self-confidence and develop effective collaborative skills (Bidabadi, Isfahani, Rouhollahi & Khalilib, 2016).

There are different ways of defining learning styles, but the convergence in the definitions points to how individuals make meaning of new information (Searson & Dunn, 2001; Cassidy, 2004). According to Searson and Dunn (2001), learning style can be defined as an individual's habitual and preferred way of absorbing, assimilating, processing, and retaining new information and skills. Naqvi and Naqvi (2017) point out that learning styles are cognitive characteristics and psychological behaviours related to how individuals learn. Abante, Almendral, Manansala, and Mañibo (2014) define learning style as a preferred way a learner adopts to make sense of the information received. While these definitions point out the learning styles, it must be noted that learners may not fit rigidly into a specific learning style, and teachers may adopt different approaches to learning to include different learning styles (Moate & Cox, 2015).

2.3 Teaching approaches

Teaching approaches are techniques that an instructor uses to assist learners in achieving learning outcomes (Cattell, 2012; Moss-Racusin, van der Toorn, Dovidio, Brescoll, Graham & Handelsman, 2016)**.** Teaching approaches are adapted differently based on their effectiveness in achieving the desired results (Moore, 2014; Osher, Kidron, Brackett, Dymnicki, Jones, & Weissberg, 2016)**.** For example, an instructor might choose a teaching approach for a specific lesson to achieve learning outcomes and, most importantly, learners' needs. The use of different teaching approaches is primarily influenced by the educational philosophy teachers subscribe to (Wiesen, 2022). Educational philosophy indicates how learners can learn new concepts and which teaching approach a teacher should engage their learners to ensure interaction in the classroom (Wiesen, 2022).

In the context of the Life Sciences curriculum, the teaching approach refers to actions intended by a teacher to engage with a situation or problem (De Jager, 2001). For example, a teaching approach would be when a teacher takes action to unpack and clarify Life Sciences concepts by using understandable language. In this way, the teacher improves learners' understanding, and their performance may also improve (De Jager, 2001; Mathew, Mathew, & Peechattu, 2017). Teaching approaches come in the form of lesson plans, lesson introductions, lesson activities given to learners, and assessment strategies during lesson presentations. Some factors that influence lesson presentation in Life Sciences classrooms, and these are the lesson context, experience of a teacher regarding the subject, facilitation during teaching, development of teaching aids for the lesson, and environmental awareness (Nasser & Mansourm, 2013; Akerson, Pongsanon, Park, Rogers, Carter & Galindo, 2017).

According to the Department of Education (2000), teaching pedagogies employed by science teachers in the classroom should enable learners to become life-long learners. However, de Jager (2001) states that most pedagogies are contrary to the aims of CAPS regarding Life Sciences. Some pedagogies do not allow learners to develop process skills using inquiry methods. Kuhn (2010) adds that the current teaching and learning of Life Sciences are largely expository.

It is important to note that many teaching approaches can be used in Life Sciences (Orlich, Harder, Callahan, Trevisan, & Brown, 2012). However, the following teaching approaches were chosen and reviewed for the study. They are a context-based approach that branches to relational, cooperative, and transmission approaches, facilitating teaching approach, executive teaching approach, experiential approach, and environmental awareness teaching approach. The following literature review is linked to teaching approaches used by Life Sciences teachers.

2.3.1 Context-based teaching approach

Context can be explained in many ways. It can be described in terms of practice, topics, problems, and situations (Kazeni & Onwu, 2013; Holbrook, 2014). Taconis and den Brok (2016) describe context as a situation that scaffolds learners to make meaning to the concepts and practices. Context-based teaching is an approach adopted in teaching and learning Life Sciences (Bennett, Lubben & Hogarth, 2007). According to Kazeni and Onwu (2013), this approach refers to the context in which Science is applied as the starting point for developing scientific ideas.

Context-based teaching involves consideration of the situation or environment where teaching will take place (Clarke & Braun, 2013). The lesson is planned to fit the context in which it will be presented. The teacher links the prior knowledge to new content, enables learners to be active participants by taking the initiative, and transfers knowledge while introducing the lesson. The context-based teaching approach has been used in teaching Life Sciences because it connects the subject to everyday life (Kazeni & Onwu, 2013). Several studies indicate that the use of a context-based teaching approach yields positive results since it is relevant to learners, their families, and peers, thus increasing the motivation for learning (Bennett, Lubben & Hogarth, 2007; Milner, 2010; Hou, 2015). Furthermore, the context-based teaching approach emphasises the context and applications as the starting point for the development of ideas to improve teaching (Bennet *et al*., 2007). These authors conclude that context-based teaching approaches ignite learners' curiosity in learning Life Sciences and help them to link it with their daily experiences. However, this cannot be used as an absolute fact since some learners lose interest in Life Sciences due to contextual factors (Atilla, 2012; National Academies of Sciences, Engineering & Medicine, 2018). English is one of the contextual factors learners face in the science classroom (National Academies of Sciences, Engineering, and Medicine, 2018). For example, in primary schools, most science concepts are taught in vernacular, making it difficult for learners to understand some of the concepts in high school. According to Majozi (2013), five context-based teaching approaches enable the teacher to link previous knowledge with new knowledge, but only three are relevant to this study. These approaches are relating, cooperating, and transmission approaches.

2.3.1.1 Relational teaching

The relational teaching approach involves teachers assisting learners in linking new concepts with previous knowledge (Satriani, Emilia & Gunawan, 2012). This approach has been used in teaching and learning Life Sciences because it strengthens the learner's prior knowledge and enhances the learning of new knowledge (concepts) (Kang, 2008). Therefore, learners show interest and participate in a lesson when they are familiar with the content using prior knowledge (Kang, 2008). Farmery (2002) argues that relational teaching is used mostly when a teacher introduces a lesson in the whole class teaching method. The whole-class presentation of a lesson requires a teacher with good expository skills to explain concepts in different ways so that learners may understand what is taught (Smagorinsky, Cook, Moore, Jackson & Fry, 2004).

2.3.1.2 Cooperative teaching

The cooperative contextual approach involves teachers organising learners in groups or pairs so that they work together and assist one another (Sharan, Sharan, & Tan, 2013). Learners are given group activities so that they may help and learn from each other. For example, best-performing learners can be mixed with average-performing learners, and they can also be grouped by age, friendship, and interests. Satriani, Emilia, and Gunawan (2012) acknowledge that the activity may be difficult when individual learners are given a problem-solving exercise related to realistic situations. However, when they work in groups, it becomes easy.

For this approach, the teacher should be equipped to form effective groups, assign appropriate tasks, give necessary direction to keep all groups active and be observant during activities. Reigeluth and Carr-Chellman (2009) are of the view that action teaching is linked to group learning which happens under work-based instruction. This implies that the teacher gives learners instructions on a particular item of work to be completed in their groups. Group lessons have been used since adopting new education policies in South Africa post-1994 (Kanjee and Sayed 2013). Zakaria and Iksan (2007) record the successful use of the cooperative approach in Life Sciences. The approach allows learners to be effective in any activity, thus promoting social interdependency. Grouping learners in Life Sciences activities help them to be active participants in the lesson, and therefore a learner-centred lesson is achieved.

2.3.1.3 Transmission teaching approach

Another context-based approach is transmission, which involves using knowledge in a new context, especially the content that has not been covered in class before (Crawford, 2001, 2007). Many studies report on the transmission teaching approach (Prosser, & Trigwell, 2014; Wong, 2014; Godino, Batanero, Cañadas & Contreras, 2015). This is a traditional method that is widely used by Life Sciences teachers to unpack new concepts (Wood 2009; Trigwell 2012; Carless, 2022). It has been documented in other studies that the transmission teaching approach requires a skilled teacher who can introduce novel ideas that motivate learners by invoking curiosity or emotions (Robinson, Neergaard, Tanggaard & Krueger, 2016.). This teaching method is expository. Expository teaching suggests that knowledge is obtained from an authoritative source, which may be a teacher, worksheet, or textbook (Smith, Ochoa-Angrino & Orleans 2011). Authoritative teaching, which is teacher-centred in nature, gives the impression to the learners that Life Sciences is based on authority (Koopman, 2017; Albayrak & Ateskan, 2022).

2.3.2 Experiential Teaching Approach

The experiential teaching approach has been widely used in the teaching of Life Sciences (Auchincloss *et al.*, 2014). This approach involves the use of previous experiences and new experiences by a teacher to allow learners to experience the natural environment, especially in Life Sciences (Bowles & Gintis, 2011). Learners should be active participants with the help of a teacher since Life Sciences is one of the practical subjects. Experiential teaching allows learners to be out of the classroom set up to explore and experience the natural environment (Behrendt, Franklin, 2014).

2.3.3 Facilitative Teaching Approach

A facilitative teaching approach involves encouraging learners to take charge of their learning process (Kahn, & O’Rourke, 2005). The teacher, as a facilitator, provides resources and necessary support to the learners. This subsequently encourages learners to learn from each other by identifying and implementing a solution to the problem (Gillies & Boyle, 2010). The facilitative approach is used in Life Sciences in the form of group work, where learners are supervised by a teacher for a given task (Carvalho, Conboy, Fonseca, Santos, Gama, & Salema, 2015). It can also come in discussions on topics such as food security, organ donations, and many more.

According to Fenstermacher, Soltis, and Sanger (2015), the facilitative approach helps learners to grow personally and reach self-actualisation. A facilitative approach makes learners deduce meaning through interacting with other learners and the environment they live (Gillies & Boyle, 2010). Facilitation requires a teacher to arrange learners in groups and allow them to ask questions and request clarity on certain concepts while the teacher moves around and provides assistance. Thus, this approach is learner-centred. Gibbs, Habeshaw, and Yorke (2000) compare the facilitator to the teacher as follows: a teacher talks and lectures in front while a facilitator supports from the back; a teacher provides answers as stipulated in the curriculum while a facilitator guides towards correct answers; a teacher would mostly give a monologue, while a facilitator would engage learners in a dialogue. Most importantly, a facilitator creates an environment for learners to conclude independently. The NSC (DoE, 2005) states that teachers should adopt the facilitation teaching approach because it is learner-centred and consequently improves learner performance.

2.3.4 Executive Approach

In this approach, a teacher is a manager and a developer of curriculum materials and teaching methods and learning activities such as pair work and group work (Fenstermacher & Soltis, 2004). The curriculum informs all teaching materials that a teacher uses. Using different materials by a teacher in a Life Sciences classroom assists learners in using their senses. In rural areas, where resources are limited, teachers become executive teachers because they must develop resources for Life Sciences lessons and thus improving understanding and interest in science lessons in learners. According to Fenstermacher, Soltis, and Sanger (2015), the use of resources by a teacher enhances learners' results. However, I argue that this is not the case; other teaching and learning factors result in good academic performance. For example, other teaching approaches are integrated with the executive approach as well as learners' attitudes toward Life Sciences as a subject (Bautista, & Romiro, 2012; Rehmat & Bailey, 2014).

Therefore, the teacher must instil motivation in learners so they may change their attitude that Life Sciences is abstract.

2.3.5 Environmental Awareness Teaching Approach

The environmental awareness teaching approach involves using the natural environment for teaching by giving activities that allow learners to interact with the environment and makes them aware of the importance of the environment during the lesson (Marcinkowski, 2009). Learners can regulate their behaviour concerning their environment once they become aware of environmental issues. Bartosh (2003) states that the environmental teaching approach should be integrated into Life Sciences with other teaching approaches for maximum instructional effectiveness. Marcinkowski (2009) concludes that teachers who use only lecture-discussion approaches in teaching and learning cannot become effective environmental educators. According to Bartosh (2003), a wide range of Life Sciences skills, such as investigation and communication skills, can be gained through the environmental awareness approach. Loubser (2005) states that there should be a good curriculum that addresses environmental issues. This involves the teaching context, where learners should be made aware of environmental issues that affect them daily, e.g., sources of air pollution such as coal burning and factories.

Littledyke (2008) concludes that environmental teaching approaches will enable learners to value their environment and become responsible adults. This is likely to establish a positive attitude towards environmental science; consequently, learners will improve their academic performance.

2.4 The role of ICTs in enhancing the teaching and learning of Life Sciences

Despite the presence of different teaching approaches, the use of ICTs (Information communications and Technologies) in teaching and learning cannot be ignored. As a subject, Life Sciences depends on many technologies that promote teaching and learning, and ICTs are one of them. Amaewhule and Blessing (2021) adopted Ebijuwa and Anyakoha's (2005) definition of ICT, which, according to them, means “tools and as well as means used for collection, capture, process, storage, transmission, and dissemination of information.”

There is a plethora of literate reviews on the use of ICTs in Life Sciences (Castaño, & Webster, 2011; Reed, 2014; Bhattacharjee & Deb, 2016; Kalogiannakis, Ampartzaki, Papadakis & Skaraki, 2018). The use of ICT in Life Sciences can be used to enhance these teaching approaches for effective teaching and learning (Barak, 2017). A study by Simon and Ngolo (2018) reports the success of using ICTs in teaching Life Sciences in Namibia. Another study by Juggenatr and Govender (2020) examines the perceptions and barriers to teachers' use of ICTs in teaching sciences. These studies report positive attitudes and indications of teachers' preparedness to use ICTs gainfully in the teaching and learning of Life Sciences. "The use of ICTs in teaching and learning is based on the notion that it will empower teachers and learners, transform teaching and learning processes from teacher dominated to learner-centred, thereby increasing the performance of the learners" (Trucano, 2005). Similar studies, though few, have been conducted in South Africa (Khalo,2020; Simon, 2014; Draper, 2010; Malope, 2021) report mixed findings about the impact of ICTs in Life Sciences. However, these studies report little on how ICTs aid learning among rural learners. Therefore, this study considers ICTs as they affect teaching and learning approaches and merit attention.

ICTs can be classified in various ways, but in this study, they are classified as devices and applications. Devices are all tangible, such as desktop computers, mobile devices (tablets, smartphones, cell phones, data projectors, etc.), and Smart TVs. All applications are not tangible; however, without applications, the devices are not useful. Applications can be programs that make devices useful. In this study, the focus will be on educational applications which are accessible to learners on desktop computers, laptops, mobile devices, Smart TVs, and mp4. Learning management applications or systems include Google Classroom and video conferences, such as Microsoft Teams or Zoom.

2.4.1 Learning management systems (LMS)

A learning management system is a software platform for teachers to take charge of courses online, enabling them to give their learners one location for course content (Kulshrestha, & Kant, 2013). This software entails a document management component and a communication part. An LMS allows teachers to work beyond classroom boundaries (Sicat & Ed,2015; Rapanta, Botturi, Goodyear, Guàrdia & Koole, 2020). Teachers can upload assignments, calendars, grade books, videos, learning materials, etc. In addition, a teacher can track the learner’s involvement in each task (Sicat & Ed, 2015). An LMS allows a teacher to create chat rooms as a platform for communication between students and a teacher. The cheapest LMS in education generally is Google Classroom and Moodle (Prasetya, 2021). These platforms can be downloaded for free and come as features when one downloads software.

The most used LMS platform is Google Classroom (Kumar, Bervell & Osman, 2020). Google Classroom is a collection of online tools that enable teachers to set assignments, have work submitted by learners, and grade and communicate feedback on graded papers (Kumar, Bervell & Osman, 2020). This platform has proven to be the most effective and efficient tool in the education sector as it allows teachers to eliminate paperwork in classrooms and make digital learning possible (Dhawan, 2020). LMS in teaching and learning Life Sciences can help improve academic performance because it promotes social constructivism and social interaction (Barak, 2017; Ouadoud, Nejjari, Chkouri & El-Kadiri, 2018). These applications can assist in teaching and learning Life Sciences through demonstrations and simulations.

Demonstrations in ICTs

Demonstration in ICTs can be done through online platforms such as Khan Academy and YouTube. Demonstrations in Life Sciences play a critical role in enhancing the teaching and learning of Life Sciences (Brame, 2016). A study by Yousef and Chatti (2014) reports a great academic improvement when demonstrations are integrated into the teaching of Life Sciences. Platforms such as Khan Academy can greatly benefit teaching Life Sciences through demonstrations because it allows students to watch a video more than once to gain more understanding. Furthermore, students can watch as a group to gain a better understanding of the phenomenon studied and assist each other. For example, an experiment on testing for starch in a leaf as an indication that photosynthesis has taken place can be difficult for many students (Atkinson & Delamont, 2017). However, if learners are given videos of the same experiment, their understanding can be improved (Brame, 2016).

Simulations

Simulation refers to the imitation of organisms' behaviour and structure to better understand the phenomena being studied (Soylu, 2016). Scientists use a vast range of simulation techniques, such as Monte Carlo simulations, agent-based modelling, cellular automata, artificial neural networks, etc., in Life Sciences (Bokulich & Oreskes, 2017). These techniques help us to understand the world of science better and predict what might happen in the future in the context of science (Bokulich & Oreskes, 2017). Simulations involve the use of different software programs in the ICTs industry (El Kadiri, Grabot, Thoben, Hribernik, Emmanouilidis, Von Cieminski, & Kiritsis, 2016). Life Sciences can now use simulations when conducting practical aspects of a topic such as Human gaseous exchange, Human respiratory system, and many more (Makransky, Thisgaard & Gadegaard, 2016). According to Smetana and Bell (2012), the use of simulations in teaching and learning Life Sciences can be more effective than traditional ways of teaching and learning in the promotion of science content knowledge, developing process skills, and facilitating conceptual change. Simulations, for example, can give a clear idea of what a kidney entails inside through computer dissection instead of practical dissection (Adams, Qiu & Mark, 2017). This, in turn, will enhance the learning process of the topic. In addition, understanding studies about DNA as a molecular for life can be simplified by using simulations to better understand molecular processes (Huggins, Biggin, Dämgen, Essex, Harris, Henchman, Khalid, Kuzmanic, Laughton, Michel & Mulholland, 2019). Furthermore, simulations are good for safety, especially when some learners are allergic or scared of certain organisms (Anderson, 2019).

Advantages of using ICTs in Life Sciences

- **They promote constructivism**

  ICTs enable teachers to apply theories of learning that put learners at the centre of learning and incorporate real-life situations into the lesson (Barak, 2006; Engel, Esser & Bleckwenn, 2019). In addition, ICTs assist learners in acquiring scientific literacy skills through social constructivism (Engel, Esser, & Bleckwenn, 2019).

- **Social interactions between learners and teachers**

ICTs allow learners to constantly communicate with each other through platforms such as WhatsApp, YouTube, Google Classrooms and many more (Prasetya, 2021). Equally, a teacher can also engage learners in the same platforms, and thus social interaction is reinforced. Furthermore, learners and teachers can participate in any social platform with different learners in different places to engage and exchange ideas that will improve their academic performance (Sicat & Ed, 2015).

- **A teacher can track learners' progress.**

  ICTS allows teachers to work outside classroom boundaries. For example, a teacher can upload assignments and track learner involvement in each task.

- **They are safe for learners who are allergic to some species (simulation).**

  ICTs allow learners to work with species that can be scary. Therefore, using techniques such as simulations can be safe for all learners and learning through visuals can improve their understanding of scientific concepts and processes in the phenomenon being studied (Bokulich & Oreskes, 2017).

- **ICTs stimulate learners' interest and thus increase creative thinking.**

  Studies by Barak (2017) suggest that ICTs strongly impact the scientific knowledge level of learners because they encourage critical thinking, resulting in improved creativity and innovation among learners. Furthermore, ICTs enhance scientific inquiry and investigation (Barak 2017).

2.4.2 WhatsApp as a learning tool

Since mobile apps became popular, WhatsApp has been a leading application that learners use to communicate amongst themselves as well as with teachers since it is readily available (Sonia & Rawekar, 2017). WhatsApp is a free messenger application that can be installed across multiple platforms, smart devices, or desktops (Lu & Churchill, 2014). It uses multimedia messages such as audio, text messages, videos, and photos. One of the main advantages of this app is that it can be easily installed on many mobile devices with different operating systems, such as android and iPhone.

WhatsApp has been a useful tool that enhances teaching pedagogies (Waleed & Al Abikya, 2021). In Life Sciences, WhatsApp has been used to communicate between learners and teachers. Its features, such as group chats, allow learners to engage with the teacher and amongst themselves beyond classroom confines, therefore, improving their academic performance (Hertzog & Swart, 2018; Wijaya, 2018; Afful & Akrong, 2020). The ability of WhatsApp to foster social interaction amongst learners is in line with Vygotsky's constructivist learning theory (Budianto, Langgeng & Yudhi, Arifani, 2021). For example, as a Life Sciences teacher, the researcher uses WhatsApp to give tasks to learners, send videos that enhance teaching and learning, additional notes that need to be studied and PowerPoint slides for a lesson of that day. This way, a teacher can use time effectively and allow learners to take charge of their academic progress and share ideas (Wargadinata, Maimunah, Eva & Rofiq, 2020). In addition, teachers can track how many learners have received the communique, limiting the chances of learners being irresponsible.

Despite the learning opportunities that this application presents, its use has some limitations. Firstly, learners must own a smart device supported by either android or iPhone systems (Bailey & Lee 2020). Some learners cannot afford these devices as they are from less fortunate backgrounds (Di Pietro, Biagi, Costa, Karpiński & Mazza, 2020). Lack of connectivity due to insufficient internet data has broken communication lines between teachers and learners because some learners can only access information when they are next to the school Wi-Fi. Some of the files and videos take up a lot of space, which creates a problem for learners and as a result, they cannot access some of the information posted via WhatsApp.

Issues with using ICTs

1. There is a lack of expertise, to some extent, among teachers, which makes it difficult to expect learners to gel in without the assistance of teachers.
2. Some schools do not have sufficient ICT equipment, such as devices and connectivity. In some instances, connecting ICTs is time-consuming, thus delaying teaching and learning. In addition, many learners do not have internet access at home, making it difficult for them to continue their schoolwork outside school hours.

3. There is a lack of accountability among learners as some use their devices for social media while in the classroom. In some cases, it is difficult for teachers to leave ICT tools in the classrooms unsupervised because they might be stolen or damaged by the learners.

However, the study will explore how ICTs can improve the teaching and learning of Life Sciences.

2.5 Pedagogical Content Knowledge and Practice

According to Nowso (2019), pedagogy is a complex process that involves teachers' beliefs and practices that results in the measurable impact of teachers' pedagogical practices. In essence, teachers' educational beliefs influence all that can be observable in the classroom during teaching and learning. Factors such as teacher beliefs, teachers' past schooling experiences, learning theories, and current curriculum and assessment policy influence the pedagogical practices of teachers (Priestley, Edwards, Priestley & Miller, 2012). Therefore, teachers' actions during teaching and learning reflect their pedagogical beliefs, which also impact their teaching methods and learning activities. The researcher takes to cognisant that there are many definitions of pedagogical beliefs, but constructivist belief has been adopted for the study.

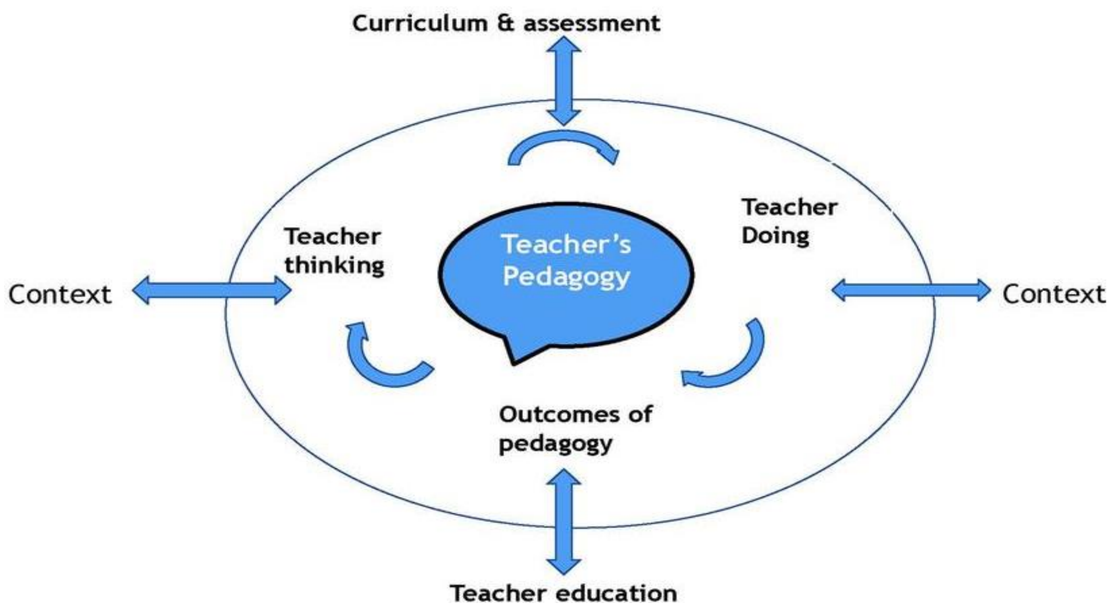


Figure 2.1: A model on enabling and constraining factors in effecting pedagogical change

(Adapted from Westbrook 2013:16)

2.5.1 Teachers' pedagogy

Teachers' pedagogy refers to approaches or strategies teachers use to implement their planned lessons (Borko, Jacobs & Koellner, 2010). This is largely influenced by the learning theories that guide a particular topic in a subject (Vermunt & Endedijk, 2011). The influence of learning theories on teachers' pedagogy can be evident in how teacher implement their preferred approaches (Starkey, 2010). This is executed within the context of what is being taught. For example, a teacher can use the environmental awareness approach (teacher doing) for topics such as the human impact on the environment to raise awareness on how human activities can be detrimental to the ecosystem. This will influence teachers' thinking on how humans should ensure that they limit the negative impact on the environment and impart that knowledge to the learners.

2.5.2 Outcomes of pedagogy

The effectiveness of Teachers' pedagogy can be measured by its outcomes (Hakim, 2015). Furthermore, the outcomes would mean the achievement of goals that were set for a lesson for a certain approach. The outcomes can be measured through assessments and learners' ability to work on the same topic with little assistance from the teacher (Margot & Kettler, 2019). The outcomes of pedagogy are intertwined with teacher education and thus depend on each other (Van Driel, 2021). Teacher education involves skills, policies, procedures, and provisions attained in institutions of higher education to equip teachers with knowledge, attitudes, behaviours, and approaches that are needed for effective teaching and learning in the classroom and beyond (Schonert-Reichl, Kitil & Hanson-Peterson, 2017). These attributes from teacher education are essential for the outcomes of pedagogy to be achieved.

2.5.3 Curriculum and assessments

Curriculum can be defined as sequential standards of planned experiences aimed at achieving academic proficiency among learners through applied learning skills (Hume & Coll, 2010). A curriculum can be addressed through different teaching pedagogies that enable learners to be engaged in logical thinking that expands their cognitive horizons to understand the subject matter (Crawford & Capps, 2016). Assessment refers to a systematic judgment used to measure the amount of learning in the context of teaching and learning (Zhang, Zeller, Griffith, Metcalf, Williams, Shea & Misulis, 2011). Black and Wiliam (2018) elucidate that curriculum and assessment are important components of pedagogy. Therefore, they are inseparable and instrumental to learning. The teachers' pedagogy is shaped largely by the curriculum (Parks & Bridges-Rhoads, 2012). For example, a curriculum includes objectives, methods, materials, and assessments that must be adopted for effective teaching and learning. This suggests that for any approach to be implemented, a curriculum serves as a guideline and assessments as a barometer to check the effectiveness of teachers' pedagogy.

2.5.4 Context of teachers' pedagogy

Teachers' pedagogy can be influenced by the social context and beliefs in their work environment (Kangas, Siklander, Randolph & Ruokamo, 2017). Teaching context can be explained as the social setting embraced in the Life Sciences classroom due to experiences, socio-cultural practices beliefs that learners have adopted because of coming from a certain cultural group (Mavuru & Ramnarain, 2018). Teachers must understand learners' diverse social-cultural backgrounds to find a way of managing these differences in the context of teaching and learning (Brown-Jeffy, & Cooper, 2011). Therefore, this knowledge shapes teachers' pedagogy so that teaching takes place within a specific context.

Garbett (2011) emphasises that there is a need for competence and understanding of the complex relationship between learners' prior knowledge, Science content and pedagogical content knowledge (PCK) for teaching and learning of Life Sciences to depend less on knowledge transmission. Shulman (1987) proposed that for teaching and learning to be effective, the teacher must possess the following knowledge:

i. Pedagogical knowledge (PK),
ii. Content knowledge (CK),
iii. Pedagogical content knowledge (PCK),
iv. Curricular knowledge,
v. Knowledge of educational contexts, and
vi. Knowledge of purposes of education.

Shulman (1987) states that a teacher must demonstrate knowledge of their subject matter so that others can learn from this knowledge with understanding. Ma'rufi, Budayasa, and Juniati (2017) define pedagogical content knowledge (PCK) as the blending of content knowledge and pedagogy for a better understanding of how concepts of subject matter are crafted and adapted to provide meaningful learning experiences. PCK is an integration of CK and PK. Shulman (1986) proposes three aspects of PCK that are crucial for effective teaching and learning:

i. Knowledge of learning difficulties learners may encounter while learning a particular topic,
ii. Knowledge of conceptions and/or misconceptions learners may bring to the classrooms about a particular topic, and
iii. Knowledge of teaching strategies appropriate for a teaching situation.

PCK is embedded in the belief that teaching and learning go beyond delivering content knowledge in a classroom setup, and that which has been learned can be absorbed for later accurate regurgitation by learners (Loughran, Berry, & Mulhall, 2012). In line with the statement, Buck, Cook, and Carter (2016) state that PCK for Life Sciences involves an understanding of its content and inquiry process, knowledge of learners and how they conceptualise what they learn, and teaching approaches that promote active inquiry and conceptual development. Teachers develop PCK from teaching experiences in the classroom as they engage students in a teaching and learning context (Kind, 2009). Some teachers have been exposed to traditional teaching, which influences their pedagogical approach when teaching various topics in the classroom.

According to Venville and Dawson (2010), for teaching and learning to be meaningful, Life Sciences must be taught in the forms that learners understand. However, this can only be achieved if the teacher's PCK is sound (Loughran *et al*., 2012). Westbrook (2013) concurs with Venville and Dawson (2010) that sound PCK is effective in appropriate teaching methods and learning activities to ensure that learners understand Life Sciences concepts. In addition, teachers with sound PCK can adapt a wide range of teaching approaches according to the needs of the learners, create a conducive learning environment, and use intriguing learning activities that improve learner achievement.

On the other hand, Life Sciences teachers with inadequate Science PCK use ineffective teaching approaches and struggle to explain certain concepts for learners to understand. In this view, it is a necessity that teachers develop sound PCK that is also aligned with teaching approaches that create a meaningful learning experience in Life Sciences.

With the introduction of ICTs in the teaching and learning space, Mishra (2000) expanded on Shulman's knowledge domains to include Technological Knowledge; hence the concept of Technological Pedagogical Content Knowledge (TPACK) was introduced.

2.6 Technological pedagogical content

TPACK has been introduced in the education fraternity to better understand the teachers' knowledge content and pedagogy for effective use of technology for teaching and learning (Sheffield, Dobozy, Gibson, Mullaney & Campbell, 2015; Padmavathi, 2017). TPACK is founded on the core of Shulman's idea of PCK with an integration of technology as another knowledge domain (Padmavathi, 2017). Therefore, for the development of sound teaching practices, knowledge about content (C), pedagogy (P), and technology (T) should be linked (Padmavathi, 2017). Studies have suggested that these concepts should not be treated as separate bodies of knowledge but rather be integrated to form technological pedagogical content knowledge (Mishra & Koehler, 2006; Koehler, Mishra, & Cain, 2013; Jang & Chen, 2010). TPACK refers to the knowledge that a teacher needs to incorporate technology in specific content areas (Jang & Chen, 2010). Niess (2011) describes TPACK as the incorporation of subject matter knowledge with technology to improve teaching and learning. Understanding the interaction between content knowledge components and pedagogical knowledge should enable teachers to use technologies to teach subject content effectively (Mishra & Koehler, 2008). Rocha, Mota and Coutinho (2011) posit that the concept of TPACK serves as the cornerstone of successful teaching and learning using technology. Therefore, teachers are encouraged to take full advantage of technology to facilitate the achievement of learning outcomes among learners (Sheffield, Dobozy, Gibson, Mullaney & Campbell, 2015).

According to Mishra and Koehler (2006), TPACK is a generalised construct which can be viewed in three major areas of research, namely:

- The implication of TPACK for teachers' professional development.
- ·The implications of TPACK for developing instructional strategies for effective teaching-learning.
- ·Studying the changes in teachers' TPACK capabilities over time.

However, the study focuses on pedagogical approaches; thus, TPACK for developing instructional strategies for effective teaching and learning is a focal point.

Studies from Laxim and Gure (2016) report the successful use of the TPACK model in teaching Life Sciences. In addition, research findings by Petra, Jaidin, Perera, and Linn (2016) indicate an improved understanding of the inquiry processes and Life Sciences concepts on photosynthesis when ICTs were integrated into the lesson**.** The findings highlight that TPACK positively impacts the teaching and learning of Life Sciences. However, one of its main disadvantages is that of being teacher-centred, with little interaction among learners, thus depriving learners of an opportunity to learn from one another (Murty & Rao, 2019). Currently, there are studies on how ICTs can increase the teaching and learning of various school subjects in South Africa using different theories of e-learning, a concept beyond the scope of this study.

2.7. Theoretical Framework

The theoretical framework looks at theories such as constructivism that underpin the study. It also explains the link between these theories and the study. Furthermore, it digs into the literature that exists on these theories about the study. Finally, the educational theory plays a significant role in building a plan that guides teaching and learning (Zhang, et al. 2011).

2.7.1 Constructivism

Constructivism is an epistemological and psychological theory that deals with how people learn using their past knowledge to negotiate the meaning of new information (Splitter, 2009). Constructivism views learning as building on internal cognitive structures, which are schemas consisting of information and the process of how this information is acquired (Pritchard & Woollard 2013). As new information is acquired through experiences, this information modifies, adds to, or changes the previous schema (Rumelhart & Norman, 1976; McLeod, 2007).

Since South African education is multicultural, there is a need to move to an approach that will include themes, activities, and outcomes accommodating learners' daily experiences and activities or examples that encourage learners to be actively involved in the learning process (Mvududu, 2005). This relates to social constructivism, which allows teachers to use knowledge through social, cultural, and political processes. The Department of Education (2005) stipulates three learning outcomes that learners should achieve in Life Sciences: scientific inquiry and problem-solving skills, construction, and application of Life Sciences knowledge. The achievement of these outcomes lies with the application of social constructivist theory due to its emphasis on the importance of integrating inquiry-based and problem-solving teaching methods and learning activities using scenarios and examples familiar to learners' social backgrounds to explain phenomena (Wallace & Kang, 2004).

The constructivism theory describes learning as an active process where learners construct new ideas or concepts based on their current or previous knowledge (Booi, 2017). Pritchard and Woollard (2013) classify constructivism based on four main principles:

1. Learning is influenced by what individuals already know.
2. New ideas are adapted from modification or change of old ideas.
3. Learning develops ideas rather than the accumulation of facts.
4. Previous experiences enhance meaningful learning.

The authors further state that the constructive theory model sees constructivism as a spiral with the students at the centre of learning. Wirth and Perkins (2008) state that as new experiences are linked with prior knowledge, deeper knowledge can be applied in different contexts. Since prior knowledge is a focal point for learning, teachers need to identify and correct the existing misconceptions at the beginning of each lesson. Constructivism encourages learner-centred pedagogy, which involves learners actively participating in the teaching and learning process rather than passively receiving information (Splitter, 2009).

2.7.2 Social Constructivism

McLeod (2007) posits that learning is regarded as a social process that is facilitated through social interactions and communication, which results in cognitive development.

Vygotsky (1978) came up with the idea of social constructivism, while Piaget (1972) founded the idea of constructivism (Nyback, 2013). Hmelo-Silver and Eberbach (2012) concluded that in social constructivism, learning is constructed in a social context and involves individuals engaging in problems in a social environment, while constructivism advocates that learning is constructed within the individual and involves prior knowledge. A study conducted by Taneri (2010) indicates that the Life Sciences curriculum is guided by constructivism, but the main issue is how each teacher interprets it.

Social constructivism is supported by the Zone of Proximal Development (ZPD) concept, which is a phase of activity where learners are assisted by a teacher or more knowledgeable peers to fulfil activities they cannot accomplish alone (Vygotsky, 1978). Students cannot learn anything difficult for them to understand since that will not be in their zone of proximal development. Therefore, a shift in a zone of proximal development needs to occur so that a learner can attain his or her potential and then proceed to challenge problems. The ZPD concept assists teachers in identifying learners' strengths and weaknesses so that they can adapt their teaching to a meaningful learning experience guided by learners' needs through various forms of scaffolding interventions. Furthermore, the application of ZPD enables teachers to mediate and provide instruction and feedback that enhances cognitive development, creating a learning environment that is valuable to learners (Fani & Ghaemi 2011).

Studies from Baviskar, Hartle, and Whitney (2009) and Pande and Bharathi (2020) reveal an improvement in learners' performance when teachers use constructivist teaching approaches in their teaching. Constructivist teaching approaches include inquiry-based teaching approach, context-based teaching approach, environmental awareness teaching approach, facilitative teaching approach, integrative approach, Dialogical Argumentation Instructional Model teaching approach and reflective approach. The lessons must challenge learners' suppositions; for example, a teacher would introduce a lesson with what learners already know (context-based teaching approach). A teacher who uses a constructivist approach to teaching and learning Life Sciences would also structure his or her lessons around big ideas. For example, allowing learners to interact with their environment (environmental awareness teaching approach). In constructivist-based teaching approaches, teachers must show their ability to impart content knowledge in many ways by giving activities that enable the active engagement of learners during the lessons. The teacher, as a facilitator and a mediator between content knowledge and learners, will then guide learners as he or she moves around the classroom to address any question that might arise and check whether learners understand the activity and give guidance (scaffolding) where learners are struggling with understanding the activity that is done in the classroom. Constructivism employs scaffolding as a mechanism to assist learners in doing a task they would not do in their capacity until they can finish it independently (Villanueva, Taylor, Therrien & Hand 2012). Scaffolding is temporary; when a learner reaches a stage when he or she can be independent, a teacher would gradually withdraw from scaffolding (Villanueva, Taylor, Therrien & Hand 2012).

According to the social constructivist teaching approach, teachers must be facilitators during teaching and learning to help learners understand the content (Fenstermacher, Soltis & Sanger, 2015). Colburn (2000) argues that Life Sciences teachers should craft investigations that encourage learners to reveal what they think when conducting laboratory investigations. Constructivist teaching approaches encourage learners to probe questions on any work. In this regard, teachers can assist learners in using discovery-based learning opportunities by providing primary skills needed for their learning.

2.7.3 Critique of the literature

The literature reviewed indicate the potential of alternative pedagogies in the teaching of Life Sciences. However, there are challenges that teachers may have to overcome to implement some of the suggested solutions due to flaws in the pedagogies. For example, the TPACK has been found to be effective for teachers and limited for learners (Olofson, Swallow, & Neumann, 2016). This means that educators need to use TPACK and other alternative pedagogies with much consideration as to benefit learners. Literature has also shown that no single pedagogy is enough by its own and the need to integrate with others. This is also emphasized in the theoretical frameworks of constructivism which alludes to the creativity of teachers in the use of resources to allow learners to construct knowledge which becomes a permanent feature of learning. It is also important to note that contextual learning is very important as beliefs and worldviews of learner will always interfere with what educators seek to achieve by using the given set of pedagogies. Therefore, the study approaches this phenomenon with much neutrality with the intention to understand which alternative pedagogies could be suitable for gainful learning of grade 11 learners in Life Sciences.

The theoretical foundation underpinning this study is social constructivism, which encourages educators to teach learners in such a way that they are to relate the knew knowledge to its application. They should use approaches such as scaffolding to assist learners to gain new skills as well as constructing new knowledge (Vygotsky, 1978). Instead of focusing on cognitive development, as suggested by Bloom, the needs have changed and now demand new forms of knowledge and skills to solve the existing problems. Undoubtedly, the use of pedagogies that utilise technology and other new innovations are emphasized. By using social constructivism, this study seeks to foster on the mastery of relevant skills while giving learners an opportunity to realise their capabilities in knowledge construction. Because of this, the study explores alternative pedagogies that will develop collaborative skills needed to solve real life problems. Life Sciences can be taught meaningfully if teachers were to use alternative pedagogies which allow learners to be the masters of their own learning.

2.8 Conclusion

This chapter reviewed the literature regarding diverse teaching approaches that can be employed in the Life Sciences classroom and the social constructivist theory that underpins this study. Five teaching approaches were identified in the literature, and these approaches include the context-based teaching approach, experiential teaching approach, facilitative teaching approach, executive teaching approach, and environmental teaching approach. In addition, concepts such as Pedagogy, PCK, CK and TPACK were discussed as they form bases for all forms of teaching approaches in Life Sciences.

A theoretical framework that guides the interpretation of the study is constructivist theory. The constructivist theory links with some of the teaching approaches that can be used by teachers in Life Sciences. Constructivism theory and social constructivism have been described in the chapter.

From the literature reviewed, there is a need to explore different pedagogies that a teacher can employ when teaching grade 11 FET Life Sciences since there is evidence that the performance, attitudes, and interests of the learners in the Life Sciences classroom are linked to teaching approaches and other contextual factors.

There is a necessity to compare the effectiveness of traditional teaching (teacher-centred) and other teaching approaches which involve the acquisition of science inquiry skills, problem-solving and critical thinking which are stipulated in the South African curriculum. The next chapter outlines the research design and methodology used for the study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The previous chapter presented detailed literature and a theoretical foundation for the study to explore alternative pedagogies for teaching FET Life Sciences. This chapter describes and justifies the methodological perspective chosen together with research methods used in data collection and analysis to achieve objectives. It also gives a detailed explanation of how each method has been incorporated into the study to ensure that the aims and objectives are achieved. Furthermore, the participatory action research (PAR) methods, observations and document analysis used in collecting data are described in detail. The arrangement of the chapter is as follows.

3.2 Research methodology process

This study adopted the research methodology process adapted from the Research Onion by Saunders (2008), shown in Figure 3.1. Each component of the research process is articulated in the subsequent subsections.

Figure 3.1 Research process followed in the study

Adapted from Research Onion by Saunders (2008)

3.2.1 Interpretivism Research Paradigm

The problem addressed in this study required the use of qualitative data about the participants' actions, behaviour, assessment tools and learners' written work that the researcher was to interpret qualitatively and subjectively. This led to the choice of interpretivism. Interpretivism is a knowledge production theory that is exploratory and is suitable for seeking different views, perceptions, and experiences of participants (Shah & Al-Bargi, 2013). Since learners are adapted to a variety of teaching approaches, their responses to any approach may be different (Clarke & Braun, 2013). In this regard, understanding and interpreting different response to these approaches demands research to have depth knowledge of interpretivism theory (Pham, 2018).

The Interpretivism paradigm uses a qualitative data collection method, which involves the use of qualitative research instruments, data presentation, and analysis (De Villiers, 2005). The rationale behind adopting this paradigm was to find out more about which teaching strategies can be effective in adequately teaching Life Sciences in the FET band. Using various data collection methods enabled the researcher to collect and interpret data to formulate answers to the main research sub-questions. For example, being a participant observer enabled the researcher to interpret how learners responded to each lesson in the classroom and how this has linked to the CAPS Life Sciences document in the approach of each lesson. Scotland (2012) alludes that interpretivism as a paradigm is characterised by a concern for the individual (learner). This validates the need for a researcher to be involved in the process of collecting data to experience how learners respond to each teaching approach to make meaning of what is taught.

3.2.2 Qualitative Research Design

Research design refers to the strategy used in research to address the research problem chronologically (Khan, 2014). According to Creswell and Creswell (2003), a good research design must address these questions in research: what needs to be researched, and how can it be researched? It is necessary to adopt a relevant method(s) in the research study to answer a question that has prompted research (Ritchie & Lewis, 2006; Ormston, Spencer, Barnard & Snape, 2014). Furthermore, research design is vital in ensuring that data collection and analysis align with methods. This will subsequently strengthen the reliability of the research and its findings (Schumacher & McMillan, 2006). The study has adopted a qualitative research design using the Participatory Action Research approach (PAR) since the research involves a teacher imparting knowledge and learners as receivers and interpreters of knowledge in the Life Sciences classroom.

3.2.3 Inductive Qualitative approach

Research approaches used in the research fraternity are inductive and deductive approaches. An inductive approach is a set of procedures that study one phenomenon to observe certain patterns and subsequently draw a conclusion-informed general set of propositions about that phenomenon (Rowlands, 2005). A deductive approach is an approach that a researcher adopts when looking at what other researchers have done by studying existing research theories of a phenomenon to test the hypothesis that emerges from relevant theories for a phenomenon (Varpio, Paradis, Uijtdehaage & Young, 2020).

The study has adopted an inductive qualitative approach. The inductive approach aims to understand the meaning in more complex data by developing emerging themes from the raw data (Thomas, 2003; Liu, 2016). The rationale behind choosing this approach is that this study explores a teaching approach that can be used in teaching Life Sciences. Exploration is associated with studying a phenomenon by observing certain trends for comparisons and drawing conclusions that can formulate a new theory in general (Pedaste, Mäeots, Siiman, De Jong, Van Riesen, Kamp, Manoli, Zacharia & Tsourlidaki, 2015). The study does not seek to test a hypothesis but seeks to find new meaning in the phenomenon that is studied through observation and emerging trends. This approach is qualitative and subjective since it is underpinned by specific theories and pedagogical beliefs (Johnston, 2014).

According to De Villiers (2005), qualitative research is a naturalistic, interpretive science involving methods, such as case studies, interviews, observation, and textual analysis, which provide insights into cultural aspects, organisational practices, and human interactions. Mogashoa (2014), on the other hand, explains qualitative research as human actions taking place within a structure of social rules wherein they have meaning. In the context of this study, the structure of social rules would refer to a Life Sciences classroom where teaching takes place. McMillan and Schumacher (2006) state that qualitative methods enable a researcher to get a detailed description of the situation, events, attitudes, and thoughts of the participants. This idea by McMillan and Schumacher (2006) can be supported by Creswell and Creswell (2017). They state that qualitative research gathers descriptive and explanatory data for a deep understanding of the phenomenon being studied through learning and engagement from the participants in real-life situations. By using an inductive approach, the researcher will be able to get insight by employing different teaching approaches to answer the research questions. Observations are key in the collection of data in qualitative research (Opie, 2004; Ciesielska, Boström & Öhlander, 2018.). Opie (2004) further stressed that qualitative research is more concerned with the process rather than the product. For example, in his research Opie (2004) explored how people use data collection to make sense of their practices and emphasise interpreting patterns and identifying themes that emerge from data instead of numbers (quantity).

Qualitative data is collected in a social setting and relies on personal contact and collaboration between the researcher and participants. Thus, a qualitative research study can be a process that empowers participants since their views can be expressed freely. Antwi and Hamza (2015) posit that qualitative research is inductive and focuses on a deeper understanding of the research in its context. The qualitative research methodology for the study was adopted based on a study conducted by Livari (2018), who asserts that this methodology enables the researcher to use interpretivism to have a clear understanding of the study through participation and analysis.

3.2.4 Participatory Action Research Strategy

For one to gain a deeper insight into contextual structuredness of meaning and different social actions, one must employ a Participatory Action Research (PAR) approach in their study (Sutton-Brown2014; Liebenberg, 2018). PAR is underpinned by research methodology and research methods which are two different concepts (Liebenberg, 2018). Kivunja and Kuyini (2017) define methodology as an academic model used within the context of a particular paradigm to conduct research. On the other hand, Elshafie (2013) views methodology as a philosophical tool employed in making decisions on methods of systematic inquiry. Contrary to this, a research method involves specific techniques and tools necessary to collect and analyse data.

Participatory action research is an applied research methodology used in collaboration with participants as a tool to yield a desired social change (Silverman & Patterson, 2014; Chevalier & Buckles, 2019). This research approach was introduced in the 1940s by a social psychologist, Kurt Lewin, to address social change in the body of knowledge through actions (Cole, Purao, Rossi & Sein, 2005). His main objective was to incorporate an approach involving participants as an alternative way to find facts as opposed to surveys and statistical approaches used in many research fields to generate facts. (Somekh & Zeichner, 2009).

In its nature, PAR creates opportunities to use findings and reflection to effect change in the body of knowledge. (Ebersohn, Ferreira & Beukes, 2012). PAR has two important aspects of research, the quest to generate academic knowledge and to act to bring change (Somekh & Zeichner, 2009). The Participatory Action Research (PAR) approach was used to collect the data. Moffitt and Vollman (2004) and MacDonald (2012) define PAR as an approach to research that includes persons being studied in any research that affects them. It allows the researcher and participants to deviate cognitively from familiar learning routines and forms of interaction to question and rethink situations and strategies that are already established (Reitan & Gibson, 2012). In addition, PAR allows the researcher to be involved as a facilitator, committed participant and learner in the research process (MacDonald, 2012). Participants are not passive in PAR but actively engaged in finding information and ideas that will be helpful for future actions (Chevalier & Buckles, 2019). This approach played a pivotal role as it provided the researcher with an opportunity to work with learners and understand which teaching approaches are effective when teaching Life Sciences. Furthermore, as a reflexive practitioner, the researcher reflected on his experiences while conducting the study.

3.2.4.1 Features of Action Research Methodology

Action research as a methodology involves practitioners who are involved in the research. The posture taken by these practitioners has influenced the researcher to select the partcipatory research, as they would narrate what transpired in the context of the study (Mahani & Molki, 2012; McNiff, 2013). Three focal points of action research are highlighted by Noffke (1997), which include personal, professional, and political dimensions. These three focal points have a different focus on Participatory action research. Personal dimensions would focus on understanding one's practice in the context of participants, while tyhe professional aspect would look at knowledge production to benefit teachers. Political dimensions would delve into the action that can be affected to bring change in the context of equity and democracy (Noffke,1997).

For this study, the research focuses on professional and personal dimensions while taking into cognisance that the political dimension has, to some extent, an influence on these foci. On the professional dimension, the study will add value to the body of knowledge as it would give an insight into how Life Sciences can be effectively taught using different approaches in conjunction with the aims and objectives stipulated in the Life Sciences CAPS document. A personal dimension would also create a platform for the researcher to reflect on the experience gained as a participant-observer and suggest effective ways to approach Life Sciences topics for effective learning.

In nature, action research is cyclical and enables the researcher to reflect on what has been done to effect decisions for further process (Chevalier & Buckles, 2019). The important stages of action research include planning, taking action and reflection (Ebersohn et al. 2012). In the context of this research, the action was taken after the research was informed by findings in the research and was used to reflect on different pedagogical approaches that can be used in teaching Life Sciences. Furthermore, the reflection was based on philosophical analyses as well as the researcher's reflection on what transpired during the study.

3.2.4.2 The relevance of participatory action research study

The research problem of the study highlights that teaching and learning of Life Sciences are not consistent with what CAPS documents require since the traditional approach is used in most schools. PAR as an approach was intended to allow the researcher to explore different approaches that encourage learner-centred teaching. Vangraan (2018) emphasises that this research method allows researchers to apply it to its local context. Educators must acknowledge the relevance of PAR as it gives a clear perspective of what needs to be done to improve teaching and learning in the life sciences classroom (Vieira & Tenreiro-Vieira, 2016). In addition, PAR could affect teachers in a way that will cause them to reconsider their approaches and make necessary changes to improve learner performance (Kemmis, McTaggart & Nixon, 2014). The latter would involve reflection from the side of a teacher and effect a change to improve academic performance, which is linked to the participatory action research process.

3.2.5 Research Timeline

Two types of research studies can assist a researcher in collecting data for a certain period, and these are cross-sectional and longitudinal research. Olsen and George (2004) define cross-sectional research as a study that collects data as a whole to study the population through observations at one identified point in time so that the relationship between two variables can be examined. A longitudinal study is also an observational study; however, a researcher collects data from one sample repetitively over a long period of time (Carlson, Sroufe & Egeland, 2004; Donche & Van Petegem, 2009). This study is cross-sectional. The cross-sectional was chosen because it is not expensive, and the researcher has the advantage of observing and taking note of changes in his participants' characteristics (Setia, 2016). Vogt, Gardner, and Haeffele (2012) echo the same sentiment as Setia (2016), that cross-sectional studies can be conducted within a short space of time, and fewer expenses are attached to them. Furthermore, the researcher is at a Masters' level and has limited skills to conduct longitudinal study. Furthermore, longitudinal studies require funding since there are costs attached to them, and they take time to finish (White & Arzi, 2005).

3.2.6 Data collection

In this section, the following is explained in depth. The site, population, participants, instruments, and methods for data collection.

3.2.6.1 Study Site

The research was conducted in a high school in the Cape Winelands Education District, Boland region, at Circuit 5 in the Western Cape. The school is a Mathematics and Science school and falls under quintile 1 (a no-fee under-resourced school). The school is situated at Mbekweni, an area that comprises of lower and middle classes in terms of income. Most people survive on seasonal jobs such as grape and apple harvesting. In essence, the economic background of many learners is not stable. The school was conveniently selected because the researcher taught there, and this was an opportunity to contribute to improving academic performance by exploring a variety of teaching approaches that can be used in the teaching and learning of life Sciences. This research will also assist other Science teachers in looking at alternative approaches that can be employed to enhance teaching and learning at the school.

Population

In any research study, the description and justification of the population, the sample and its size, and the methods and process of selecting the sample are important phenomena that should be accounted for (Onwuegbuzie & Collins, 2007). In addition, target populations must be identified to clarify the study's actual participants (McMillan & Schumacher, 2010). Wellman, DiFranza, Savageau, Godiwala, Friedman, and Hazelton (2005) describe the population as a total collection of analyses at the disposal of a researcher to draw specific conclusions. This study used three populations, schools, learners and teaching approaches.

Population and sampling of schools

The population for this study consisted of 7 schools in the West Coast cluster from which one school was selected. All these schools in the cluster offer Life Sciences in Grades 10 to 12 using either English or Afrikaans as a medium of instruction. A sample is a group of subjects or participants from whom the data is collected (McMillan & Schumacher, 2006). The purposive sampling technique was used to select one school where the researcher was teaching to enable Participatory Action research without disruption. A study by MacDonald (2012) states that PAR allows the researcher to be involved as a facilitator, committed participant and learner in the research process. Furthermore, by using the school of practice, the researcher was not going to be an intruder, and learners were familiar with the researcher.

Population and sampling of learners

There were 178 Grade 11 learners taking Life Sciences at the sampled school. The researcher purposively chose 43 learners who are in his Life Sciences class. According to McMillan and Schumacher (2006), purposive sampling allows the researcher to choose small or large groups likely to have knowledge and information about the subject of interest. Furthermore, learners were selected for convenience since the researcher teaches them.

The rationale for using a small sample size stemmed from the fact that the study was not a survey which would normally require a large sample size. In addition, the researcher does not want to make broader generalisations which are required in large samples.

Characteristics of learners

The 43 learners are all African, and their home language is IsiXhosa. Most of them come from a location next to the school that predominantly has Xhosa-speaking people. These learners come from low-income homes where some parents work on the nearest farms that harvest grapes and apples. The class is made up of mixed abilities. Some learners are capable of learning very quickly, while others take time to understand some of the concepts taught.

Population of teaching approaches

Many teaching approaches can be used in Life Sciences (Veselinovska, Gudeva & Djokic, 2011; Clarke & Braun, 2013). However, the teacher could not apply all but sampled a few to use in the study. The population of teaching approaches chosen for the study includes Context-based teaching that can be subdivided into relational, transmission and cooperative; facilitative approach; environmental awareness approach; and online learning. These approaches have been explained in Chapter 2, Literature Review.

3.2.6.2 Data collection methods

The data was collected qualitatively through participant observations, document analysis and assessments. These various methods provided the research with rich data for analysis and enabled the researcher to see which teaching approach was effective for teaching and learning FET Life Sciences topics in the school curriculum.

Participant Observation

A study by Brophy (2006) suggests that using observational methods enables the researcher to collect essential information about the phenomena while the study is in progress in the natural classroom setting. According to Cohen, Morrison, and Manion (2017), there is more to observation than just looking. Cohen *et al*. (2017) allude to this by stating that observations offer an opportunity for a researcher to gather live data from a naturally occurring situation, which is the presentation of a lesson in the classroom or any educational setup. Participant observation involves a coordinated noting and recording of behaviour and events in the social setting using thorough and comprehensive field notes (Takyi, 2015; Mwangi & Bettencourt, 2017). Takyi (2015) further states that participant observation is an innovative qualitative research method that is a rich source of data collection and is mostly used in PAR. Participant observation allows the researcher to research subjects in a social situation and captures the context of the social setting in which individuals function by recording human behaviour subjectively and objectively (MacDonald, 2012). This enabled the researcher to be part of the learning process observed through hearing, seeing, and experiencing the reality of the social situation with the participants. Therefore, the researcher, as a participant-observer, did not only observe Life Sciences activities unfolding but also engaged in activities to get a deeper insight into which teaching approach works best and in which setting.

In PAR, observation plays an important role in the collection of information necessary for that particular study (Vangraan, 2018). Two forms of observation can be used in a PAR study, namely, structured and unstructured observations (Somekh & Lewin, 2011).

Structured observations

The structured observation involves scheduling all expectations of the lesson in accordance with the study (Brophy, 2006; Somekh & Lewin, 2011). This observation guides a researcher to focus on certain aspects of lessons relating to the study. Furthermore, in the situation whereby more than one sample is observed, it applies comparisons. However, a structured observation can limit the findings because it is objective, thus leading to missing out on some unanticipated observations that can be valuable (Lindorff & Sammons, 2018). Furthermore, it does not assist in giving knowledge that might give rise to a new theory of knowledge (Bollig & Buttkus, 2020).

Unstructured observations

Unstructured observations are non-systematic observations used in research to study a certain phenomenon without using pre-determined categories. Urquhart (2015) posits that unstructured observations are good for exploratory studies; hence it was chosen for this study. Unstructured observations allow a researcher to freely observe and record whatever he or she thinks is useful for the study (Urquhart, 2015; Fusch, Fusch & Ness, 2017). This is an advantage because it allows a researcher to discover new concepts; subsequently, new learning theories may develop to advance knowledge in a restricted way (Fusch, Fusch & Ness, 2017). Furthermore, unstructured observations assist in understanding a phenomenon in a more subjective way, which has qualitative research features (Lope & Whitehead, 2013). However, a researcher notes that unstructured observations are difficult as the observer may miss out on some important aspects, thus requiring a great deal of observational skill (Cohen, Manion & Morrison, 2017). In essence, unstructured observations demand a researcher to take notes during the lesson (Somekh & Lewin, 2011). In this study, unstructured observation during lesson time was employed by taking notes on how learners responded to each teaching approach. This was also done to check whether the approach correlated with the expectation of the CAPS document on that topic.

In this study, the observations were made during the teaching of lessons, and marking of scripts. Observation involved looking at the learner's participation during group work, individual work and questions asked by a teacher. Observations were made on how the pedagogies influenced learners' interaction and their participation during the lesson and when completing the class activities. The observation also extended to written work. The researcher checked how learners responded to different questions for tasks given after the use of different pedagogies. During each observation, the teacher would write down every notable behaviour in relation to the pedagogy employed in that particular lesson.

Document analysis

Document analysis, in simple terms, can be defined as a way of reviewing and evaluating documents. Corbin and Strauss (2008) argue that a researcher can only make meaning through document analysis when examining and interpreting the document to gain understanding and desired knowledge. There are a variety of documents that can be used in any study, but this study focused on principles guiding the CAPS document on what needs to be taught in Life Sciences and how it should be taught.

The primary reason for adopting the CAPS document as a tool of analysis is to evaluate how the requirements of each section of Life Sciences are met in terms of teaching approaches. One of the advantages of analysing documents is that the credibility of the research finding is more likely to be enhanced since they will be guided by what the document expects in each topic of Life Sciences (Botha, 2015). In addition, documents are stable; therefore, the researcher does not adjust what is being studied (Merriam, 1988). Finally, documents have the advantage of being subject to repeated reviews. In essence, the advantages of document analysis involve tracking change and development and can verify findings from other sources (Owen, 2014). It can also supplement data, thus adding to the body of knowledge (Owen, 2014).

In summary, the advantages of document analysis include the provision of data on the context within which the teacher participants operate; it can suggest some questions to be asked or situations to be studied; it can provide supplementary data, thus adding to the knowledge base; it is a means of tracking change and development; it can verify findings or corroborate evidence from other sources (Li 2016).

The Life Sciences CAPS document was used as a guideline for achieving a learner-centred approach to teaching and learning Life Sciences. The document was analysed in the context of literature and educational theories adopted by the study. This enabled the researcher to critically zoom in on important aspects to consider when teaching Life Sciences using a certain approach. Furthermore, the CAPS document gave the researcher an insight into how each lesson must be planned for different teaching approaches like argumentation, practical work (inquiry-based learning), traditional approaches, and data management exercises to encourage learners to use a synthesis of data, evaluation of data and other learner-centred approaches. For example, the CAPS document stipulates how practical work should be conducted in Life Sciences. Engaging this document enabled the researcher to plan his practical lesson based on CAPS requirements. Skills such as handling apparatus, recording, observation, and interpretation of data were prerequisites in the completion of a practical task that was given to the learners.

Assessments

Assessment, in the school context, refers to a range of tools that a teacher employs to evaluate the learning progress and skills acquisition and educational needs of learners (DBE, 2011). The assessments are integral in informing the teachers about the learners' level of understanding of the concepts taught. Assessments play an integral role in the teaching and learning process. They play a crucial role in how teachers teach, how learners learn and the motivation behind teaching and learning (Dudu & Samuel, 2017). In the school context, assessment refers to a variety of approaches or strategies that teachers can use to measure, document, and evaluate learning progress, acquisition of skills as well as academic gaps and educational needs of learners (National Research Council, 2001; Ananiadoui & Claro, 2009). In essence, the assessments aim to inform the teacher about learners' level of understanding of the concepts taught in the classroom. The main purpose of assessments is for teachers to do self-introspection about their teaching style as learning patterns from learners are informed by teaching approaches employed by the teacher and by the outcomes of learning in the whole process (Dudu & Samuel, 2017). Assessments played a major role in this study because they gave the researcher a clear indication of which teaching approach worked the best based on the results. These assessments involved formal and informal assessments such as practical demonstrations, practical exams, formal exams, classwork, practical laboratory work, and group work.

3.2.7 Data Analysis

According to Creswell (2013), data analysis consists of the following features:

- Preparing and organising the data,
- Representing the data in figures, tables or discussions, and
- Reducing the data into themes.

The data were collected through participant observation, document analysis and learner assessments. The data obtained from these sources of evidence was then analysed through the development of themes. The study adopted an inductive thematic approach, where the themes were developed as the analysis continued. All data collected were analysed within the framework of the qualitative research methods. Discussion and interpretation of themes from participant observation, assessments and document analysis were informed by literature that was provided within the context of the research questions of the study. Bowen (2009) suggests that data collected through document analysis can be analysed by integrating and organising views and trends in the patterns. The main document that was analysed was the CAPS Life Sciences document. The results from assessments enabled and researcher to develop themes that were in conjunction with what was observed during the lesson time, and this gave a clear understanding that learners' response in any lesson is purely based on the approach employed.

3.4 Trustworthiness

Tuli (2011) emphasise the importance of ensuring that one's research is reliable and trusted. This can only be achieved by using credible and authentic methodology that will ensure that there is no bias in the research. For the trustworthiness of the study, credibility, dependability, transferability, confirmability, and triangulation are adopted. Onwuegbuzie and Combs (2010) describe Triangulation as a tool for using a variety of data sources within research to gain a better understanding of a phenomenon that is studied.

A triangulation of participant observation, assessments and document analysis was employed in the study to ensure the credibility and transferability of the research findings. According to Schumacher and McMillan (2006), triangulation strengthens data collected through qualitative methods. Schumacher and McMillan (2006) further assert that triangulation increases confidence in research data since it involves multiple sources to enhance the robustness of findings. These different methods of data collection enhanced the validation of research and captured different views of the subject investigated. Furthermore, using these data sources helped to identify contradictions and weaknesses of data produced by each source of evidence, thus enhancing the trustworthiness of the research. In essence, triangulation assisted in analysing differences and similarities found among data collected and added credibility through a convergence of evidence attained.

3.4.1 Credibility

The validity of research methodology in qualitative research is described using terms such as quality, rigour, credibility, and trustworthiness (Anney, 2014; Hadi & José Closs, 2016; Ghafouri & Ofoghi, 2016). Koo and Li (2016) describe credibility as the extent to which the actual meanings of the research participants have been represented. Choy (2014) posits that the strength of a qualitative study that intends to explore a problem relies on its credibility. For example, the credibility of research findings in this study depends on methodological decision-making coupled with participants' exact input in the study. Research credibility is guaranteed when parameters of the study such as settings, population and theoretical framework are explained thoroughly (Anney, 2014; Moon, Brewer, Januchowski-Hartley, Adams & Blackman, 2016). The aspects of research design such as research focus, the context, participant selection, and data collection influence how the research questions can be answered and subsequently increase the research credibility (Elo, Kääriäinen, Kanste, Pölkki, Utriainen & Kyngäs, 2014).

For the credibility of this research:

- Multiple data sources (triangulation) such as participatory observations, document analysis and assessment have been used (Renz, Carrington & Badger, 2018).
- Sharing the research process and findings with participants and the supervisor (who adds perspective on data analysis and interpretations) has been followed (Khan, 2014).
- Communicating findings with participants to ensure that findings reflect their experiences (Khan, 2014).
- Preconceived ideas about the subject being researched have been avoided, but the focus was on data collected in the study (Gray, 2021).
- In the event that the researcher provided an alternative explanation, justification was provided (Conway & Lance, 2010).

3.4.2 Dependability

Dependability refers to the consistency of findings over a period of time (Anney, 2014; Mohajan, 2017). It looks at how participants' evaluation of findings, interpretations and recommendations correlate with data received from the informants of the study (Sullivan, 2011). For consistency to be achieved, the research process adopted by the study should be in line with the accepted standards of a particular research design (Venkatesh, Brown & Bala, 2013). There are strategies involved in ensuring dependability in the research. This involves replication, peer examination, and code-recode (Mohajan, 2017). However, it is difficult to replicate the results. Hence there is a need to emphasise the transparency of the research and justifications of research methods and data collection methods chosen (Jacobs, Büthe, Arjona, Arriola, Bellin, Bennett, Björkman, Bleich, Elkins, Fairfield & Gaikwad, 2021). For the dependability of the study, systematic data collection through document analysis and assessment policies from CAPS was gathered. Peer examination as means of dependability was also involved, where a colleague and supervisors checked whether anything might be out of the framework of the study. A code-recode strategy for data processing was used to verify the data interpretation.

3.4.3 Transferability

Transferability refers to the extent to which the qualitative research results can be transferred to other contexts or settings with other respondents (Anney, 2014; Mohajan, 2017; Kyngäs, Kääriäinen & Elo, 2020). Research transferability is enhanced by a thorough description of the context and assumptions central to the study (Nyirenda, Kumar, Theobald, Sarker, Simwinga, Kumwenda, Johnson, Hatzold, Corbett, Sibanda & Taegtmeyer, 2020). Therefore, the researcher has to facilitate the transferability judgement through thick descriptions and purposeful sampling (Mohajan, 2017). However, this depends on the sensibility of data transfer (Trochim, 2006; Farrelly, 2013). The study uses document analysis for transferability to get an insight into how the findings are related to other studies.

3.4.4 ConfIrmability

Confirmability refers to the extent the results obtained from the study can confirm or validated by other researchers (Trochim, 2006; Anney, 2014; Mohajan, 2017). Confirmability seeks to establish that data and interpretation of findings are not altered by the researcher but derived from the data. (Yin, 2003; Anney, 2014). Studies from Anney (2014) and Bowen (2009) and Li (2004) suggest that audit trial, reflexive journal, and triangulation are central to achieving confirmability of the scientific research, but this study will adopt reflexive journal and triangulation. Reflexive journal involves reflexive documents that a researcher uses to reflect on, interpret thoroughly and plan the data collection (Koch, 2006). In the context of this research, the researcher will adopt this method and use document analysis (CAPS) to achieve confirmability in the study. This method will ensure that there is no distortion in the study. Furthermore, triangulation as a form of multiple evidence such as assessments, participatory observation and document analysis will strengthen the confirmability of the study (McMillan, 2006). Moreover, participants will access all data collected to confirm its credibility. Lastly, the researcher will avail data collected to supervisors and other interested parties to ensure confirmability (Golafshani, 2003).

3.5 Ethical considerations

According to Sikes (2004), research ethics deals with the application of moral principles to avoid harming and affecting other people's lives in the process of doing research. For the ethical requirements of the study, the researcher applied for ethical clearance from the Cape Peninsula University of Technology to facilitate the collection of data that could not have commenced without ethical clearance. Furthermore, the researcher obtained written permission from the Western Cape Education Department to conduct research at the school with Grade 11 learners taking Life Sciences. The researcher liaised with the principal of the school through a formal letter sent via email to request permission to conduct his research. Consent from learners and parents for learners to participate in the study was drafted. The purpose of the study was explained, and the choice to decline to participate was also given to the participants. The names and responses of the participants were kept anonymous to guarantee their confidentiality. Pseudonyms were used to conceal the identity of participants. Learners were informed about voluntary participation in the study, especially in the data collection stage, where they could withdraw whenever they felt so.

3.6 Conclusion

In this chapter, the research methodology employed during the study was discussed. The rationale behind using a qualitative research approach and interpretivist research paradigm was also explained. The link between this study and the PAR method was clarified. The data was collected through a triangulation of multiple methods such as participant observation, assessments, and document analysis to ensure that results were not based on one source and, subsequently, to ensure there were no biases in the study. The significance of ethical considerations was explained in the study to ensure that every step is within the jurisdiction of CPUT and WCED guidelines for ethics. The following chapter will discuss the findings in-depth.

CHAPTER 4: PRESENTATION OF RESULTS ANALYSIS AND INTERPRETATION

4.1. Introduction

In the previous chapter, the research design and methodology and the data collection methods were discussed in depth. The main aim of the research was to explore alternative pedagogical approaches that can be used to teach FET Life Sciences. The study sought to answer a critical question: What alternative teaching approaches can be employed for effective teaching of the FET school Life Sciences curriculum?

Sub-questions

1. What are the possible strategies that can be used for adequate teaching of selected FET school Life Sciences topics?
2. How effective is each strategy in imparting school Life Sciences topics selected from the CAPS curriculum?

This chapter presents results collected through participant observation, document analysis and assessments in the study in a quest to answer the research questions. The results are then analysed in the context of a theoretical framework and paradigms underpinning the study. The data obtained from these sources of evidence was then analysed through the development of themes. According to Van Graan (2020), themes help to identify the important concepts in line with the study and can also provide meaningful interpretation of the results.

The following is the outline of the chapter:

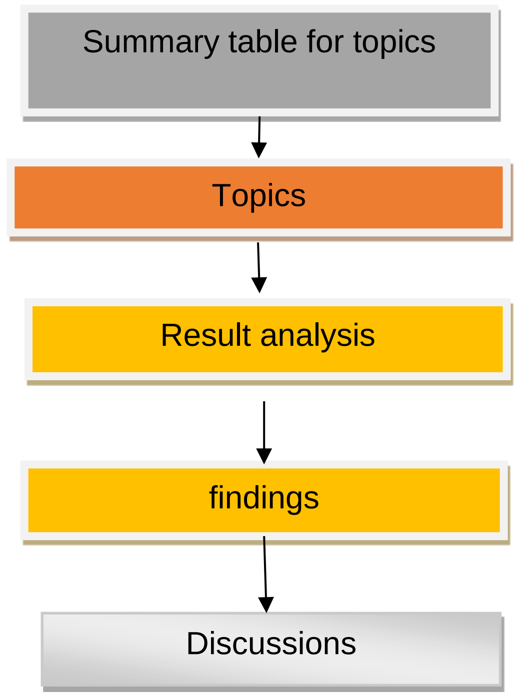


Figure 4.1 Chapter outline of the study.

Table 4.1 shows a list of topics, specific aims, sub-aims, time allocated, teaching approaches and assessments used to get an insight into the alternative pedagogies for teaching FET Life Sciences. A detailed account of each topic and its accessories is provided in subsequent sub-sections.

4.2. Presentation and Interpretation of Data

This section gives a narration of the six topics used to collect data that sought to answer the research questions. Furthermore, each topic has its findings, followed by a discussion of the results. The overview of the topics is given in Figure 4.1.

Table 4.1: Overview of topics and teaching approaches employed in conjunction with Life Sciences Specific Aims and assessment conducted

TOPIC	SPECIFIC AIMS AND SUB AIMS	DURATION (IN WEEKS)	TEACHING APPROACHES	ASSESSMENT CONDUCTED
Biodiversity and classification of microorganisms (Fungae, Protista and Monera)	**Specific Aim 1**: Knowing Life Sciences **Sub aim 1**: Acquire knowledge. **Specific aim 3**: The Value and Application of Life Sciences Knowledge in the Industry in Respect of Career Opportunities and Everyday Life **Sub aim:** Developing Language Skills: Reading and Writing.	**2**	Context-based teaching • Relational • Transmission • Cooperative	Research on diseases caused by a microorganism. Test on microorganisms
Photosynthesis	**Specific Aim 1**: Knowing Life Sciences **Sub aim1**: Acquire knowledge. **Specific Aim 2: Investigating Phenomena in Life Sciences** **Sub aims**: follow instructions, Handle equipment or apparatus, make observations and interpret the information.	**2**	Context-based teaching • Relational • Transmission Facilitative approach	Practical investigation on photosynthesis and a control test

TOPIC	SPECIFIC AIMS AND SUB AIMS	DURATION (IN WEEKS)	TEACHING APPROACHES	ASSESSMENT CONDUCTED
Cellular respiration	**Specific Aim 1:** Knowing Life Sciences. Sub aim 1: acquire knowledge **Specific Aim 2:** Investigating Phenomena in Life Sciences **Sub aim1:** interpret **Sub aim 2:** Design/Plan investigations or experiments	**2**	Context-based teaching • Cooperative • transmission	Investigation
Excretory system	**Specific Aim 1**: Knowing Life Sciences. **Sub aim 1**: acquire knowledge **Specific Aim 3**: Appreciating and Understanding the History, Importance and Applications of Life sciences in society. **Sub aim 1**: The Value and application of life sciences knowledge in the industry in respect of Career opportunities and everyday life	**3**	Context-based teaching • Relational • transmission	Take-home test

TOPIC	SPECIFIC AIMS AND SUB AIMS	DURATION (IN WEEKS)	TEACHING APPROACHES	ASSESSMENT CONDUCTED
Human impact on the environment (food security)	**Specific Aim 3**: Appreciating and Understanding the History, Importance and Applications of Life sciences in society. **Sub aim 1**: The Value and application of life sciences knowledge in the industry in respect of Career opportunities and everyday life	**2**	Environmental awareness approach Facilitative approach Corporative approach Relational approach	Group task on food security.
Animal Nutrition	**Specific Aim 1**: Knowing Life Sciences **Sub aim 1**: Acquire knowledge. **Specific aim 3**: The Value and Application of Life Sciences Knowledge in the Industry in Respect of Career Opportunities and Everyday Life	**2**	Integration of ICTs with Context-based teaching • Relational • transmission Corporation	Test and class activity.

4.2.1. Topic 1: biodiversity and classification of microorganisms (Fungae, Protista and Monera)

The topic dealt with characteristics of microorganisms under the kingdom *Monera, Protista* and *Fungi.*

Specific aim 1: Knowing Life Sciences

Sub aim 1: Acquire knowledge.

Specific aim 3: The Value and Application of Life Sciences Knowledge in the Industry in Respect of Career Opportunities and Everyday Life.

Sub aim: Developing Language Skills: Reading and Writing.

For this topic, both relational and transmission approaches were intended to assist learners in using prior knowledge of microorganisms learnt in Grades 8 and 9. The use of prior knowledge was in line with the social constructivist theory of learning, which states that learners make new meanings of unfamiliar context based on familiar context (prior knowledge). The teacher started the lesson by posing three questions to involve learners in the lesson. The questions asked sought the learner's prior knowledge on the classification of microorganisms, giving one example for each microorganism and distinguishing between a virus and bacterium. Of the three questions asked, only three learners were able to answer the first question. However, learners could not write kingdom classification in a sequence (from Monera to Animalia). The other learners wrote that Porifera, Bryophytes, and Bacteria are Kingdoms of species. The two learners were able to recognise a virus as parasitic and being smaller than a bacterium, and the other learner wrote that viruses cause diseases. The overall impression of the teacher was that most learners were unable to link the current topic with the previous knowledge. Learners' prior knowledge was poor because they failed to recall basic facts on classifying microorganisms into kingdoms. Due to this development, the teacher switched to the transmission approach, where learners were exposed to basic concepts used in this topic. However, this teacher-centred approach provided limited learner interactions. One would expect that Grade 11 learners are at the operational stage of Piaget, which involves the ability to classify and reason logically based on the information they have accumulated in Grades 8, 9 and 10 on microorganisms.

The Transmission approach assisted learners in making connections between viruses and bacteria based on their differences. The teacher used a textbook and handouts for structural components of viruses and bacteria. This enabled learners to see some differences in terms of features such as *flagella, plasmids DNA coat, etc*. The teacher started the lesson by writing some important aspects of Biodiversity such as domain, classification, phyla, order, family, genera, and species. This was to emphasise the systemic way of classifying organisms. The lesson extended to Protista and fungi.

Learners were assessed on two tasks: group research and a control test.

Group research required them to research any disease caused by either Monera, Fungi and Protists. They had to use internet articles, library books and experts on such diseases. The second part was to present their research on the chosen disease. The task aimed to enable learners to develop writing skills as per sub aim 2.5.3 in CAPS (2012: 19), which states, "*It will therefore be critical to afford learners opportunities to read scientific texts and to write reports, paragraphs, and short essays as part of the assessment, especially in (but not limited to) the informal assessments for learning".* The presentation was used to teach learners to present their work in front of other learners to improve their presentation skills and the ability to argue facts.

In the control test, learners were tested based on cognitive demands of assessment such as **Knowing Science** (state, name, describe), **Understanding Science** (explain, compare and calculate), **Applying Scientific Knowledge** (predict, use knowledge) and **Evaluating, Analysing and Synthesising Scientific Knowledge** (differentiate, discuss). All this was tied with specific aim 1 of CAPS.

The results from the research task show that learners did well, and this might be because they were working together (cooperative learning). Some learners chose diseases such as COVID-19, which were easy to write and report about. The teacher could have omitted common diseases such as HIV, TB, COVID-19, etc., to ensure that learners do thorough research on less familiar diseases. In the control test, the overall performance of the learners based on percentage average (Refer to Figure 4.2 (c), Appendix D) shows that learners have performed well in the context of South African standards. However, when one assesses individual performance, some learners did not do well on the test, which has to do with the understanding and application of concepts in a new context. For example, some learners could not answer questions focused on calculation and scientific knowledge, such as setting hypotheses and variables. In essence, they could not integrate what they learned in Grade 10 on scientific methods for investigation.

The relational and transmission approaches worked for the lesson based on individual performance. However, integrating ICTs such as PowerPoint with pictures and videos on the structures of bacteria, viruses, and Protista could have improved teaching and learning. A teacher could have introduced a topic by first asking five classifications of organisms only instead of asking learners three questions at the same time, which was assumed in this study as overwhelming.

4.2.1.1 FINDING #1: Lack of prior knowledge addressed Research Question 1.

The researcher found that there was a lack of Prior knowledge from the learners regarding Kingdom classification. The topic is taught in Grades 8 and 9, yet learners could not write kingdoms in sequential order. The transmission method assisted learners in acquiring the knowledge needed to make meaning to what was taught, even though it was teacher centred. The use of group work was effective because it allowed learners to share ideas among themselves (cooperation); thus, a sense of responsibility for acquiring knowledge was instilled.

Assessments indicated that learners are still struggling with interpretation skills and scientific concepts such as hypothesis, independent and dependent variables, and drawing conclusions on the given data because learners poorly attempted this question (See Figures 4.2 (*a)* and (*b*). This again points out the learners' lack of prior knowledge because these scientific concepts are taught from Grades 6 to 12. A practical investigation of the prevalence of bacteria or fungi on agar plates and bread moulds could have improved learners' understanding of the scientific concepts as well as concepts of microorganisms by using what they are all familiar with (bread mould) as proposed in the Grade 11 CAPS document. Consequently, there could have been skills acquisition stipulated in Specific Aim 3.

4.2.2 Topic 2: Photosynthesis

Specific Aim 1: Knowing Life Sciences

Sub aim: Acquire knowledge.

Specific Aim 2: Investigating Phenomena in Life Sciences

Sub aims: follow instructions, handle equipment or apparatus, make observations and interpret the information.

Photosynthesis is a topic that starts as early as Grade 6 in some schools. However, some concepts form foundational knowledge and should be introduced so that learners can connect photosynthesis in Grade 11 with photosynthesis concepts taught in previous grades (Grades 6-10). The teacher started the lesson by asking what they understood about photosynthesis. Almost everyone in the class raised his or her hand since they knew the definition of photosynthesis. One learner defined photosynthesis by saying that "it is a process whereby plants manufacture their food using sunlight". The teacher then proceeded to ask one of the learners to write the requirements and products of photosynthesis. This is how it was written: *sunlight+water→ oxygen+glucose.* The teacher had to ask if the formula was correct or not. Some learners identified some substances that were missing in the formulae. The teacher noticed that some learners did not make meaning of the formula, but It was all about **memorising facts on photosynthesis.** The teacher had to write the formula in a correct sequence and emphasised that on the left were all substances required for photosynthesis (requirements), and on the right were the products. The importance of knowing how to draw and label chloroplast was emphasised. The teacher used a facilitative approach to lesson introduction by allowing learners to engage each other on a formula for photosynthesis and correct one another. Then, the teacher had to switch back to context-based (relational) by referring to some important concepts of photosynthesis, such as chlorophyll and chloroplast. Most learners could not differentiate between the two and were reminded of a chloroplast as an organelle only found in plant cells based on Grade 10 work.

The teacher then proceeded to use the transmission approach to teach two types of photosynthesis: light-dependent and light-independent phases of photosynthesis. It was very important for the teacher to highlight that since photosynthesis only takes place during the day, the dark phase does not imply that it happens during the night.

All substances in the equation of photosynthesis were unpacked as to how they relate to these different phases.

Learners were assessed on a practical investigation as suggested by CAPS (2012: 41) and a control test, as shown in Appendix D.

The practical investigation focused on testing for the presence of starch in the leaf. The instructions to carry out the investigation were outlined (Refer to practical task on photosynthesis). Learners worked in groups of five. All apparatus for the investigation were placed at two stations. This task was an open inquiry; hence learners had to formulate their hypothesis, observe and record the results, and draw a conclusion from their results. The cognitive demands that were assessed as per the CAPS document were:

Applying scientific Knowledge

Evaluating, analysing and synthesising scientific knowledge.

It was necessary to allow learners to work independently so that they could *follow instructions, handle equipment or apparatus, make observations and interpret the information*.

The assessment demonstrated that the facilitative approach and transmission assisted learners in making meaning of photosynthesis concepts. However, the result from the investigation showed that learners were not equipped to carry out an investigation that involved open inquiry because some learners in the groups could not handle the apparatus appropriately. Furthermore, the experiment took place in a classroom with a space conducive for conducting experiments since they involve harmful chemicals such as ethyl alcohol. The wearing of protective gear was also an issue as some learners wanted to touch ethyl alcohol with bare hands. The teacher could have opted for guided inquiry first before the open inquiry to expose learners to the handling of apparatus. The use of videos on how the starch is tested on the leaf could have also been used to enhance their understanding of the practical. As a result, some groups struggled with the experiment because they were unfamiliar with independent learning.

In the control test, most learners did well in section A, which was more routine questions (knowing science). However, questions involving data interpretations and comparison were the most difficult questions. Learners could not answer the questions they were asked (Refer to Figure 4.3, Appendix D). The reason behind this could be a lack of clarity on concepts and the inability of the teacher to unpack those concepts. For example, on the factors that affect the rate of photosynthesis, there were two graphs representing light intensity and carbon dioxide concentration. Some learners failed to answer questions relating to those two graphs; they could not make meaning using what they had been taught in class. The researcher suggests that using videos and demonstrations could have assisted learners in understanding what was asked. Furthermore, it is important to write concepts that learners need to note before teaching depth knowledge.

4.2.2.1 Finding # 2: Lack of scientific skills to conduct practical investigation addressed Research Questions 1 and 2

The teacher employed a facilitative, transmission and relational approach to teaching the topic. There was no meaning attached to what learners knew about photosynthesis; this was evident when learners could not write a proper equation for photosynthesis.

The lack of exposure to the use of apparatus was evident in a practical investigation. Hence the teacher had to emphasise the importance of knowledge of apparatus. This could be because these learners were not exposed to practical work that required them to use materials. Learners worked in groups to experiment, which assisted them in engaging with one another on how they carried out the investigative practical, drawing observations and interpreting data from what was being done. The learners were able to experiment successfully and were fascinated that, indeed, leaves have starch. This indicates that practical aspects of photosynthesis play a key role in enhancing the teaching and learning of concepts. Furthermore, the adherence to the CAPS document on photosynthesis ensured that learners were involved in the lesson (learner-centred) and could use their senses to learn optimally. Skills in conducting experiments per instructions, handling equipment or apparatus, making observations and interpreting data were gained.

Learners were able to answer routine questions on the control test but could not answer questions that related to the demonstration of scientific knowledge (Refer to Figure 4.4 (a) and (b), Appendix D)**.** This could have been avoided if a teacher had started with a practical experiment before the control test. The practical work would have reinforced the key concepts of photosynthesis and scientific knowledge. Consequently, learners could have performed better.

The assessments demonstrated that the facilitative approach, transmission, and relational approaches assisted learners in making meaning of photosynthesis concepts.

4.2.3. Topic 3: Cellular respiration

Specific Aim 1: Knowing Life Sciences.

Sub aim 1: acquire knowledge

Specific Aim 2: Investigating Phenomena in Life Sciences

Sub aim 1: Interpret

Sub aim 2: Design/Plan investigations or experiments

The lesson was to enhance learners' knowledge of respiration through investigation that has questions which foster them to use skills such as interpretation and analysis. The teacher presented the lesson using a context-based teaching approach (relational approach), where learners were asked to define what respiration is **(prior knowledge**). No learner gave a definition; this could be because the topic was not introduced thoroughly in Grades 8 and 9. Therefore, the teacher had to employ a transmission approach, which was teacher centred. There was an emphasis on the fact that cellular respiration is a reverse reaction of photosynthesis, and it was easy to show that to learners because they already know the chemical formula for photosynthesis. The teacher used resources such as PowerPoint presentations to show both animal and plant cells with mitochondria. Since it was explained in Grades 8, 9, and 10 that mitochondrion is a site for photosynthesis, it was easy for some of them to link that with Grade 11 respiration content. New concepts such as glycolysis, catabolic, aerobic, and anaerobic were unpacked because that was the key to making them understand the content. For example, aerobic and anaerobic were explained by the teacher by saying that *aero* is associated with oxygen and *anaero* is the opposite (lack of oxygen).

A practical demonstration using a mirror was shown to the learners to prove that water was one of the by-products of cellular respiration. As you breathe in front of the mirror, a mist is produced, which is evident that water is the product of respiration. The concepts of ATP as an energy carrier were also explained.

The assessment for the topic was the investigation based on analysis and interpretation using skills stipulated in CAPS.

The investigation was guided by the cognitive assessment model for Life Sciences as per the CAPS document: Knowing Science (state, name, describe), Understanding Science (explain, compare and calculate), Applying Scientific Knowledge (predict, use knowledge) and Evaluating, Analysing and Synthesising Scientific Knowledge (differentiate, discuss).

The skills tested are in line with specific aim 2 skills in the CAPS document. The investigation tested learners' abilities to use scientific concepts in the context of cellular respiration (see Appendix 3 for investigation). Learners had to work individually to answer the questions. However, they were allowed to discuss the question with one another (cooperative learning). This yielded positive results for some learners since they were able to remind each other of concepts such as hypotheses and variables.

The results from the assessment showed that questions 1 and 2 were the most poorly answered. This could be because learners lacked scientific knowledge. For example, one learner wrote investigation questions as follows: *investigations on whether germinating seeds releases carbon dioxide during respiration* (Refer to figure 4.5 (a), Appendix D*).* This demonstrates that there was a lack of understanding from the learner. Another poorly answered question was the identification of different variables in the investigation. Furthermore, some learners did not even answer questions about variables**.**

The poor interpretation of questions could also because the teacher did not expose learners to scientific procedures when one investigates a phenomenon. Furthermore, the use of the transmission approach could have been used together with videos showing the release oxygen during cellular respiration by germinating seeds. The teacher could have used an additional investigation task before this one, perhaps using the snail to demonstrate that oxygen is released during cellular respiration. In this way, learners would have been familiar with some of the concepts asked in the investigation and subsequently learned critical skills such as interpretation, analysis, and the use of prior knowledge in the new context. The transmission approach isolates learners from the core learning, which is against social constructivism, which insists that learners should be at the centre of learning. Using African beer as an example of cellular respiration could have enhanced learners' understanding because most learners are familiar with that beer, and this experiment is less expensive. The issue of African beer could have realised sub aim 2.5.3.2 of specific aim 3 of life sciences CAPS (2012: 17): "*Relationship Between Indigenous knowledge and Life Sciences*"

4.2.3.1 Finding #3: Lack of scientific knowledge and prior knowledge addressed

Research Questions 1 and 2

The results demonstrate that lack of prior knowledge hinders learners from understanding some scientific concepts relating to cellular respiration. This was evident when the learner could not even define what cellular respiration was. With the lack of prior knowledge, learners struggled to answer questions that involved scientific knowledge. For example, in investigating whether germinating releases carbon dioxide, some learners could answer investigation questions properly. Furthermore, most learners did not answer questions on variables correctly (Refer to 4.5 (b) and (c), Appendix D). The use of the relational approach could not be effective because learners did not relate, using prior knowledge on the definition of cellular respiration; hence the transmission approach was predominantly used. The use of the transmission approach limited learners to gain a deeper understanding of cellular respiration.

Any teaching approach or practice that ignores learners' knowledge about the content disadvantages them because it treats them as passive recipients of knowledge. The constructivist theory of learning encourages the use of learners' prior knowledge in all learning situations. Therefore, appropriate teaching approaches should acknowledge the prior knowledge of learners in various learning situations.

4.2.4 Topic 4: Excretory system

The teacher introduced the lesson by asking learners the meaning of "excrete". Learner X answered the question by saying that it means to remove waste. That was the point of departure; learners were then asked how humans get rid of the waste in the body. Learner Y mentioned urination, and Learner P said through getting rid of faeces. The teacher asked: "Can someone say something about the skin in terms of excretion?" (scaffolding) Learners who participate in sports said that when you sweat, there is waste in the form of water and salt that comes out through pores. The teacher then defined excretion as a process whereby our body removes waste products that can be harmful to our well-being. Organs responsible for excretion (lungs, skin, kidneys, and liver) were explained. There was an argument between learners as to whether faeces are part of this waste or not. Some learners said faeces were a waste; therefore, the gut is also an organ of excretion. The teacher mediated by clarifying the issue and said faeces are all undigested food and was never used for metabolic activities and are not metabolic waste. It is only those four organs that excrete metabolic waste. The teacher employed a relational and transmission approach by explaining the concepts of excretion and its importance in bringing balance to our bodies. Specific aim 1, which emphasises the knowledge of Life Sciences, was integrated to achieve learning objectives.

The teacher gave an individual take-home test with some concepts not taught in the class. This was done purposefully to allow learners to use research skills to find information and to involve parents or guardians in the study of a learner.

Most learners did well in the take-home test. However, some could not answer certain questions because they were difficult for them, and no one at home could help with some concepts. Most learners could not link what was taught in the class with what was asked in the test. This brings transmission and relational teaching approaches into the spotlight; they do not place a learner at the centre. Thus, learners could not answer questions they were asked due lack of meaning in some aspects of the topic. As suggested by CAPS content coverage for Grade 11, practical tasks such as dissections of a kidney could have reinforced some of the concepts that learners were taught about the kidney. Furthermore, this could have enabled them to have first-hand experience of what was taught, and sections of the kidney such as the cortex and medulla could have been identified. Handling apparatus as a skill could have been enhanced. This is in line with social constructivism, where learners socialise with objects (kidneys) to make better meaning to the concepts. Furthermore, research on disorders associated with kidneys could have been given to learners to work cooperatively and learn from one another.

4.2.4.1 Finding # 4: Understanding of concepts through relational approach addressed Research Question 1

Learners demonstrated that they know excretion, even though it was not prior knowledge relating to what they learnt in previous grades; hence the teacher used a transmission approach for the lesson. The transmission approach was instrumental in breaking down the concepts of human excretion because learners did not have a deeper understanding of the concepts. The relational approach assisted learners in relating excretory organs, such as skin, with which they were familiar. The assessment showed that learners did understand what was taught because they were able to answer questions correctly (Refer to Figure 4.6 (a) and (b), Appendix D).

4.2.5. Topic 5: Human impact on the environment (food security)

Specific Aim 3: Appreciating and understanding the history, importance and applications of Life Sciences in society.

Sub aim 1: The value and application of Life Sciences knowledge in the industry in respect of career opportunities and everyday life

The topic was linked to the population ecology of Grade 11. The approach used for the lesson was facilitative, corporative approach, and environmental approach. The teacher introduced the lesson by asking learners which activities they think that impact the environment negatively. For example, Learner X mentioned the emission of gases from factories which result in air pollution, and Learner Y mentioned disposal of wastes in the streets as one of the activities that impact negatively. The aim of the question was not only to mention those activities but also to look at **HOW** they impact negatively. These probing questions were designed to help learners relate to the topic based on what they see and experience daily. This was in the context of Specific Aim 3: *Appreciating and Understanding the History, Importance and Applications of Life Sciences in Society*. Learners needed to see a link between societal practices and Life Sciences.

The lesson was learner-centred because they had to discuss among themselves issues due to human activities that impact the environment. The lesson was interactive; there was a contestation of views, and learners had to support their statements. This part assisted them in developing *debating skills* and the ability to cite evidence from reliable scholarly sources. Toulmin's model of argumentation was then introduced as guidance in a debate. This was critical so that they may develop scientific skills and learn how to find evidence in a claim (critically evaluate scientific information).

Learners were given a group task (5 in each group) on the impact of the human population on food security. They were required to use Toulmin's model as a guide for their research. The teacher played a short video about the human impact on diversity and its implications on food security. The probing question was, "Is increasing human population a threat to food security?" Some groups had to agree with the statement, while others had to disagree. The teacher allocated groups on this question so that they may not choose only one side of the question. The most important aspect of the work was that learners had to use provided academic articles on food security to agree or disagree with the question by citing whatever evidence supports their claim. This was critical because they would develop scientific knowledge and skills. The teacher employed a facilitative approach to ensure clarity in every group.

The lesson enabled learners to think out of the box and work cooperatively because they had to bring their ideas and find statements supporting them (scientific evidence). The environmental awareness approach was used in theory. The teacher thinks that if the learners were taken, for example, to places with alien species as an example of demonstrating human impact on the environment, it could have assisted them to relate with that and subsequently brings awareness to human activities that might degrade the environment. However, many learners were aware of most human activities that negatively impact the environment. The use of the cooperative approach allowed learners to learn from each other (social constructivism). Toulmin's model exposed learners to a scientific way of reasoning with facts; thus, some scientific skills were gained. Conscientious learners experienced the importance of finding innovative ways to deal with food security crises. This is tied explicitly to specific aim 3 2.5.3.3 *The Value and Application of Life Sciences Knowledge in the Industry in Respect of Career Opportunities and Everyday Life topic.*

4.2.5.1 Finding # 5: The effective use of cooperative and facilitative approaches.

Learners relied on prior knowledge of environmental studies to understand the topic. The use of cooperative and facilitative approaches was effective because it allowed learners to engage in discussions with each other with little assistance from the teacher.

Toulmin's model exposed learners to a scientific way of reasoning with facts, debating skills and the ability to cite evidence from scholarly sources. With the environmental awareness approach, learners were made aware of practical ways to deal with food crises.

4.2.6. TOPIC 6: Animal nutrition

Specific Aim 1: Knowing Life Sciences

Sub aim 1: Acquire knowledge.

Specific Aim 3: The Value and Application of Life Sciences Knowledge in the Industry in Respect of Career Opportunities and Everyday Life.

The lesson was based on animal nutrition, with humans as a reference to animal nutrition. The lesson was online, on the Google Teams platform, which had PowerPoint slides with notes and videos to enhance teaching and learning. Since the teacher was not physically present in the classroom, the lesson was projected using a data projector in the class. The teacher integrated a transmission, relational and corporative teaching approach for the lesson. The teacher had asked one teacher assistant to assist in the classroom by showing learners which button they must press if they want to ask questions and to monitor any technical issue that might arise.

The teacher started the lesson by asking about the meaning of the term “nutrition”. ***Learner X*** responded, "*It is nutrients that we get from food.”* The teacher proceeded to ask what nutrients are if nutrition is nutrients. That is where learners realised that nutrition and nutrients are related but do not mean the same thing. The teacher explained nutrients as a process in animals that includes ingestion, digestion, absorption, assimilation, and the egestion of food in the body. Learners were encouraged to write meanings of these concepts of Animal Nutrition so that they may have a better understanding of the topic. Next, a video of 5 minutes was played, showing how nutrition as a process takes place in our bodies and which organs play a role in the whole process. The teacher encouraged learners to take notes while the video was playing. Once the video was finished, the teacher asked what the process of taking food through the mouth was called. ***Learner Y*** answered, “*It is ingestion.”* The teacher then asked them to name the canal responsible for transporting food to the stomach. ***Learner P*** responded by saying it was the alimentary canal. There was a question from ***Learner X,*** who asked about the difference between a canal and an oesophagus. The teacher responded that the oesophagus is part of the alimentary canal.

Learners were given activities during the lesson so that they may discuss questions among themselves but write their answers individually. Most of the learners got the answers correct (Refer to Figure 4.7 (a), (b) and (c), Appendix D). Furthermore, learners wrote a test on animal nutrition to test their understanding of the concepts. Questions were asked in conjunction with what Life Sciences Cognitive demands for assessment recommends. For example, there were routine questions in the multiple-choice and biological terms. Question 2 required them to identify different organs in the human body that forms part of the nutrition. These are cognitive demands that were used for the test: knowing science (state, name, describe), **Understanding Science** (explain, compare and calculate), **Applying Scientific Knowledge** (predict, use knowledge) and **Evaluating, Analysing and Synthesising Scientific Knowledge** (differentiate, discuss). All this was tied with specific aim 1 of CAPS. Learners did well on the test because they were able to answer questions as they were asked (Refer to Figure 4.8 (a) and (b), Appendix D). However, most learners struggled to answer 3.3 and 3.4. These questions required a learner to demonstrate an understanding of different organs and their adaptations to perform functions (Refer to Figure 4.8 (a) and (b), Appendix D).

4.2.6.1 Finding #6: The integration of ICTs with other teaching approaches addressed Research Question 2.

The researcher found that learners enjoyed the lesson, and it was their first time being taught online. The use of the ICT platform, along with the relational and transmission approach, enabled learners to understand the content better since there were pictures to improve their understanding of the concepts. For example, there were animated pictures showing peristalsis assisted with the movement of food in the oesophagus. Learners interacted with the teacher and among themselves throughout the lesson. Learners demonstrated that they understood what was taught since they could answer questions relating to the lesson and work cooperatively. Furthermore, results from the assessment show that learners responded positively to the lesson. However, the major issue was the projection of pictures on the slide. Pictures were unclear, and the light reflected on the board made it difficult for learners to see pictures properly.

4. 3. Discussion of Findings

The purpose of employing different approaches for each lesson was to determine the effectiveness of each approach in enabling learners to acquire knowledge as stipulated in CAPS Life Sciences Specific Aims: 1, 2, and 3. The study found that there are factors that amounted to the effectiveness and ineffectiveness of the teaching approach. The following is a discussion of the findings of the study.

Lack of prior knowledge limited the use of a single teaching approach on its own but forced a teacher to integrate different approaches for effective teaching and learning. Relational, cooperative, experiential, environmental awareness and facilitative approaches could not be used independently of the transmission approach. This is primarily due to the learners' lack of prior knowledge, which limited them from participating in the lesson. This resulted in the use of the transmission approach, which is teacher-centred with little participation from the learners. This was warranted in **Findings #1, #3, and #4**, where it was found that learners could not accommodate new knowledge using existing knowledge. For example, when the teacher asked learners to write five kingdom classifications of organisms and their examples in topic 1, most learners could not write them. The teacher had first to identify any existing knowledge and misconceptions the learners might be having about microorganisms so that learners may be engaged. Esanu and Hatu (2015) state that any teaching approach or practice which ignores learners' knowledge about the content disadvantages the learners because it treats them as passive recipients of knowledge; hence the teacher has to check for prior knowledge. Furthermore, **finding #3** indicates that learners were unable to make meaning of the definition of cellular respiration, a topic introduced in Grade 7. This is consistent with the findings from Wirth and Perkins (2008), who state that prior knowledge is key for the introduction of a new topic, and it is, therefore, a duty of a teacher to identify any existing prior knowledge and misconceptions at the beginning of each lesson.

With a teacher opting for the transmission approach to introduce some concepts, it must be noted that learners were limited in terms of demonstrating their thinking abilities. Hence, they became passive recipients of knowledge with little interaction and subsequently became disengaged when the transmission approach was employed. Bond (2020) and Brown and Crippen (2017) observe that there is always little active learning involved when using traditional methods of teaching sciences, such as the transmission approach, because they demotivate learners who subsequently withdraw from learning activities. For example, a teacher observed that while he was explaining the important concepts such as *domains, kingdoms, and scientific names of organisms* in Topic 1, some learners at the back were on their phones, and this is evident that they were disengaged because they could not relate to what was taught. The integration of transmission and cooperative teaching approach in Topic 1 was effective since learners were able to share ideas and learn from each other. Zakaria and Iksan (2007) states that the use of a cooperative approach allows learners to be effective in any activity given, thus promoting social interdependency. This was also evident in Topic 2, where the teacher used a transmission, cooperative and facilitative approach to deliver the lesson and assist learners with photosynthesis practicals.

The CAPS document stipulates that the Life Sciences curriculum is organised according to four knowledge strands developed progressively over three years of FET. These knowledge strands are:

- Knowledge Strand 1: Life at the Molecular, Cellular and Tissue Level.
- Knowledge Strand 2: Life Processes in Plants and Animals
- Knowledge Strand 3: Environmental Studies.
- Knowledge Strand 4: Diversity, Change and Continuity.

These knowledge strands links with what learners were taught in Natural Sciences Senior Phase; thus, teachers need to help learners to recognise the links between topics in Grade 11 and what they learnt in Natural Sciences Senior Phase (CAPS, 2011). In essence, CAPS emphasises that prior knowledge should enable learners to use familiar contexts to make meaning of unfamiliar contexts.

The results demonstrate that a lack of prior knowledge can also affect learners' performance in questions relating to scientific investigation. This was evident in **Findings #1, #2, and #3 (on assessments)** because most learners could not answer questions in the test and practical assessments that related to concepts such as hypothesis, variables and concluding. Furthermore, the lack of adherence to CAPS in previous grades might have played a role in the lack of acquiring scientific skills.

Subsequently, this led to a lack of understanding of these aforementioned concepts. For example, CAPS recommends that teachers use bread mould as a practical investigation to explain the characteristics of fungi in Grade 11, and this would have afforded learners to acquire scientific skills and perform better in the investigative section of a test.

It is important to highlight that even though the transmission approach was proved to be disengaging the learners, there were lessons such as human excretion where it was effective, especially in unpacking terms associated with the urinary system. The study found that learners demonstrated an understanding of human excretion concepts when answering assessment questions, and most did well in the test (see appendix xxx). Crawford 2007 states that the transmission approach is effective when it is used to teach content that learners are unfamiliar with. Furthermore, Scott (2015) supports the findings by stating that the transmission approach is effective when a teacher introduces a new topic, and this requires a skilled teacher who can use everyday life experiences to invoke curiosity in the learners. This is true because learners were familiar with the concepts of organs of excretion, such as the skin and kidneys. This, however, had an element of relational approach within the transmission because learners could relate to some organs and waste produced during excretion. The practical aspect of the topic, such as dissecting the kidney as stipulated by the CAPS Life Sciences document, could have enabled learners to gain live experience on sections of the kidneys such as *the medulla* and *cortex*. This would have improved their understanding of the urinary system.

Findings #2 and **#3** demonstrate that learners were not exposed to scientific investigative concepts in previous grades. Learners could not link concepts of photosynthesis, such as chlorophyll (green pigment) and radiant energy from the sun to real-life situations. However, it must be noted that the learner had existing schemas on photosynthesis. Therefore, the teacher was required to scaffold them to accommodate new knowledge with existing knowledge. For example, the teacher explained that chlorophyll is a green pigment in the leaf, which traps sunlight from the sun. On cellular respiration, a teacher used a chemical formula for photosynthesis to emphasise that it is the reverse of cellular respiration. This way of teaching is linked to the concept of social constructivism.

The social constructivist approach implies that teachers should use scenarios and examples that learners are familiar with, to explain a phenomenon (Wallace & Kang, 2004). In the context of the study, the teacher used facilitative and relational approaches to enable learners to relate to Topics 2 and 3.

Findings #2 show that facilitative and relational approaches help learners to understand the concepts of photosynthesis better through hands-on investigation tasks. Since learners were at the centre of the lesson, this was an attribute of the social constructivist approach, which encourages learner-centred pedagogy where learners are actively involved in the teaching and learning process rather than passive (Splitter, 2009). Furthermore, allowing learners to be involved helped them to probe questions that stemmed from curiosity. This is supported by Colburn (2000) and Fenstermacher, Soltis, and Sanger (2015), who posit that the social constructivist approach encourages learners to probe questions that are instrumental in completing the given task, hence a teacher should provide opportunities for learners to discover phenomena and thus gain primary skills needed for scientific investigations. The practical task is suggested by the CAPS Life Sciences document under Specific Aim 2 (Investigating Phenomena in Life Sciences). CAPS advocates for implementing investigative tasks that allow learners to gain scientific knowledge and skills, such as observations, analysis, interpretations, and drawing conclusions about the phenomenon investigated. This enables learners to develop curiosity and interest in wanting to know how the natural world relates to living things.

Group work for conducting experiments on testing starch in a green leaf allowed learners to share ideas, and where necessary, the teacher assisted (facilitative approach) them with questions that would lead them to find meaning in what they were doing. This was in line with Vygotsky's Zone of Proximal Development (ZPD). ZPD is a phase in the learning process where the teacher, as someone more knowledgeable, assists (scaffolds) learners to accomplish activities they could not do alone (Vygotsky, 1978). Furthermore, knowledgeable learners can also scaffold their counterparts; hence group work was formed. By using the ZPD concept, a teacher could identify learners' strengths and weaknesses and explain what needed to be clarified, and learners could work on their own. Fani and Ghaemi (2011) support the statement by stating that the application of ZPD in investigation activities allows teachers to be mediators between learners and the activity. Furthermore, the group work for Topic 1 assisted learners in working cooperatively, thus learning from each other. It then meant that learners had to research diseases caused by microorganisms on their own. This has enabled them to perform better in the group task. A study by Emilia and Gunawan (2012) agrees that learners perform better when they work as a group because they can share ideas and tackle difficult questions independently.

The study found that prior knowledge played a significant role in Topic 5 on *the human impact on the environment.* Learners were able to answer questions posed by a teacher using what they were familiar with; hence they engaged each other on ways in which humans impact the environment, thus posing a threat to food security. The finding is in line with Kang's (2008) findings which state that learners show interest and maximum participation in a lesson when they can relate to the lesson using prior knowledge and are familiar with concepts. Integration of argumentation using Toulmin’s model enhanced learners debating skills and scientific ways of finding evidence that supports their claims. With the environmental awareness approach, learners were made aware of practical ways to deal with food crises. CAPS emphasises the importance of acquiring skills such as writing and reading as part of Specific Aim 3. Therefore, learners could learn about indigenous ways of securing food and how these indigenous ways are useful in learning Life Sciences.

The use of ICT as alternative pedagogy to the teaching of Life Sciences was explored, focusing on TPACK. **Finding #6** showed a recorded success when ICTs were integrated into the lesson. This is supported by Laxim and Gure (2016), who reported a significant improvement when the TPACK model was used in teaching and learning Life Sciences. Moreover, understanding the content and pedagogy enabled the teacher to integrate technologies effectively to enhance learning. Learners demonstrated an understanding of nutrition concepts and how they are linked to each other, and this was achieved through a video that was played before the lesson could commence. Consequently, there was a great improvement in how learners responded to questions when writing class activities. This is in line with research findings from Petra, Jaidin, Perera, and Linn (2016), who report an improvement in understanding of inquiry processes and Life Sciences concepts on photosynthesis when ICTs were integrated into the lesson. Furthermore, the findings reveal that the integration of ICTs cannot be limited to photosynthesis but can also be used in other topics within Life sciences. The study found that learners performed better when integrating transmission, relational and corporative approaches with ICTs. Bharathi (2020) states that there is an improvement in learners' performance when constructive teaching approaches are used in a lesson.

The study found that the social constructivist approach can be used to integrate ICTs with other teaching approaches. Learners were given a group task during the lesson and were able to work cooperatively by engaging one another on the questions that were asked. As Zakaria and Iksan (2007) suggested, this approach enables learners to be effective in any given task, promoting social independence among learners. The concept of social interdependence is reinforced by the theory of social constructivism, which indicates that context-based teaching approaches (cooperative, relational, and transmission), facilitative approaches and environmental awareness approaches pride themselves on prior knowledge, which learners use to relate to unfamiliar learning situations (Baviskar, Hartle & Whitney, 2009; Bharathi, 2020).
The impact of TPACK was evident in findings from Animal Nutrition, which seeks to suggest that ICTs are upon us and, therefore, should be embraced.

Chapter Summary

This chapter discussed findings from different topics in Grade 11 Life Science. These findings were based on how effective teaching approaches were in each of the topics. The findings reveal that lack of prior knowledge is a contributing factor in ensuring that teaching approaches are effective or not. Furthermore, it reveals that constructivist approaches improve social cohesion among learners and teachers. Finally, the integration of ICTs has introduced a new teaching model, TPACK, which impacts the outcomes of the lesson, thus improving academic results.

The next chapter deals with the conclusion of the study based on its findings. Furthermore, it looks at the limitations of the study and finally makes recommendations that will assist Life Sciences teachers in selecting pedagogical approaches that will improve teaching and learning in the classroom.

CHAPTER 5: CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

5.1: Conclusions

The study aimed to explore alternative pedagogies for teaching FET Life Sciences. The study sought to answer a critical question: What alternative teaching approaches can be employed for effective teaching of the FET school Life Sciences curriculum? Furthermore, the study looked at possible teaching approaches that can be used that are adequate for teaching FET school Life Sciences topics and their effectiveness.

The first objective was to identify different teaching approaches for teaching Life Sciences, and the following teaching approaches were identified context-based teaching approaches (transmission, relational and cooperative approach), Facilitative approach, experiential approach, and environmental awareness teaching approach. The second objective was to investigate the level of effectiveness of each teaching strategy for teaching Life Sciences and was in line with the following sub-questions in the research.

What alternative teaching approaches can be employed for effective teaching of the FET school Life Sciences curriculum?

How effective is each strategy in imparting school Life Sciences topics selected from the CAPS curriculum?

The study concludes that facilitative and corporative teaching approaches are the most effective approaches that a teacher can employ to teach Life Sciences because they are learner-centred, thus encouraging critical thinking and learning independency among learners. Furthermore, the integration of ICTs in the lesson enhances the effectiveness of these strategies. On the other hand, the use of the transmission approach alone was ineffective because it did not promote critical thinking, and learners depended on a teacher to explain everything. Furthermore, the relational approach was also ineffective because learners lacked prior knowledge.

The study revealed that a teacher should incorporate more than one teaching approach in the lesson for effective teaching and learning. Learners were not exposed to scientific concepts in previous grades; hence they struggled with scientific-related questions, which hindered the effectiveness of the transmission approach that was used predominantly in those instances and was ineffective. The study will raise awareness among Life Sciences teachers that adhering to the CAPS document when teaching Life Sciences is important. Furthermore, integrating ICTs with different teaching approaches improve teaching and learning; thus, academic performance is improved. Prior Knowledge plays a significant role in teaching and learning; therefore, learners should be taught scientific concepts at lower grades to ensure that they accommodate unfamiliar concepts using familiar concepts.

Limitations of the study

The study focused on one group of learners in one school; therefore, the sample population was too small to give a generalised conclusion. Furthermore, the study did look at learning styles that learners prefer, which might influence how learners respond to different teaching approaches. Plenty of teaching approaches could have been used to get an insight into how learners respond to each teaching approach.

Recommendations

The study found that teaching approaches used in Life Sciences play a role in imparting knowledge and skill acquisition necessary for the subject. The research recommends that teachers align their teaching practice with the CAPS document for Life Sciences so that the teaching approaches employed are effective. These approaches must foster social interaction among learners and teachers. Furthermore, the study recommends the following:

- Learning opportunities should be created where learners can think critically and develop skills to acquire the information they will remember for application in life. It is only in this way that the CAPS aim(s) can be achieved.
- Teachers should improve their pedagogical practice by familiarising themselves with teaching approaches recommended for the 21st Century.
- Life Sciences teachers should employ teaching approaches that are inquiry-based and learner-centred. In addition, lesson planning should be a teacher's priority because it gives structure to what is taught.
- Scientific basic concepts should be introduced at lower grades, where learners will be familiarised with the handling of apparatus and concepts such as hypotheses, variables and observations.

- The education department must facilitate workshops to train teachers about the importance of integrating ICTs in Science lessons and other subjects.
- Life sciences teachers should understand the requirements of CAPS documents in each topic. This will ensure that a teacher plan activity per CAPS standard. Moreover, adhering to the CAPS document will enable the teacher to see the need to incorporate different teaching approaches. For example, if CAPS suggests that a teacher conduct a practical with learners on cellular respiration, then it must be executed in practice, not in theory.
- A school must have a designated class for the use of ICTs because reflections of the sun in the class can make it impossible for learners to see pictures clear in the presentation. Furthermore, Science labs for experiments should be fully-fledged and adhere to the standard requirement of labs.

REFERENCES

Abante, M.E.R., Almendral, B.C., Manansala, J.R.E. and Mañibo, J. 2014. Learning styles and factors affecting the learning of general engineering students. *International Journal of Academic Research in Progressive Education and Development,* 3(1):16-27.[Accessed 15 March 2022]

Abbitt, J.T. 2011. Measuring technological pedagogical content knowledge in preservice teacher education: A review of current methods and instruments. *Journal of Research on Technology in Education,* 43(4):281-300. https://doi.org/10.1080/15391523.2011.10782573 [Accessed 20 March 2022]

Abell, S.K., 2013. Research on science teacher knowledge. *Handbook of research on science education*:1105-1149: Routledge. [Accessed 15 March 2022]

Abell, S.K., Appleton, K., & Hanuscin, D. (Eds.). 2007. Handbook of Research on Science Education (1st ed.): Routledge. https://doi.org/10.4324/9780203824696 [Accessed 10 May 2022]

Adams, F., Qiu, T., Mark. 2017. Soft 3D-Printed Phantom of the Human Kidney with Collecting System. Ann Biomed Eng 45: 963–972. https://doi.org/10.1007/s10439-016-1757-5 [Accessed 09 April 2022]

Aikens, M.L. & Dolan, E.L. 2014. Teaching quantitative biology: goals, assessments, and resources*. Molecular Biology of the Cell,* 25(22): 3478-3481. https://doi.org/10.1091/mbc.e14-06-1045 [Accessed 10 March 2022]

Akerson, V.L., Pongsanon, K., Park Rogers, M.A., Carter, I. & Galindo, E. 2017. Exploring the use of lesson study to develop elementary preservice teachers' pedagogical content knowledge for teaching the nature of science. *International Journal of Science and Mathematics Education*, *15*(2): 293-312. [Accessed 20 March 2022]

Al Abiky, W.B. 2021. Days without schools: The effectiveness of WhatsApp, as an English learning tool, during COVID-19 pandemic. *Revista Argentina de Clínica Psicológica*, *30*(1):774. DOI: 10.24205/03276716.2020.2074 [Accessed 13 July 2022]

Alam, M. 2016. Constructivism: A paradigm shift from teacher-centered to student-centered approach. *The International Journal of Indian Psychology,* 4(1): 51-59. www.ijip.in [Accessed 17 June 2022].

Alemu, G., Stevens, B. and Ross, P. 2012. Towards a conceptual framework for user-driven semantic metadata interoperability in digital libraries: *A social constructivist approach.* New Library World, 113(1/2): 38-54. www.emeraldinsight.com/0307-4803.htm [Accessed 18 June 2022].

Alharahsheh, H.H. and Pius, A. 2020. A review of key paradigms: Positivism VS interpretivism. *Global Academic Journal of Humanities and Social Sciences*, *2*(3): 39-43. DOI: 10.36348/gajhss.2020.v02i03.001 Available online at https://gajrc.com/ [Accessed 11 May 2021].

Alt, D. 2015. Assessing the contribution of a constructivist learning environment to academic self-efficacy in higher education. *Learning Environ Res,* 18:47–67. https://doi.org/10.1007/s10984-015-9174-5 [Accessed 05 February 2022].

Anderson, A. 2019. Virtual reality, augmented reality and artificial intelligence in special education: a practical guide to supporting students with learning differences: Routledge. [Accessed 01 July 2022].

Andrews, T.M., Leonard, M.J., Colgrove, C.A. and Kalinowski, S.T. 2011. Active learning is not associated with student learning in a random sample of college biology courses. *CBE— Life Sciences Education*, *10*(4): 394-405. https://doi.org/10.1187/cbe.11-07-0061 [Accessed 22 June 2022].

Aragon, S. & Johnson, E. 2004. Factors influencing completion and non-completion of community college online courses. In EdMedia+ Innovate Learning (3498-3505): Association for the Advancement of Computing in Education (AACE). DOI: 10.1080/08923640802239962. [Accessed 05 July 2022].

Atkinson, P. & Delamont, S. 2017. Mock-ups and cock-ups: The stage-management of guided discovery instruction. In School experience (87-108): Routledge. [Accessed 11 June 2021].

Aziz, A.M, Zannat, R & Hena, M. 2021. Teachers' Perception and Practices towards Promoting Critical Thinking among Learners: A Study of Selected Secondary Schools in Dhaka City. Bangladesh Journal of Integrated Thoughts, 16(25). https://doi.org/10.52805/bjit.v16i25.216 [Accessed 10 August 2021].

Bada, S.O. & Olusegun, S. 2015. Constructivism learning theory: A paradigm for teaching and learning. *Journal of Research & Method in Education,* 5(6): 66-70. DOI: [Accessed 10 July 2021].

Barak, M. 2006. Instructional principles for fostering learning with ICT: teachers' perspectives as learners and instructors*. Education Information Technology*, 11:121–135. https://doi.org/10.1007/s11134-006-7362-9 [Accessed 05 July 2022].

Barak, M. 2017. Science Teacher Education in the Twenty-First Century: a Pedagogical Framework for Technology-Integrated Social Constructivism. *Research Science Education*, 47(2): 283–303. https://doi.org/10.1007/s11165-015-9501-y [Accessed 07 April 2022].

Basu J.S. & Barton, A.C. 2010. A Researcher-Student-Teacher Model for Democratic Science Pedagogy: *Connections to Community, Shared Authority, and Critical Science Agency, Equity & Excellence in Education*, 43:1 72-87. DOI: 10.1080/10665680903489379 [Accessed 09 May 2021].

Bautista, R.G. 2012. "The convergence of mastery learning approach and self-regulated learning strategy in teaching biology." *Convergence* 3:10. [Accessed 12 March 2021].

Beard, C.M. & Wilson, J.P. 2006. *Experiential learning: A best practice handbook for educators and trainers*: Kogan Page Publishers. [Accessed 16 July 2022].

Behrendt, M. & Franklin, T. 2014. A review of research on school field trips and their value in education*. International Journal of Environmental and Science Education*, 9(3): 235-245. Doi: 10.12973/ijese.2014.213a [Accessed 09 September 2021].

Berwick, D.M.& Finkelstein, J.A. 2010. Preparing medical students for the continual improvement of health and health care: Abraham Flexner and the new "public interest". *Academic Medicine*, *85*(9): S56-S65. Doi: 10.1097/ACM.0b013e3181ead779 Accessed 08 February 2022].

Bhattacharjee, B. & Deb, K. 2016. Role of ICT in 21st century's teacher education. *International Journal of Education and Information Studies*, *6*(1): 1-6. http://www.ripublication.com [Accessed 03 July 2022].

Bidabadi, N.S., Isfahani, A.N., Rouhollahi, A. & Khalili, R. 2016. Effective teaching methods in higher education: requirements and barriers. *Journal of advances in medical education & professionalism*, 4(4): 170 https://www.ncbi.nlm.nih.gov/pmc/articles. [Accessed 16 March 2022].

Black, P. & Wiliam, D. 2018. Classroom assessment and pedagogy. *Assessment in education: Principles, policy & practice*, *25*(6): 551-575. https://doi.org/10.1080/0969594X.2018.1441807 [Accessed 17 May 2021].

Bokulich, A. & Oreskes, N. 2017. Models in Geosciences. In: Magnani, L., Bertolotti, T. (eds) Springer Handbook of Model-Based Science: Springer Cham. https://doi.org/10.1007/978-3-319-30526-4_41 [Accessed 13 February 2022].

Bollig, B., & Buttkus, M. 2020. On Limitations of Structured (Deterministic) DNNFs. *Theory Computing System* 64:799–825. https://doi.org/10.1007/s00224-019-09960-w [Accessed 10 April 2022].

Bond, M., 2020. Facilitating student engagement through the flipped learning approach in K-12: A systematic review. *Computers & Education*, *151*:103819.[Accessed 17 September 2021].

Booi, K.2017. *Life Sciences teacher educators' perspectives of the principle of knowledge integration in the Life Sciences teacher education curriculum* (Doctoral dissertation, Cape Peninsula University of Technology). Ir.cput.ac.za [Accessed 21 May 2021].

Borko, H., Jacobs, J & Koellner, K. 2010. Contemporary approaches to teacher professional development. *International encyclopedia of education*, *7*(2): 548-556. http://www.elsevier.com/locate/permissionusematerial [Accessed 16 April 2022].

Brame, C.J. 2016. Effective educational videos: Principles and guidelines for maximizing student learning from video content. *CBE— Life Sciences Education,* 15(4): 6. https://doi.org/10.1187/cbe.16-03-0125 [Accessed 11 July 2022].

Brawand, A & King-Sears, M.E. 2017. Maximizing pedagogy for secondary co-teachers. *Support for Learning*, 32(3): 216-230. https://doi.org/10.1111/1467-9604.12166 [Accessed 15 October 2021].

Bray, M., Adamson, B. & Mason, M. (eds). 2014. *Comparative education research: Approaches and methods*, (19): Springer. [Accesse 16 May 2021].

Brophy, J. 2006. Observational Research on Generic Aspects of Classroom Teaching.

Brough, C.J. 2012. Implementing the democratic principles and practices of student-centred curriculum integration in primary schools. *Curriculum Journal*, *23*(3): 345-369. https://doi.org/10.1080/09585176.2012.703498 [Accessed 05 April 2022].

Brown, J.C. & Crippen, K.J. 2017. The knowledge and practices of high school science teachers in pursuit of cultural responsiveness. *Science Education*, *101*(1): 99-133. https://doi.org/10.1002/sce.21250 [Accessed 27 April 2022].

Brownell, S.E., & Tanner, K.D. 2012. Barriers to faculty pedagogical change: Lack of training, time, incentives, and tensions with professional identity? *CBE— Life Sciences Education*, *11*(4): 339-346. https://doi.org/10.1187/cbe.12-09-0163 [Accessed 25 April 2022]

Brown-Jeffy, S. & Cooper, J.E. 2011. Toward a conceptual framework of culturally relevant pedagogy: An overview of the conceptual and theoretical literature. *Teacher education quarterly*, *38*(1): 65-84. http://www.jstor.org/stable/23479642. [Accessed 15 June 2022].

Calderón, M., Slavin, R. & Sanchez, M. 2011. Effective instruction for English learners. *The future of children*: 103-127. JSTOR, http://www.jstor.org/stable/41229013. [Accessed 4 June 2022].

Cassidy, S. 2004. Learning styles: An overview of theories, models, and measures. *Educational psychology,* 24(4): 419-444. https://doi.org/10.1080/0144341042000228834 [Accessed 10 July 2021]

Castaño, C. & Webster, J. 2011. Understanding Women's Presence in ICT: the Life Course Perspective. *International Journal of Gender, Science & Technology*, *3*(2). https://genderandset.open.ac.uk/index.php/genderandset/article/view/168. [Accessed 11 July 2022].

Clarke, V. & Braun, V. 2013. Teaching thematic analysis: Overcoming challenges and developing strategies for effective learning. *The psychologist,* 26(2). https://uwe-repository.worktribe.com/preview/937606/Teaching [Accessed 14 May 2022].

Cleveland, L.M., Olimpo, J.T. & DeChenne-Peters, S.E. 2017. Investigating the relationship between instructors' use of active-learning strategies and students' conceptual understanding and affective changes in introductory biology: A comparison of two active-learning environments. *CBE—Life Sciences Education*, 16(2): 19.https://doi.org/10.1187/cbe.16-06-0181 [Accessed 03 March 2022].

Cohen, L., Manion, L. & Morrison, K. 2011. Research Methods in Education (7th ed.). London: Routledge.

Coil, D., Wenderoth, M.P., Cunningham, M. & Dirks, C. 2010. Teaching the process of science: faculty perceptions and an effective methodology. *CBE—Life Sciences Education*, 9(4): 524-535 https://doi.org/10.1187/cbe.15-03-0062 [Acccessed 11 March 2022].

Cooper, M.M., Stowe, R.L., Crandell, O.M. & Klymkowsky, M.W. 2019. Organic chemistry, life, the universe and everything (OCLUE): A transformed organic chemistry curriculum. *Journal of Chemical Education*, *96*(9): 1858-1872. https://doi.org/10.1021/acs.jchemed.9b00401 [Accessed 13 June 2022].

Crawford, B. & Capps, D. 2016. What knowledge do teachers need for engaging children in science practices? *Cognition, metacognition, and culture in STEM education*, *2*: 1-24. https://www.researchgate.net/profile/Barbara-Crawford-2/publication/281938840 [Accessed 12 May 2021].

Creswell, J.W. & Creswell, J.D. 2017. *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage publications.

Cronje, A. 2011, "The effect of constant curriculum change on the agency and identity of Science teachers: a case study in a developing country", *International Journal of Arts & Sciences,* 4(8): 347-359. https://www.proquest.com/docview/9083 [Accessed 15 June 2021].

Dalton, E.M., Mckenzie, J.A. & Kahonde, C. 2012. The implementation of inclusive education in South Africa: Reflections arising from a workshop for teachers and therapists to introduce Universal Design for Learning. *African Journal of Disability,* 1(1): 1-7. https://hdl.handle.net/10520/EJC131478 [Accessed 03 August 2021].

De Villiers, M.R. 2005. Interpretive research models for informatics: Action Research, Grounded Theory, and the Family of Design-and Development Research. *Alternation*, 12(2): 10-52. https://hdl.handle.net/10520/AJA10231757_388 [Accessed 10 June 2021].

Department Of Education. 2008. National Curriculum Statement: Grades 10-12 (Life sciences). Pretoria, South Africa, Government Printers. www.education.gov.za. [Accessed 24 April 2021].

Department of Education. 2011. Curriculum and Assessment Policy statements (CAPS) for Life Sciences Grades 10-12. Pretoria: National Department of Education. [Accessed 24 April 2021].

Department of Education. 2011. National Curriculum Statement Grades R–12: Curriculum and Assessment Policy (CAPS) Life Sciences. [Accessed 24 April 2021].

Devlin, M. & Samarawickrema, G. 2010. The criteria of effective teaching in a changing higher education context. *Higher Education Research & Development*, *29*(2): 111-124. https://doi.org/10.1080/07294360903244398 [Accessed 10 April 2022].

Dhawan, S. 2020. Online learning: A panacea in the time of COVID-19 crisis. *Journal of educational technology systems,* 49(1): 5-22. doi: 10.1177/00472395211063754.[Accessed 10 July 2022].

Di Pietro, G., Biagi, F., Costa, P., Karpiński, Z. & Mazza, J. 2020. The likely impact of COVID-19 on education: Reflections based on the existing literature and recent international datasets (30275). Luxembourg: Publications Office of the European Union. https://ec.europa.eu/jrc [Accessed 09 July 2022].

Dudu, W.T. 2017. Addressing Content Knowledge Gaps, Didactics and Pedagogy to Improve Teacher Effectiveness in Life Sciences in Dinaledi Schools: A Case Study. uir.unisa.ac.za [Accessed 17 March 2021].

Duit, R., Gropengießer, H., Kattmann, U., Komorek, M., & Parchmann, I. 2012. "The Model of Educational Reconstruction – A Framework for Improving Teaching and

Learning Science". In *Science Education Research and Practices in Europe*. Leiden, The Netherlands: Brill. https://brill.com/view/book/edcoll/9789460919008/BP000003.xml [Accessed 11 November 2021].

El Kadiri, S., Grabot, B., Thoben, K.D., Hribernik, K., Emmanouilidis, C., Von Cieminski, G. & Kiritsis, D. 2016. Current trends on ICT technologies for enterprise information systems. *Computers in Industry,* 79: 14-33. https://doi.org/10.1016/j.compind.2015.06.008 [Accessed 17 July 2022].

Elliott, J. 2006. A curriculum for the study of human affairs: the contribution of Lawrence Stenhouse. In *Rethinking Schooling* (293-310): Routledge. [Accessed 11 April 2022].

Engel B, Esser M, & Bleckwenn M. 2019. Piloting a blended-learning concept for integrating evidence-based medicine into the general practice clerkship. *GMS J Medical Education* 15;36(6): 71. doi: 10.3205/zma001279. PMID: 31844643; PMCID: PMC6905357. [Accessed 16 July 2022].

Esanu, A, & Hatu, C. 2015. The significance of prior knowledge in physics learning. *The International Scientific Conference eLearning and Software for Education*; Bucharest,3. https://www.proquest.com/docview/1681285499?pq-origsite=gscholar&fromopenview=true [Accessed 11 April 2022].

Farooq, M.S., Chaudhry, A.H., Shafiq, M & Berhanu, G. 2011. Factors affecting students' quality of academic performance: a case of secondary school level. *Journal of quality and technology management*, *7*(2): 1-14. https://d1wqtxts1xzle7.cloudfront.net/48101755/01- [Accessed 18 May 2021].

Fauth, B., Decristan, J., Decker, A.T., Büttner, G., Hardy, I., Klieme, E. & Kunter, M. 2019. The effects of teacher competence on student outcomes in elementary science education: The mediating role of teaching quality. *Teaching and Teacher Education,* 86: 102882. https://doi.org/10.1016/j.tate.2019.102882 [Accessed 25 May 2021].

Ferreira, J.G. 2011. Teaching Life Sciences to English second language learners: What do teachers do? *South African Journal of Education*, *31*(1). DOI: 10.15700/saje.v31n1a409. [Accessed 01 August 2022].

Ga, A. 2017. Effective Teaching Strategies September 2017. Conference: Orientation and Refresher Workshop for Teachers. Doi:10.13140/Rg.2.2.34147.09765

Gettinger, M. & Kohler, K.M. 2013. Process-outcome approaches to classroom management and effective teaching. In *Handbook of classroom management* (83-106): Routledge.

Gillies, R.M. & Boyle, M. 2010. Teachers' reflections on cooperative learning: Issues of implementation. *Teaching and Teacher Education*, 26(4): 933-940. https://doi.org/10.1016/j.tate.2009.10.034 [Accessed 22 May 2022].

Godino, J.D., Batanero, C., Cañadas, G. & Contreras, J.M. 2015. Linking inquiry and transmission in teaching and learning mathematics. *CERME 9-Ninth Congress of the European Society for Research in Mathematics Education* (2642-2648). https://hal.archives-ouvertes.fr/hal-01289439. [Accessed 27 May 2022].

Gurvitch, R. & Lund, J. 2014. Animated video clips: Learning in the current generation. *Journal of Physical Education, Recreation and Dance*, 85(5): 8-17. https://doi.org/10.1080/07303084.2014.897566 [Accessed 06 July 2022].

Guzey, S.S., Ring-Whalen, E.A., Harwell, M. & Peralta, Y. 2019. Life STEM: A case study of Life Sciences learning through engineering design. *International Journal of Science and Mathematics Education*, 17(1): 23-42. https://doi.org/10.1007/s10763-017-9860-0 [Accessed 20 June 2022].

Hackling, M.W. & Prain, V. 2005. Primary connections: Stage 2 trial. https://ro.ecu.edu.au/ecuworks/6224/ [Accessed 02 June 2021].

Hakim, A. 2015. Contribution of competence of teacher (pedagogical, personality, professional competence and social) on the performance of learning. *The International Journal of Engineering and Science*, *4*(2): 1-12. https://www.theijes.com/papers/v4-i2/Version-3/A42301012.pdf [Accessed 10 April 2021].

Hoque. E. 2016. Teaching Approaches, Methods, and Techniques. Conference: International Conference on Language education and ResearchAffiliation: University of English and Foreign Languages, DOI:10.13140/RG.2.2.21377.66400

Hsieh, S.W., Jang, Y.R., Hwang, G.J. & Chen, N.S. 2011. Effects of teaching and learning styles on students' reflection levels for ubiquitous learning. *Computers & Education*, *57*(1): 1194-1201. https://doi.org/10.1016/j.compedu.2011.01.004 [Accessed 18 August 2021].

Huggins, D.J., Biggin, P.C., Dämgen, M.A., Essex, J.W., Harris, S.A., Henchman, R.H., Khalid, S., Kuzmanic, A., Laughton, C.A., Michel, J. & Mulholland, A.J. 2019. Biomolecular simulations: From dynamics and mechanisms to computational assays of biological activity. Wiley Interdisciplinary Reviews: *Computational Molecular Science,* 9(3):1393. https://doi.org/10.1002/wcms.1393 [Accessed 15 July 2022].

Hume, A. & Coll, R. 2010. Authentic student inquiry: The mismatch between the intended curriculum and the student-experienced curriculum. *Research in Science & Technological Education*, *28*(1): 43-62. https://doi.org/10.1080/02635140903513565 [Accessed 25 February 2022]

Issac, Jerin C. 2010. Methods and Strategies of Teaching: an overview. Pondicherry University Press

Jackson, C., De Beer, J. & White, L. 2016. Teachers' affective development during an indigenous knowledge professional teacher intervention. https://uir.unisa.ac.za/ [Accessed 30 July 2022].

Jensen, J.L., Kummer, T.A. & Godoy, P.D.D.M. 2015. Improvements from a flipped classroom may simply be the fruits of active learning*. CBE—Life Sciences Education,* 14(1): 5. https://doi.org/10.1187/cbe.14-08-0129 [Accessed 20 October 2021].

Jeroen, H.L, Janssen & Wubbels, T. 2018. Collaborative learning practices: teacher and student perceived obstacles to effective student collaboration, *Cambridge Journal of Education,* 48(1): 103-122, DOI: 10.1080/0305764X.2016.1259389 [Accessed 09 September 2021]

Kalogiannakis, M., Ampartzaki, M., Papadakis, S. & Skaraki, E. 2018. Teaching natural science concepts to young children with mobile devices and hands-on activities. A case study. *International Journal of Teaching and Case Studies*, *9*(2): 171-183. [Accessed 30 July 2022].

Kangas, M., Siklander, P., Randolph, J. & Ruokamo, H. 2017. Teachers' engagement and students' satisfaction with a playful learning environment. *Teaching and Teacher Education*, 63: 274-284. https://www.researchgate.net/profile/Evangelia-Skaraki/publication/323265826 [Accessed 10 June 2022].

Kazeni, M. & Onwu, G. 2013. Comparative effectiveness of context-based and traditional approaches in teaching genetics: Student views and achievement. *African*

Journal of Research in Mathematics, Science and Technology Education, 17(12): 50-62. https://hdl.handle.net/10520/EJC143301 [Accessed 30 July 2021].

Kazeni, M.M.M. 2012. *Comparative effectiveness of context-based and traditional teaching approaches in enhancing learner performance in Life Sciences* (Doctoral dissertation, University of Pretoria). http://hdl.handle.net/2263/24059 [Accessed 27 July 2021].

Kidman, G. 2012. Australia at the crossroads: A review of school science practical work. *Eurasia Journal of Mathematics, Science and Technology Education*, *8*(1): 35-47. https://eprints.qut.edu.au/56064/1/56064.pdf [Accessed 30 August 2021].

Komarraju, M., Karau, S.J., Schmeck, R.R. & Avdic. 2011. The Big Five personality traits, learning styles, and academic achievement. *Personality and individual differences*, *51*(4): 472-477. https://doi.org/10.1016/j.paid.2011.04.019 [Accessed 10 June 2021].

Krahenbuhl, K.S. 2016. Student-centered education and constructivism: Challenges, concerns, and clarity for teachers. The Clearing House: *A Journal of Educational Strategies, Issues and Ideas*, 89(3): 97-105. https://doi.org/10.1080/00098655.2016.1191311 [Accessed 10 June 2021].

Kumar, J.A., Bervell, B. & Osman, S. 2020. Google Classroom: insights from Malaysian higher education students' and instructors' experiences. *Education and information technologies,* 25(5): 4175-4195. https://doi.org/10.1007/s10639-020-10163-x [Accessed 03 July 2022].

Lindorff, A. & Sammons, P. 2018. Going beyond structured observations: looking at classroom practice through a mixed method lens. *ZDM Mathematics Education* 50**:** 521–534. https://doi.org/10.1007/s11858-018-0915-7 [Accessed 07 September 2021].

Love, B., Hodge, A., Corritore, C. & Ernst, D.C. 2015. Inquiry-based learning and the flipped classroom model*. Primus,* 25(8): 745-762. https://doi.org/10.1080/10511970.2015.1046005 [Accessed 15 May 2021].

Lui, A. 2012. Teaching in the Zone. An introduction to working within the Zone of Proximal Development (ZPD) to drive effective early childhood instruction (White paper). [Accessed 29 May 2021].

Lyons, T. 2006. “Different countries, same science classes: Learners‟ experiences in their own words.” *International Journal of Science Education,* 28(6):591-613. Doi.org/10.1080/09500690500339621 [Accessed 20 April 20221].

Makransky G, Thisgaard M.W & Gadegaard, H. 2016. Virtual Simulations as Preparation for Lab Exercises: *Assessing Learning of Key Laboratory Skills in Microbiology and Improvement of Essential Non-Cognitive Skills,*11(6): e0155895.doi: 10.1371/journal.pone.0155895 [Accessed 04 July 2022].

Mansour, N. 2013. Consistencies and Inconsistencies Between Science Teachers' Beliefs and Practices. *International Journal of Science Education,* 35(7):1230-1275. DOI: 10.1080/09500693.2012.743196 [Accessed 19 November 2021].

Margot, K.C. & Kettler, T. 2019. Teachers' perception of STEM integration and education: a systematic literature review. *International Journal of STEM education*, *6*(1): 1-16. https://doi.org/10.1186/s40594-018-0151-2 [Accessed 20 January 2022].

Mavuru, L. & Dudu, W.T. 2020. Advances in inquiry-based science education in Zimbabwean schools. In School science practical work in Africa (32-49): Routledge. [Accessed 19 September 2021].

Mavuru, L. & Ramaila, S. 2019. Integration of learners' socio-cultural experiences in life Sciences classrooms: do learners approve? *EDULEARN19 Proceedings*, 3878-3884. https://www.researchgate.net/ [Accessed 05 August 2021].

Mavuru, L. & Ramnarain, U. 2018. Relationship between teaching context and teachers' orientations to science teaching. *EURASIA Journal of Mathematics, Science and Technology Education*, *14*(8): 1564. https://doi.org/10.29333/ejmste/91910 [Accessed 18 May 2022].

McLeod, S. 2007. Jean Piaget's theory of cognitive development. https://www.simplypsychology.org/piaget.html?campaignid=70161000000RNtB&vid=2120483 [Accessed 23 April 2021].

McLeod, S. A. 2007. Vygotsky. (Online) Available at http://www.simplypsychology.org/vygotsky.html [Accessed 23 April 2021].

McLeod, S.A., 2012. What is the zone of proximal development? https://www.simplypsychology.org/Zone-of-Proximal-Development.html [Accessed 23 April 2021]

McMillan, J. & Schumacher, S. 2006. Research in education Evidence-Based Inquiry (6th ed.). Virginia: Pearson Education.

Mnguni, L. 2018. Citizenship education and the curriculum ideologies of Natural Sciences and Life Sciences curricula in South Africa. *Curriculum Perspectives,* 38(2): 97-106. https://doi.org/10.1007/s41297-018-0044-z [Accessed 19 August 2021]

Moate, R.M. & Cox, J.A. 2015. Learner-Centred Pedagogy: Considerations for application in a Didactic Course. *Professional Counselor*, *5*(3): 379-389. https://eric.ed.gov/?id=EJ1069427 [Accessed 21 January 2022].

Molefe, L., Stears, M. & Hobden, S. 2016. Exploring student teachers' views of science process skills in their initial teacher education programmes. *South African Journal of Education,* 36(3). Doi: 10.15700/saje.v36n3a1279 [Accessed 10 June 2021].

Moore, K.D. 2014. *Effective instructional strategies: From theory to practice*: Sage Publications.

Motallebzadeh, K., Kafi, Z. & Kazemi, S. 2016. EFL Teachers' Perspectives towards Effective Teaching: A Comparative Study. *Caspian Journal of Applied Sciences Research*, *5*(2). https://web.s.ebscohost.com [Accessed 13 May 2022].

Muijs, D. & Reynolds, D. 2017. *Effective teaching: Evidence and practice*: Sage. [Accessed 02 August 2021].

Mvududu, N. 2005. Constructivism in the statistics classroom: From theory to practice. *Teaching statistics,* 27(2): 49-54. https://doi.org/10.1111/j.1467-9639.2005.00208.x [Accessed 10 May 2021].

Mwangi, C.A. and Bettencourt, G.M. 2017. A qualitative toolkit for institutional research*. New Directions for Institutional Research, (*174):11-23. https://doi.org/10.1002/ir.20217 .[Accessed 20 March 2022].

Naqvi, A. & Naqvi, F. 2017. A study on learning styles, gender and academic performance of post-graduate management students in India. *International Journal of*

Economic Management Sciences, *6*(398): 2. DOI: 10.4172/2162-6359.1000398 [Accessed 15 February 2022].

Naqvi, A. 2017. A Study on Learning Styles, Gender and Academic Performance of Post Graduate Management Students in India. *International Journal of Economics Management Science*, 6: 398. https://doi: 10. 4172/2162 – 6359. 1000398. [Accessed 15 February 2022].

National Research Council. 2011. *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics*. National Academies Press. [Accessed 15 June 2021].

Nwosu, C.M. 2019. *An exploratory analysis of pedagogical practices in science classrooms: a case study* (Doctoral dissertation). http://hdl.handle.net/10500/27229 [Accessed 29 May 2021].

Nyback, M. H. 2013. A Constructivist Approach to Teaching and Learning at the Degree Programme in Nursing at Novia University of Applied Sciences. Serie R: Rapporter, 6/2013. https://urn.fi/URN:ISBN:978-952-5839-73-9 [Accessed 31 May 2021].

Olofson, MW., Swallow, MJC & Neumann, MD. 2016. TPACKing: A constructivist framing of TPACK to analyze teachers' construction of knowledge. Computers & Education Volume 95 (2016):188-201, https://doi.org/10.1016/j.compedu.2015.12.010

Onwu, G.O. & Kyle, Jr, W.C.U.O.M., 2011. Increasing the socio-cultural relevance of science education for sustainable development. *African Journal of Research in Mathematics, Science and Technology Education*, *15*(3): 5-26.https://hdl.handle.net/10520/EJC92764 [Accessed 15 November 2021].

Opie, C. 2004. Doing educational research. *Doing Educational Research*:1-264. http://digital.casalini.it/9781473914032 [Accessed 15 April 2021].

Orlich, D.C., Harder, R.J., Callahan, R.C., Trevisan, M.S. & Brown, A.H. 2012. *Teaching strategies: A guide to effective instruction*. Cengage Learning.

Osher D, Kidron Y, Brackett M, Dymnicki A, Jones S, Weissberg RP. 2016. Advancing the Science and Practice of Social and Emotional Learning: Looking Back and Moving

Forward. *Review of Research in Education*, 40(1): 644-681. doi:10.3102/0091732X16673595 [Accessed 30 June 2022].

Osman, A. 2018. *Experiences of physics teachers when implementing problem-based learning: a case study at Entsikeni cluster in the Harry Gwala District Kwazulu-Natal, South Africa* (Doctoral dissertation) https://core.ac.uk/download/pdf/231923017.pdf. [Accessed 16 August 2021].

Ouadoud, M., Nejjari, A., Chkouri, M.Y., El-Kadiri, K.E. 2018. Learning Management System and the Underlying Learning Theories. In: Ben Ahmed, M., Boudhir, A. (eds) Innovations in Smart Cities and Applications: SCAMS 2017. Lecture Notes in Networks and Systems, (3): Springer, Cham. https://doi.org/10.1007/978-3-319-74500-8_67 [Accessed 10 July 2022].

Owen, G.T. 2014. Qualitative methods in higher education policy analysis: Using interviews and document analysis. *The qualitative report,* 19(26):1. https://d1wqtxts1xzle7.cloudfront.net/ [Accessed 15 May 2022].

Parks, A.N. & Bridges-Rhoads, S. 2012. Overly scripted: Exploring the impact of a scripted literacy curriculum on a preschool teacher's instructional practices in mathematics. *Journal of Research in Childhood Education*, *26*(3): 308-324. https://doi.org/10.1080/02568543.2012.684422. [Accessed 10 May 2022]

Penn, M., U. Ramnarain, M. Kazeni, T. Dhurumraj, L. Mavuru,M & Ramaila.S. 2021. "South African primary school learners' understandings about the nature of scientific inquiry." *Education,* 49, (3): 263-274. https://doi.org/10.1080/03004279.2020.1854956 [Accessed 10 June 2021].

Pherson-Geyser, M., de Villiers, R. & Kavai, P. 2020. The Use of Experiential Learning as a Teaching Strategy in Life Sciences. *International Journal of Instruction*, *13*(3): 877-894. www.e-iji.net [Accessed 16 April 2022].

Piaget, J. 1972. Intellectual evolution from adolescent to adulthood. *Human development,* 16: 346-370. https://doi.org/10.1159/000271225 [Accessed 07 May 2021].

Popham, M., Counts, J., Ryan, J.B. & Katsiyannis, A. 2018. A systematic review of self-regulation strategies to improve academic outcomes of students with EBD. *Journal of*

Research in Special Educational Needs, *18*(4): 239-253. https://doi.org/10.1111/1471-3802.12408 [Accessed 27 May 2022].

Pozas, M., Letzel, V. & Schneider, C. 2020. Teachers and differentiated instruction: exploring differentiation practices to address student diversity. *Journal of Research in Special Educational Needs*, *20*(3): 217-230. doi: 10.1111/1471-3802.12481 [Accessed 08 February 2022].

Prasetya, R. 2021. English Teaching Based-Strategy LMS Moodle and Google Classroom. English Education: *Journal of English Teaching and Research,* 6(1): 32-44. https://doi.org/10.29407/jetar.v6i1.15622 [Accessed 09 July 2022].

Preethlall, P. 2015. *The relationship between life sciences teachers' knowledge and beliefs about science education and the teaching and learning of investigative practical work* (Doctoral dissertation). https://ukzn-dspace.ukzn.ac.za/ [Accessed 16 March 2021].

Priestley, M., Edwards, R., Priestley, A. & Miller, K. 2012. Teacher agency in curriculum making: Agents of change and spaces for manoeuvre. *Curriculum Inquiry*, 42(2): 191-214. https://doi.org/10.1111/j.1467-873X.2012.00588.x [Accessed 20 May 2022].

Prosser, M. & Trigwell, K. 2014. Qualitative variation in approaches to university teaching and learning in large first-year classes. *Higher Education*, *67*(6): 783-795. https://doi.org/10.1007/s10734-013-9690-0 [Accessed 15 January 2022].

Rapanta, C., Botturi, L., Goodyear, P., Guàrdia, L. & Koole, M. 2020. Online university teaching during and after the Covid-19 crisis: Refocusing teacher presence and learning activity. *Post-digital science and education,* 2(3): 923-945. https://doi.org/10.1007/s42438-020-00155-y [Accessed 22 July 2022].

Reed, P. 2014. Staff experience and attitudes towards technology-enhanced learning initiatives in one faculty of Health & Life Sciences. *Research in Learning Technology*, *22*. https://doi.org/10.3402/rlt.v22.22770 [Accessed 05 July 2022].

Rehmat, A.P., Bailey, J.M. 2014. Technology Integration in a Science Classroom: Preservice Teachers' Perceptions. *Journal Science Education Technology*, 23: 744–755. https://doi.org/10.1007/s10956-014-9507-7 [Accessed 30 June 2022].

Roig, M.E. 2008. The relationship between learning style preference and achievement in the adult student in a multicultural college, Walden University.

Rumelhart, D.E. & Norman, D.A. 1976. Accretion, tuning and restructuring: Three modes of learning. California Univ San Diego La Jolla Center for human information processing. https://apps.dtic.mil/sti/citations/ADA030406 [Accessed 29 October 2021].

Samaneka, F. 2015. *An exploration of Grade 10 Life Sciences teachers' views on the implementation of the practical examinations in Life Sciences at selected high schools in the Estcourt region* (Doctoral dissertation). https://ukzn-dspace.ukzn.ac.za/ [Access 07 February 2022].

Samuel, K.B. & Dudu, W.T. 2017. Bridging The Knowledge Gap in The Teaching and Learning of Science Subjects: An Opportunity Created For 'Progressed Learners' in One District of The Northwest Province. *Rethinking Education in the 21st Century*. [Accessed 10 March 2022].

Schonert-Reichl, K.A., Kitil, M.J. & Hanson-Peterson, J. 2017. To Reach the Students, Teach the Teachers: A National Scan of Teacher Preparation and Social & Emotional Learning. A Report Prepared for CASEL. *Collaborative for academic, social, and emotional learning*. https://eric.ed.gov/?id=ED582029. [Accessed 02 February 2022].

Schunk, D.H. 2012. *Learning theories an educational perspective sixth edition*: Pearson.

Scott, C.L. 2015. The Futures of Learning 3. What kind of pedagogies for. [Accessed 10 May 2022].

Searson, R. & Dunn, R. 2001. "The learning-style teaching model". *Science and Children,* 38 (5):22-26. [Accessed 12 July 2021].

Sicat, A.S. & Ed, M.A. 2015. Enhancing college students' proficiency in business writing via Schoology. *International Journal of Education and Research*, 3(1): 159-178. [Accessed 17 June 2022].

Sikes, P. 2004. Methodology, procedures and ethical concerns. In C. Opie (Ed.), *Doing educational research* (58-72). London: Sage Publications.

Smetana, L.K. & Bell, R. 2012. Computer Simulations to Support Science Instruction and Learning: A critical review of the literature. *International Journal of Science Education*, 34(9): 1337-1370. DOI: 10.1080/09500693.2011.605182 [Accessed 02 July 2022].

Soylu, F. 2016. An Embodied Approach to Understanding: Making Sense of the World Through Simulated Bodily Activity. Front. Psychology. 7:1914. doi: 10.3389/fpsyg.2016.01914 [Accessed 02 July 2022].

Splitter, L. 2009. Authenticity and Construction in Education, Studies in Philosophy and Education. Springer Science and Business. http://www.springerlink.com/content/53t61n7634849x58/ [Accessed 29 April 2021].

Stains, M. & Vickrey, T. 2017. Fidelity of implementation: An overlooked yet critical construct to establish effectiveness of evidence-based instructional practices. *CBE—Life Sciences Education,* 16(1):1. https://doi.org/10.1187/cbe.16-03-0113 [Accessed 15 July 2022].

Starkey, L. 2010. Teachers' pedagogical reasoning and action in the digital age. *Teachers and Teaching: theory and practice*, *16*(2): 233-244. [Accessed 30 May 2022].

Stronge, J.H, Ward, T.J. & Grant, L.W. 2011. What Makes Good Teachers Good? A Cross-Case Analysis of the Connection Between Teacher Effectiveness and Student Achievement. *Journal of Teacher Education*. 2011;62(4):339-355. doi:10.1177/0022487111404241 [Accessed 15 April 2022].

Sultan, M.F., Asim, M. & Khaskhely, F.Z. 2019. Apparent causes for ineffective teaching in primary schools: evidence from government schools of Karachi. *New Horizons,*13(1): 1992-439. DOI:10.2.9270/NH.13.1(19).12 [Accessed 26 May 2021].

Taasoobshirazi, G. & Carr, M. 2008. A review and critique of context-based physics instruction and assessment. *Educational Research Review*, *3*(2): 155-167.https://doi.org/10.1016/j.edurev.2008.01.002 [Accessed 25 November 2021].

Tabulawa, R. 2013. *Teaching and learning in context: Why pedagogical reforms fail in Sub-Saharan Africa*. African Books Collective.

Takyi, E. 2015. The challenge of involvement and detachment in participant observation. *Qualitative Report*, 20(6). http://www.nova.edu/ssss/QR/QR20/6/tayki2.pdf [Accessed 20 February 2022].

Taneri, P.O. 2010. “Implementation of constructivist Life Sciences curriculum: a case study,” PhD. - Doctoral Program, Middle East Technical University. https://hdl.handle.net/11511/20043 [Accessed 19 November 2021].

Titsworth, S., McKenna, T.P., Mazer, J.P. & Quinlan, M.M. 2013. The bright side of emotion in the classroom: Do teachers' behaviours predict students' enjoyment, hope, and pride? *Communication Education*, *62*(2): 191-209. https://doi.org/10.1080/03634523.2013.763997 [Accessed 22January 2022].

Ültanir, E. 2012. An epistemological glance at the constructivist approach: Constructivist learning in Dewey, Piaget, and Montessori. *International journal of instruction*, *5*(2). www.e-iji.net [Accessed 05 April 2015].

Van Driel, J. 2021. The development of preservice chemistry teachers’ pedagogical content knowledge. In *Science Teachers’ Knowledge Development* (157-191): Brill. [Accessed 16 March 2022].

Van Graan, D.C. 2020. *Exploring inquiry-based education in a professional learning programme for science teachers* (Doctoral dissertation, Stellenbosch: Stellenbosch University). http://hdl.handle.net/10019.1/109244 [Accessed 30 July 2021].

Van Suid-Afrika, R. 2012. Department of Basic Education. Annual Report 2010/2011. [Accessed 12 April 2021].

Van Wyk, G. 2013. *The professional development of life sciences teachers’ pedagogical content knowledge and profile of implementation concerning the teaching of DNA, meiosis, protein synthesis and genetics within a community of practice* (Doctoral dissertation, University of Johannesburg). [Accessed 13 May 2021].

Van Wyk, M. M. 2013. Exploring Students Perceptions of Blogs During Teaching Practice Placements. *Mediterranean Journal of Social Sciences*, 4(14): 525.ISSN 2039-2117.]https://www.mcser.org/journal/index.php/mjss/article/view/ [1634. accessed 12 July 2022].

Vermunt, J.D. & Endedijk, M.D. 2011. Patterns in teacher learning in different phases of the professional career. *Learning and individual differences*, *21*(3): 294-302. [Accessed 12 July 2022].

Veselinovska, S.S., Gudeva, L.K. & Djokic, M. 2011. Applying appropriate methods for teaching cell biology. *Procedia-Social and Behavioral Sciences,* 15: 2837-2842. https://doi.org/10.1016/j.sbspro.2011.04.199 [Accessed 20 November 2021].

Vollman, A. R., Anderson, E. T. & McFarlane, J. 2004. Canadian Community as partner. Philadelphia, PA: Lippincott Williams & Wilkins. [Accessed 15 May 2022].

Vygotsky, L. S. 1978. Mind in society: The development of higher mental process. Cambridge, MA: Harvard University Press. [Accessed July 2021].

Wallace, C.S. & Kang, N.H. 2004. An investigation of experienced secondary science teachers' beliefs about inquiry: An examination of competing belief sets. *Journal of Research in Science Teaching*, *41*(9): 936-960. https://doi.org/10.1002/tea.20032 [Accessed 20 March 2022].

Wargadinata, W., Maimunah, I., Eva, D. & Rofiq, Z. 2020. Students' responses on learning in the early COVID-19 pandemic. Tadris: *Journal of Education and Teacher Training*, 5(1):141-153. http://ejournal.radenintan.ac.id/index.php/tadris [Accessed 22 July 2022].

Wiesen, G. 2022. What Is a Teaching Methodology? Last Modified Date: May 28, 2022, https://www.languagehumanities.org/what-is-a-teaching-methodology.htm [Accessed 21 June 2022].

Williams, K. & Williams, C. 2011. Five key ingredients for improving motivation. *Research in Higher Education Journal,* 11. http://aabri.com/manuscripts/11834.pdf [Accessed 13 June 2021].

Willingham, D.T. 2020. Ask the Cognitive Scientist: How Can Educators Teach Critical Thinking? American Educator, 44(3):41. [Accessed 20 July 2021].

Wirth, K.R. & Perkins, D. 2008. Learning to learn [Accessed 30 May 2022].

Wong, A.C.K. 2014. Moving From a Transmission to a Social Reform Teaching Perspective: Using Teachers 'Action Research as Critical Pedagogy in Higher

Education. *The Canadian Journal of Action Research*, *15*(3): 48-64. https://doi.org/10.33524/cjar.v15i3.157 [Accessed 21 July 2021].

Wright, G. Analysis of Five Instructional Methods for Teaching Sketchpad to Junior High Students. Journal of Technology Education 24 (1):54-72. https://files.eric.ed.gov/fulltext/EJ991240.pdf

York, T.T., Gibson, C. & Rankin, S. 2015. Defining and measuring academic success. *Practical assessment, research, and evaluation*, *20*(1): 5. https://doi.org/10.7275/hz5x-tx03 [Accessed 15 May 2021].

Zhang, G., Zeller, N., Griffith, R., Metcalf, D., Williams, J., Shea, C. and Misulis, K. 2011. Using the context, input, process, and product evaluation model (CIPP) as a comprehensive framework to guide the planning, implementation, and assessment of service-learning programs. *Journal of Higher Education Outreach and Engagement*, *15*(4): 57-84. [Accessed 13 March 2022].

APPENDICES

Appendix A: CPUT Ethical clearance to conduct research

Cape Peninsula
University of Technology

Faculty of Education
Highbury Road
Mowbray
7700
Tel: +27 21 959 6583

FACULTY OF EDUCATION

On the **9 December 2021** the Chairperson of the Faculty of Education Ethics Committee of the Cape Peninsula University of Technology granted ethics approval **(EFEC 6-12/2021)** to **Z. Mkhanyiswa** for an MEd degree.

Title:	**Exploring alternative pedagogies for teaching of Grade 11 Further Education and Training Life Sciences.**

Comments:

The EFEC unconditionally grants ethical clearance for this study. This clearance is valid until **31st December 2024**. Permission is granted to conduct research within the **Faculty of Education only**. Research activities are restricted to those details in the research project as outlined by the Ethics application. Any changes wrought to the described study must be reported to the Ethics committee immediately.

Date: 15 December 2021

Dr Zayd Waghid
Chair of the Education Faculty Ethics committee (EFEC)
Faculty of Education

Appendix B: WCED permission letter to conduct research at the chosen school

Western Cape Government
Education

Directorate: Research

meshack.kanzi@westerncape.gov.za
Tel: +27 021 467 2350
Fax: 086 590 2282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20220527-2560
ENQUIRIES: Mr M Kanzi

Mr Zukisani Mkhanyiswa
19 Bain Street
Wellington
7655

Dear Zukisani Mkhanyiswa,

RESEARCH PROPOSAL: EXPLORING ALTERNATIVE PEDAGOGIES FOR TEACHING OF FURTHER EDUCATION AND TRAINING IN SCHOOL LIFE SCIENCES.

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **27 May 2022 till 30 September 2022.**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Mr M Kanzi at the contact numbers above quoting the reference number.
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards,
Meshack Kanzi
Directorate: Research
DATE: 27 May 2022

1 North Wharf Square, 2 Lower Loop Street, Foreshore, Cape Town 8001
tel: +27 21 467 2531

Private Bag X 9114, Cape Town, 8000
Safe Schools: 0800 45 46 47
wcedonline.westerncape.gov.za

Appendix C: Consent form for participants

CONSENT FORM FOR THE RESEARCH

- I .... voluntarily agree to participate in this research study.

- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
- I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.
- I have understood the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.
- I understand that participation involves answering questions asked.
- I understand that I will not benefit directly from participating in this research.
- I agree to my interview being audio-recorded.
- I understand that all information I provide for this study will be treated as confidentiality.
- I understand that in any report on the results of this research my identity will remain anonymous. This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of the people I speak about.
- I understand that if I inform the researcher that myself or someone else is at risk of harm they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission.
- I understand that under freedom of information legalisation I am entitled to access the information I have provided at any time while it is in storage as specified above.
- I understand that I am free to contact any of the people involved in

the research to seek further clarification and information.

Signature of research participant

-- ---------------------------------

Signature of participant Date

-- -------------------------------

Parent's signature Date

I believe the participant is giving informed consent to participate in this study

--- -------------------------

Signature of researcher Date

Appendix D: Research instruments (lesson plans and assessments)

Name of the teacher	Mr Z. Mkhanyiswa
School:	North Face High school
Grade	11
TOPIC 1	BIODIVERSITY AND CLASSIFICATION OF MICROORGANISMS (FUNGAE, PROTISTA AND MONERA)
Lesson Objective(s)	At the end of the lesson, Learners would be able to: • Which diseases are caused by microorganisms in these kingdoms? • Explain what causes each disease. • Identify different symptoms. • Understand how to treat these diseases.
Teaching Methods	• A dialogue between a teacher and students. • Group discussion • Brainstorming • Work in groups Question and answer
Teachers' actions and Learner's activities	• The lesson will be teacher and learner centred since it will be a dialogue. • Learners will be able to use prior knowledge on diseases such as TB, HIV, and Malaria division from Life Orientation. • Learners will work in groups of 5 and choose one disease caused by microorganisms. • The teacher will facilitate the session by going from table to table to any questions related to the task.
Teaching Resources	• Textbook • Handouts. • Internet. • Newspapers and magazines
Assessmen t(s)	• Learners will be given Group work and will be required to share their work with the class **(Refer to Microorganism Task)**. There will be also a question session between learners and teachers as well.

LIFE SCIENCES GROUP TASK

Educator: Mr Z. Mkhanyiswa

The following task contains PART A and Part B You are required to form a group of 5 for this task. **PART A (Research)**

This task requires students to do research on any disease that is caused by fungi, monera and Protists based on the following:

1. The name of diseases
2. The causes of the disease of your choice
3. Symptoms (10)
4. South African/ Global Statistics regarding the disease of your choice. (10)
5. Treatment of that particular disease. (10)

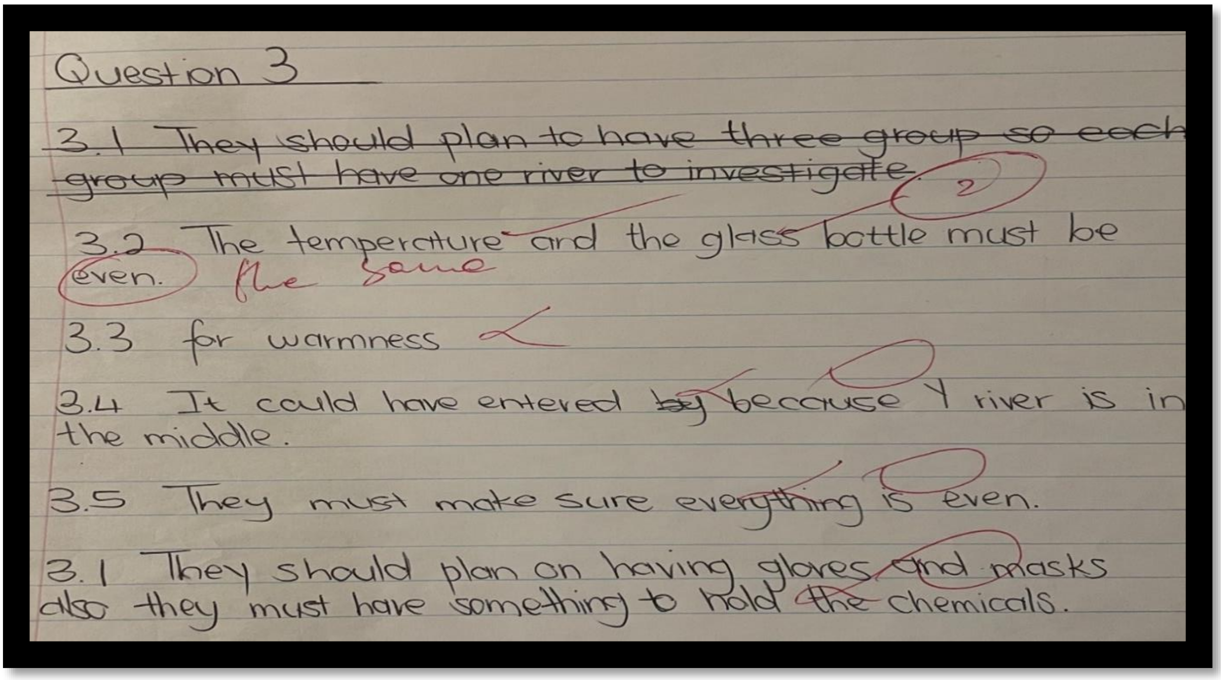
PART B (Presentation)

Present your research to the class with your group. There will be a question session after each presentation. **(20)**

NB: Choose from the following diseases:

Influenza, Rabies, TB, Cholera, Anthrax, Malaria, Rust, and Thrush.
TOTAL= 50 Marks

NB: CONTROL TEST FOR MARCH 2022 (QUESTION 3 FROM BIODIVERSITY OF MICROORGANISMS)



Question 3

~~3.1 They should plan to have three group so each group must have one river to investigate.~~ 2

3.2 The temperature and the glass bottle must be even. the same

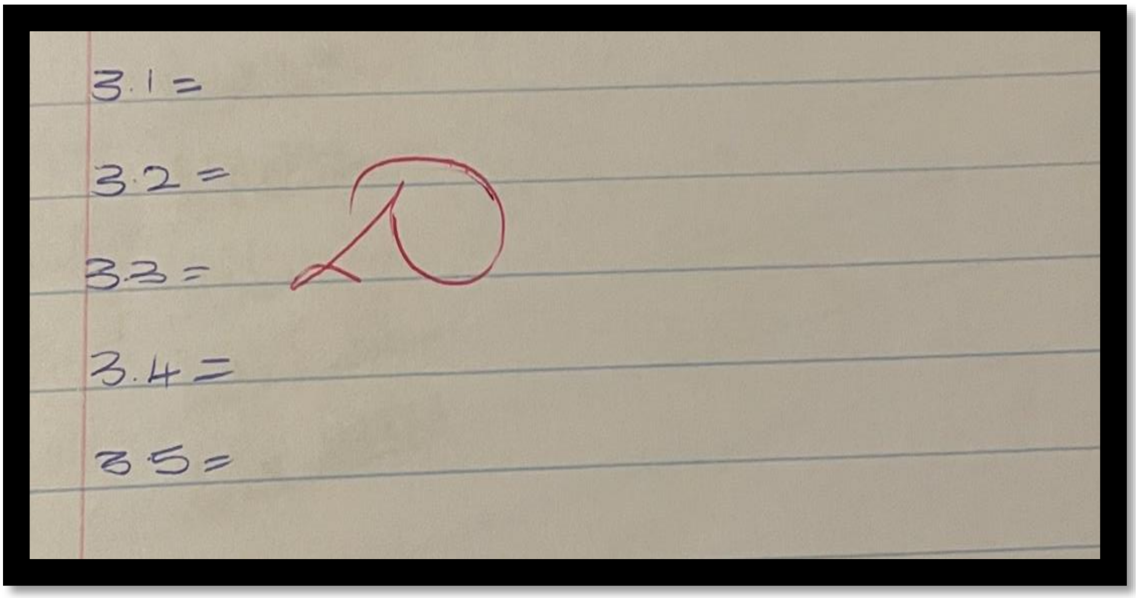
3.3 for warmness

3.4 It could have entered ~~by~~ because Y river is in the middle.

3.5 They must make sure everything is even.

3.1 They should plan on having gloves and masks also they must have something to hold the chemicals.

(a)



3.1 =

3.2 =

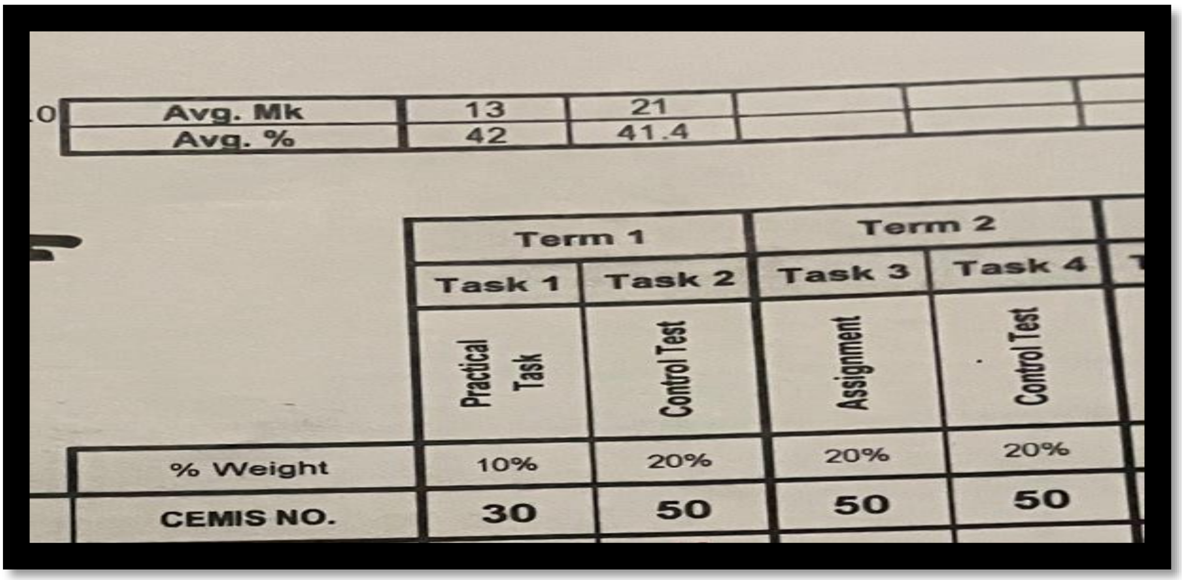
3.3 =

3.4 =

3.5 =

(b)

Figure 4.2 (a) and (b): Shows question 3 that was poorly answered by learners in the topic 1 test.



Avg. Mk	13	21		
Avg. %	42	41.4		

	Term 1		Term 2	
	Task 1	Task 2	Task 3	Task 4
	Practical Task	Control Test	Assignment	Control Test
% Weight	10%	20%	20%	20%
CEMIS NO.	30	50	50	50

Figure 4.2 (c): Illustrates the average percentage obtained by the learners on the controlled test.

Name of the teacher	Mr Z. Mkhanyiswa
School:	North Face High school
Grade	11
TOPIC 2	PHOTOSYNTHESIS
Lesson Objective(s)	At the end of the lesson, Learners would be able to: • Know what photosynthesis is. • Recall the requirements of photosynthesis • Understand two phases of Photosynthesis • Differentiate between the Light and Dark phase
Teaching Methods	• A dialogue between a teacher and students. • Group discussion • Question and answer
Teachers' actions and Learner's activities	• The lesson will be teacher and learner centred since they have prior knowledge about Photosynthesis from previous grades • The teacher will explain the two phases of photosynthesis • The teacher will also ask learners to recall the requirements of photosynthesis. .
Teaching Resources	• Textbook • Handouts.

Assessment(s)	Learners will be given a Practical task and a photosynthesis test. Refer to Photosynthesis practical task.

Grade 11: Photosynthesis

Practical lesson on Photosynthesis Educator: Mr Z. Mkhanyiswa

PHOTOSYNTHESIS TASK

Starch Testing Experiment in Plants What You Need:

Two plants

Beaker or glass jar

Saucepan on the stove

- Ethyl alcohol
- Iodine solution
- Tweezers

Steps for testing starch

1. Place one of the plants in a dark room for 24 hours; place the other one on a sunny windowsill.
2. Wait 24 hours.
3. Fill the beaker or jar with ethyl alcohol.
4. Place the beaker or jar in a saucepan full of water.
5. Heat the pan until the ethyl alcohol begins to boil.
6. Remove from the heat.
7. Dip each of the leaves in the hot water for 60 seconds, using tweezers.
8. Drop the leaves in the beaker or jar of ethyl alcohol for two minutes (or until they turn almost white).
9. Set them each in a shallow dish.
10. Cover the leaves with some iodine solution and watch.

OBSERVATION:

The hot water kills the leaf, and the alcohol breaks down the chlorophyll, taking the green colour out of the leaf. When you put iodine on the leaves, one of them will turn blue-black and the other will be reddish-brown. Iodine is an indicator that turns blue-black in the presence of starch. The leaf that was in the light turns blue-black, which demonstrates that the leaf has been performing photosynthesis and producing starch.

Try the test again with a variegated leaf (one with both green and white) that has been in the sunlight. A leaf needs chlorophyll to perform photosynthesis — based on that information, where on the variegated leaf do you think you would find starch?

Based on the study formulate your hypothesis, identify variables, collect and analyse data, and draw conclusions. **15 MARKS**

Group 1

[redacted]

Grade 1[redacted]

Life Sciences Practical

Results of the investigation

The Value of starch test

The plant that was investigated as an experiment was given the following:

- Carbon dioxide, from the atmosphere around the plant
- Water
- light energy that came from the sun.

You did not answer the question

The plant was green, which means it contained chlorophyll. We used a living plant, so we can therefore assume that it contained some enzymes that are used to control all living processes such as photosynthesis.

In our investigation, the plant was allowed to photosynthesise by ensuring that all ~~five~~ 3 requirements were present. It produced glucose which was converted to starch. This means that we can use the presence of starch in the leaves of a plant as proof that it photosynthesised. We can be equally certain that if the leaves of a plant do not have starch, then photosynthesis did not take place as we investigated another plant as a control and was

Figure 4.3: Shows how one group answered a practical task on photosynthesis.

PHOTOSYNTHESIS AND RESPIRATION TEST

INSTRUCTIONS AND INFORMATION

Read the following instructions carefully before answering the questions.

1. Answer ALL the questions.
2. Write ALL the answers in the ANSWER BOOK.
3. Start the answers to EACH question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. Make ALL drawings in pencil and label them in blue or black ink.
7. Draw diagrams, flow charts or tables only when asked to do so.
8. The diagrams in this question paper are NOT necessarily drawn to scale.
9. Do NOT use graph paper.
10. You must use a non-programmable calculator, protractor and a compass where necessary.
11. Write neatly and legibly.

SECTION A

QUESTION 1

1.1 Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (1.1.1 to 1.1.3) on your ANSWER SHEET, for example

1.1.4 D.

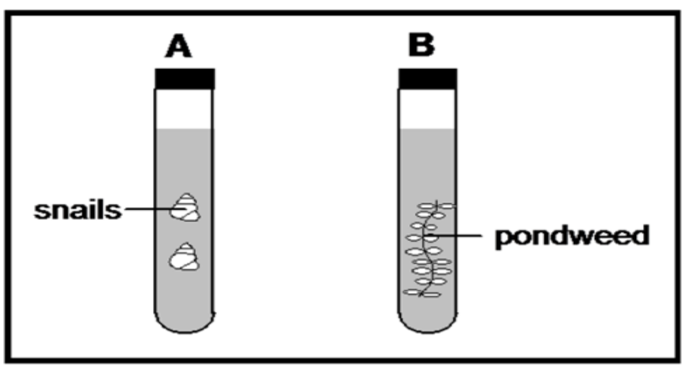
1.1.1 The following are involved in the process of cellular respiration:

1. Water
2. Energy
3. Oxygen
4. Carbohydrates
5. Carbon dioxide

Which ONE of the following equations correctly represents their involvement in the process of cellular respiration?

A 1 + 2 = 3 + 4 + 5
B 2 + 3 = 1 + 4 + 5
C 3 + 4 = 1 + 2 + 5
D 4 + 5 = 1 + 2 + 3

1.1.2 Test tubes **A** and **B** below were placed in bright light.



Which of the following is correct regarding the test tubes?

A CO_2 will be used in test tube **A**.
B CO_2 will be used in test tubes **A** and **B**.
C O_2 and CO_2 will be produced in test tube **B**.
D O_2 and CO_2 will be produced in test tubes **A** and **B**.

1.1.3 Cellular respiration in a green leaf takes place …

A continuously.

B during the day only.
C during the night only.
D in tissues without chlorophyll only. (3 x 2)
(6)

1.2 Give the correct **biological term** for each of the following descriptions. Write only the term next to the question number (1.2.1 to 1.2.4) on your ANSWER SHEET.

1.2.1 The concentration of sense organs at the anterior end of an animal leading to the formation of a head.
1.2.2 The cell organelles that synthesise enzymes for photosynthesis.
1.2.3 The plastid that absorbs radiant energy during photosynthesis.
1.2.4 The top layer of a leaf which is transparent to allow light through

1.3 Indicate whether each of the statements in COLUMN I applies to **A only**, **B only**, **both A and B** or **none** of the items in COLUMN II. Write **A only**, **B only**, **both A and B** or **none** next to the question number (1.3.1 to 1.3.3) on your ANSWER SHEET, for example 1.3.4 B only.

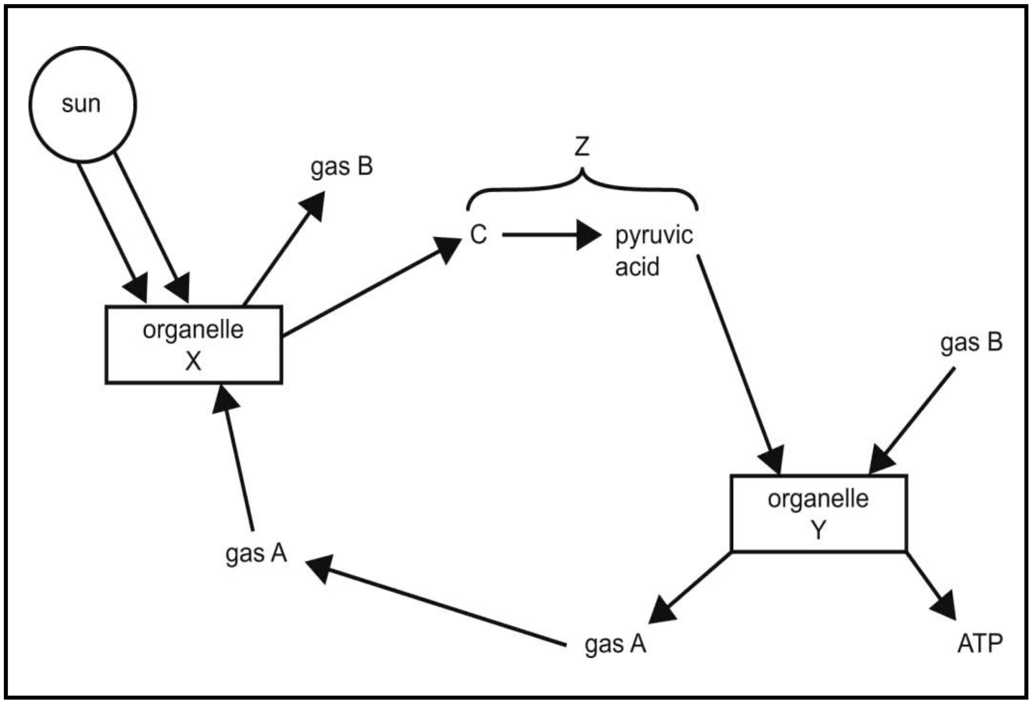
	COLUMN I	COLUMN II
1.3.1	Organisms that are able to manufacture their own food	A: Autotrophs B: Heterotrophs
1.3.2	Contains chlorophyll to trap sunlight for photosynthesis	A: Granum B: Stroma
1.3.3	During vigorous exercise, lactic acid is released in the muscle cells	A: Aerobic respiration B: Anaerobic respiration

(3 x 2) **(6)**
TOTAL SECTION A: 16

SECTION B

QUESTION 2

2.1 Study the diagram below and answer the questions that follow.



2.1.1 Identify organelles **X** and **Y**. (2)

2.1.2 Which biochemical processes are occurring inside organelle **X** and organelle **Y**? (2)

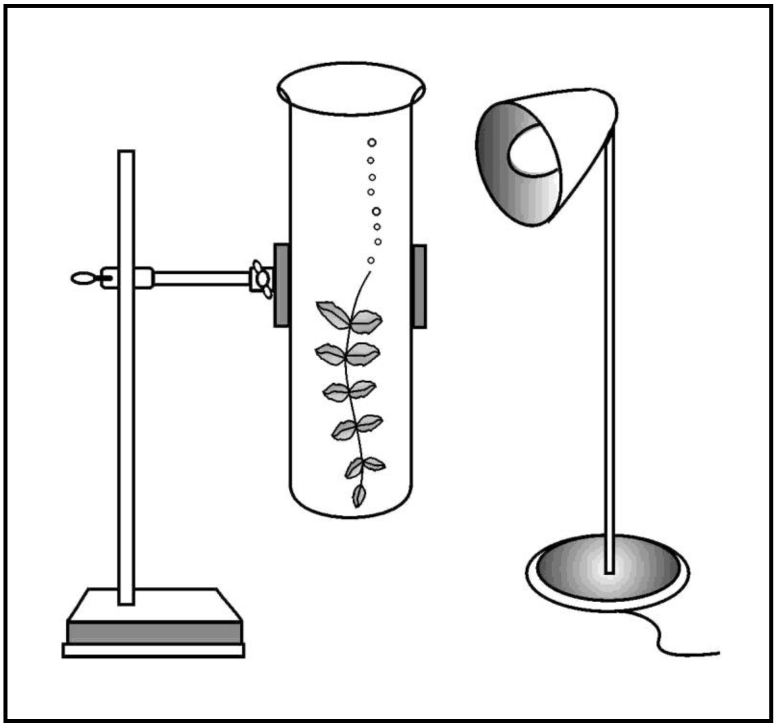
2.1.3 Tabulate THREE differences between photosynthesis and cellular respiration. (7)

2.1.4 Provide labels for **A**, **B** and **C**. (3)

2.1.5 Name the chemical process indicated by **Z**. (1)

(15)

2.2 Xabiso wants to investigate factors that affect the rate of photosynthesis. He uses a water plant, lamp, thermometer and a light meter. Xabiso sets up the experiment as shown below. He gradually moves the lamp closer to the water plant. At various distances from the water plant, he reads the light intensity using the light meter. He measures the rate of photosynthesis by counting the number of bubbles produced per minute at each light intensity.



2.2.1. Which factor affecting the rate of photosynthesis is Xabiso trying to measure?
(1)

2.2.2. Provide a hypothesis for Xabiso's investigation. (2)

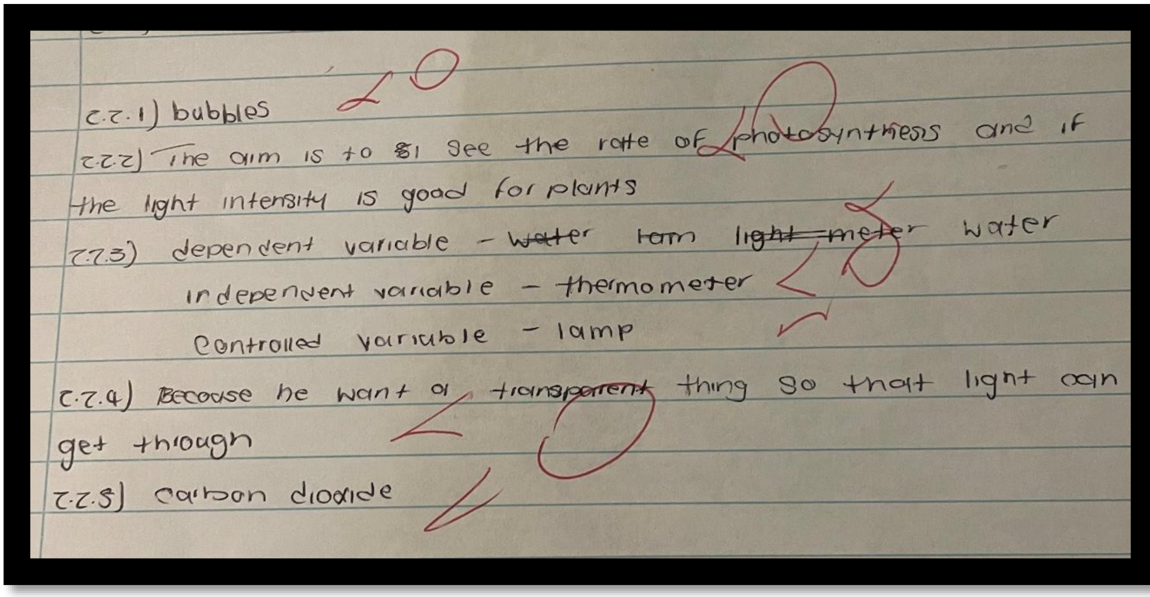
2.2.3. Identify the:
a) dependent variable (1)
b) independent variable (1)
c) controlled variables (1)

2.2.4. Why does Xabiso use a water plant rather than a pot plant? (2)

2.2.5. Which gas is being released? (1)

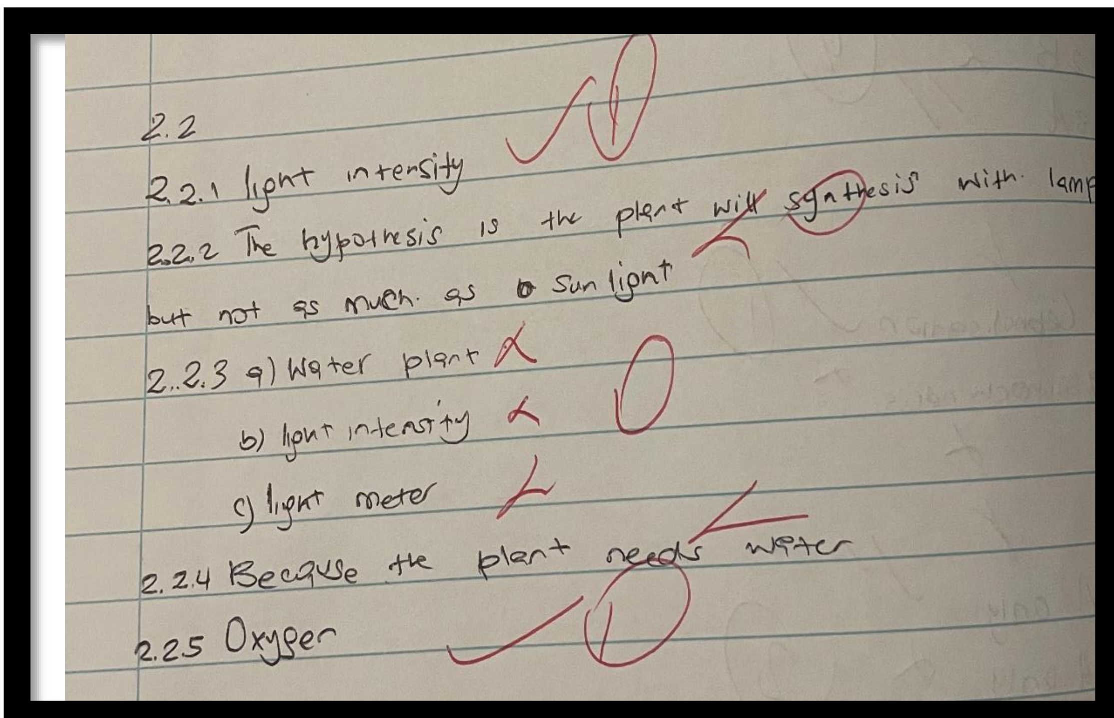
(9)

GRAND TOTAL: 50



2.2.1) bubbles
2.2.2) The aim is to ~~81~~ see the rate of photosynthesis and if the light intensity is good for plants
2.2.3) dependent variable - ~~water~~ rom ~~light meter~~ water
independent variable - thermometer
controlled variable - lamp
2.2.4) Because he want a transparent thing so that light can get through
2.2.5) carbon dioxide

(a)



2.2
2.2.1 light intensity
2.2.2 The hypothesis is the plant will synthesis with lamp but not as much as sun light
2.2.3 a) Water plant
b) light intensity
c) light meter
2.2.4 Because the plant needs water
2.2.5 Oxygen

(b)

Figure 4.4 (a) and (b): Shows how learners answered a question relating to scientific concepts.

Name of the teacher	Z. MKHANYISWA
School:	North Face High school
Grade	11
TOPIC 3	Cellular Respiration
Lesson Objective(s)	At the end of the lesson, Learners would be able to: • Define what cellular respiration is. • Explain two types of cellular respiration and their by-products • Explain different stages of cellular respiration • Describe the role of anaerobic respiration in the production of alcohol and bread.
Teaching Methods	The lesson will be teacher-centred since it will be their first time learning about cellular respiration in depth. • Teacher presentation and explanation • Question and answer
Teaching Resources	• Textbook • PowerPoint presentation • Handouts.
Assessment(s)	Learners will be given a homework and later write a test after all the Concepts in the lesson has been taught **(Refer to Cellular respiration TASK).**

DATE: 15 May 2022

CELLULAR RESPIRATION

TIME: 30 minutes

MARKS

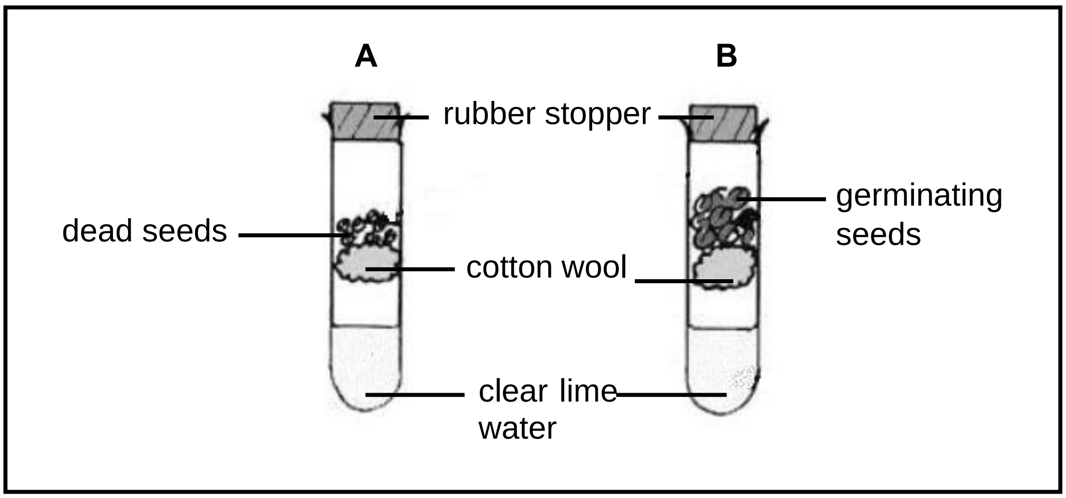
30

NAME: ………………………………………………..

QUESTION 1

1.1 Learners wanted to investigate if germinating seeds release carbon dioxide during respiration.

The learners:
- Set up the investigation as indicated below
- Sterilised both sets of seeds before they placed it inside the test tubes
- Left the apparatus in a safe place
- Recorded any colour change of the clear lime water in both test tubes after TWO days



1.1.1 Provide an investigative question for the experiment.

____

____ (2)

1.1.2 State the following for the investigation:

(a) Dependent variable

____ (1)

(b) Independent variable

____ (1)

(c) TWO fixed (controlled) variables

____

____ (2)

1.1.3 Why were the seeds sterilised at the start of the investigation?

____

____ (1)

1.1.4 What colour change was observed in test tube:

A

____ (1)

B

____ (1)

1.1.5 Give a reason for the colour change in test tube **B**.

____ (1)

1.1.6 Why can experiment **A** serves as a control?

____ (2)

(12)

1.2 The following table shows the relation between the amount of FOUR gasses present in exhaled air. Other gasses contribute to more or less 1%.

Type of gas	**Average percentage of gas per volume of exhaled air (%)**
Water vapour	5
Nitrogen	78
Oxygen	12
Carbon dioxide	4

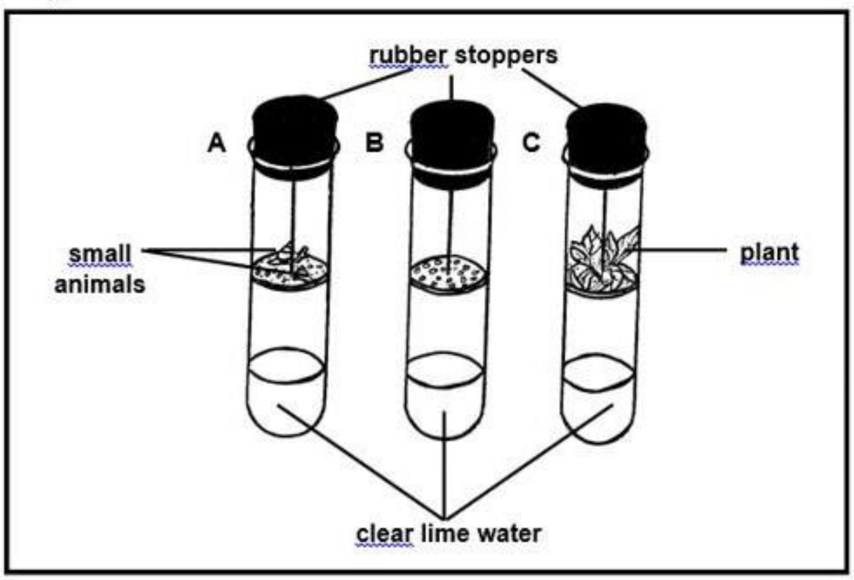
Draw a bar graph of the information in the table.

(6) QUESTION 2

2.1 A group of Grade 11 learners conducted an investigation after having gathered facts about cellular respiration and photosynthesis.

The learners set up the investigation as shown in the diagram. They:

- Placed small living animals and a healthy plant onto thin discs cut from a spongy material into two test tubes
- Kept a third test tube without any living organisms
- Placed all three test tubes in a room with bright, natural sunlight



2.1.1 What is the purpose of using:

(a) Rubber stoppers in each test tube

____ (1)

(b) The spongy disks

____ (1)

2.1.2 State TWO ways in which the reliability of this investigation can be improved.

____

____ (2)

2.1.3 Predict the results expected in the following test tubes after a few hours:

A ____

C ____ (2)

2.1.4 Give a reason for your answer in QUESTION 2.1.3 - Test tube **C**

____

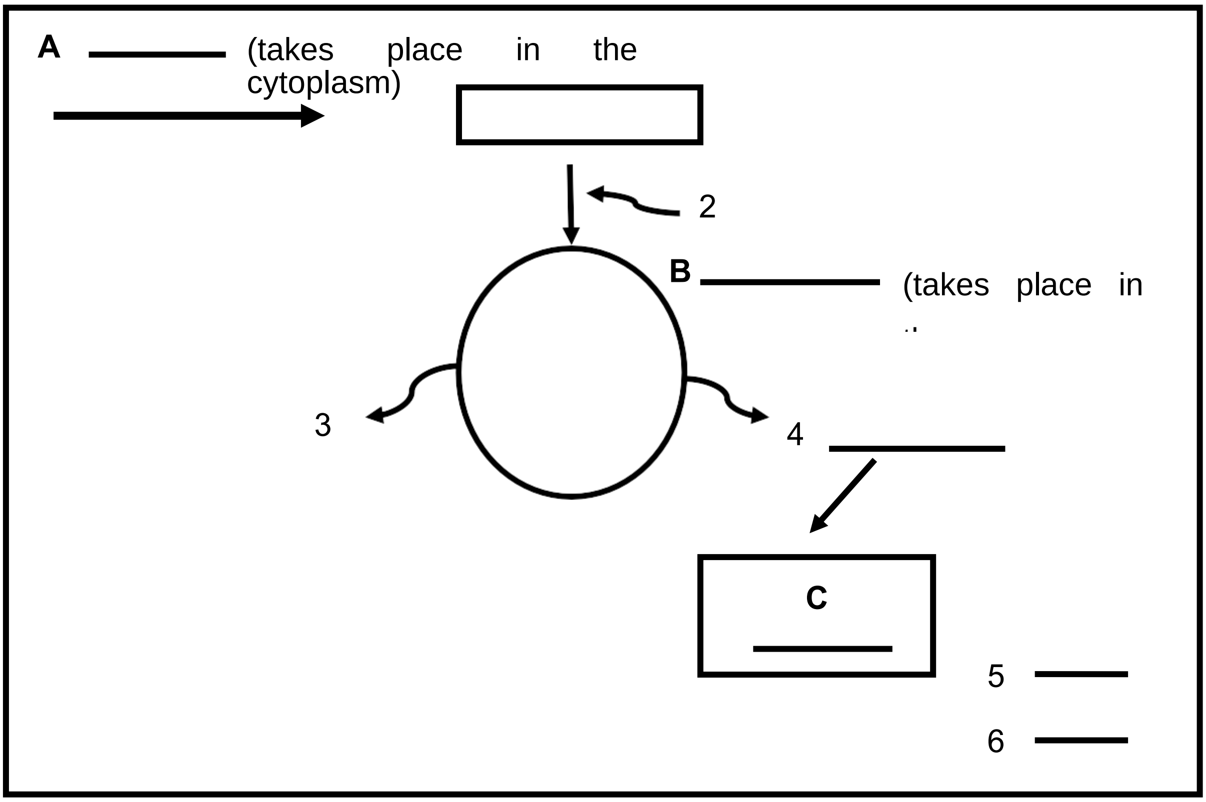
____

____ (2)

(8)

QUESTION 3

3.1 Answer the questions on the schematic presentation of the process of cellular respiration.



3.1.1 Name the following phases in the process of respiration:

A ____ (1)

B ____ (1)

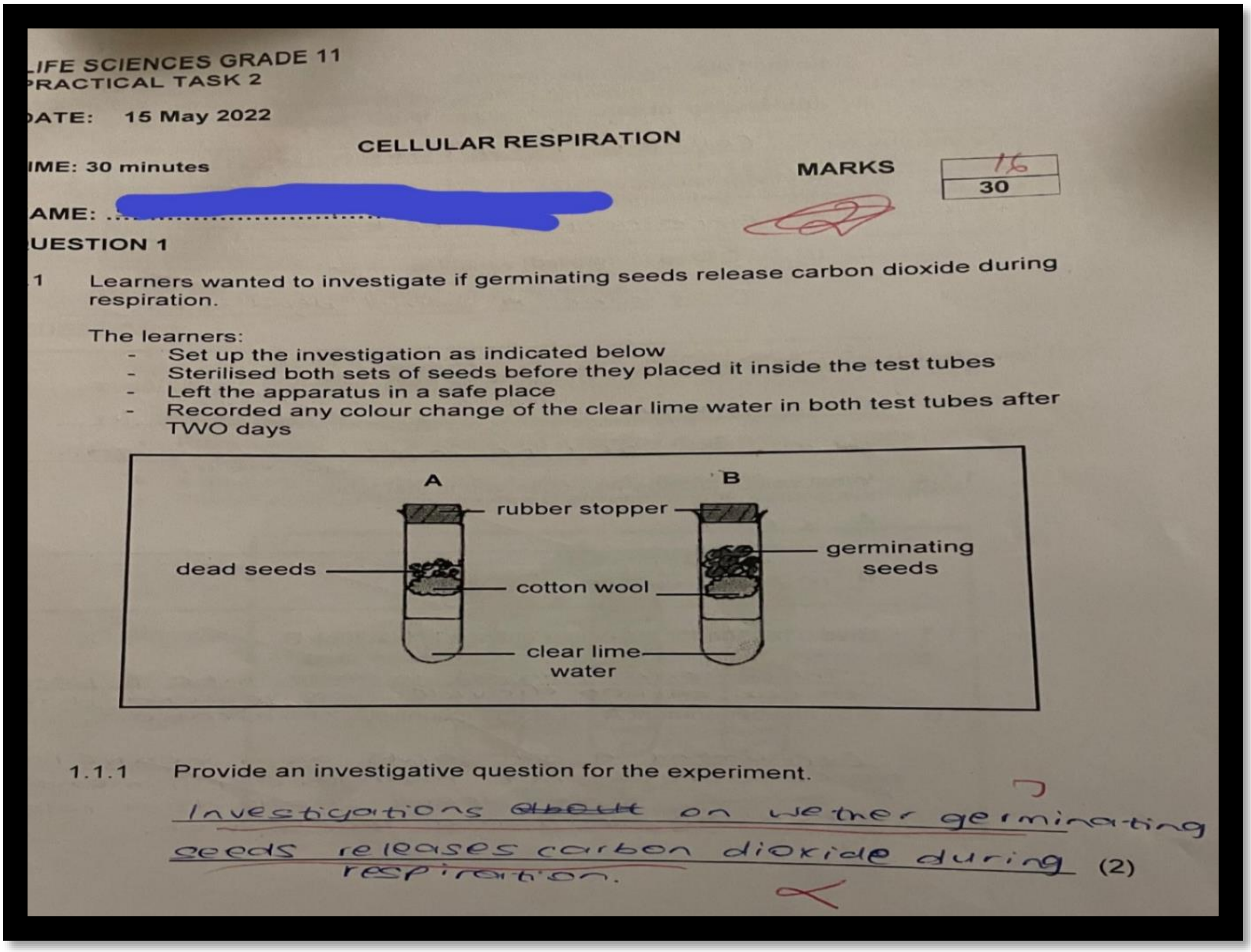
3.1.2 Name the gas:

2 ____ (1)

3 ____ (1)

(4)

TOTAL: 30



LIFE SCIENCES GRADE 11
PRACTICAL TASK 2

DATE: 15 May 2022

CELLULAR RESPIRATION

TIME: 30 minutes

MARKS 16/30

NAME: [redacted]

QUESTION 1

1.1 Learners wanted to investigate if germinating seeds release carbon dioxide during respiration.

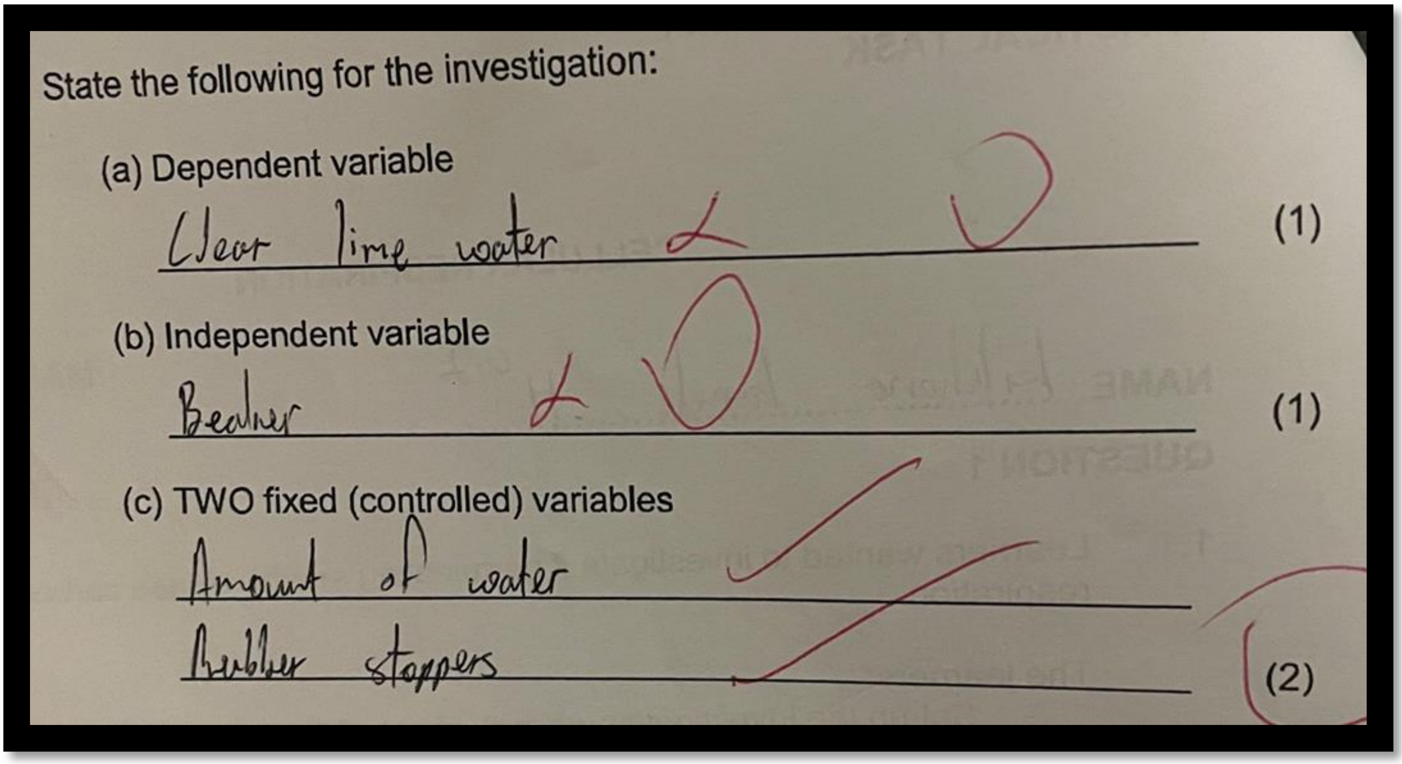
The learners:

- Set up the investigation as indicated below
- Sterilised both sets of seeds before they placed it inside the test tubes
- Left the apparatus in a safe place
- Recorded any colour change of the clear lime water in both test tubes after TWO days

1.1.1 Provide an investigative question for the experiment.

Investigations ~~about~~ on wether germinating seeds releases carbon dioxide during respiration. (2)

Figure 4.5 (a): Shows how one learner responded to question 1.1.1



State the following for the investigation:

(a) Dependent variable

Clear lime water (1)

(b) Independent variable

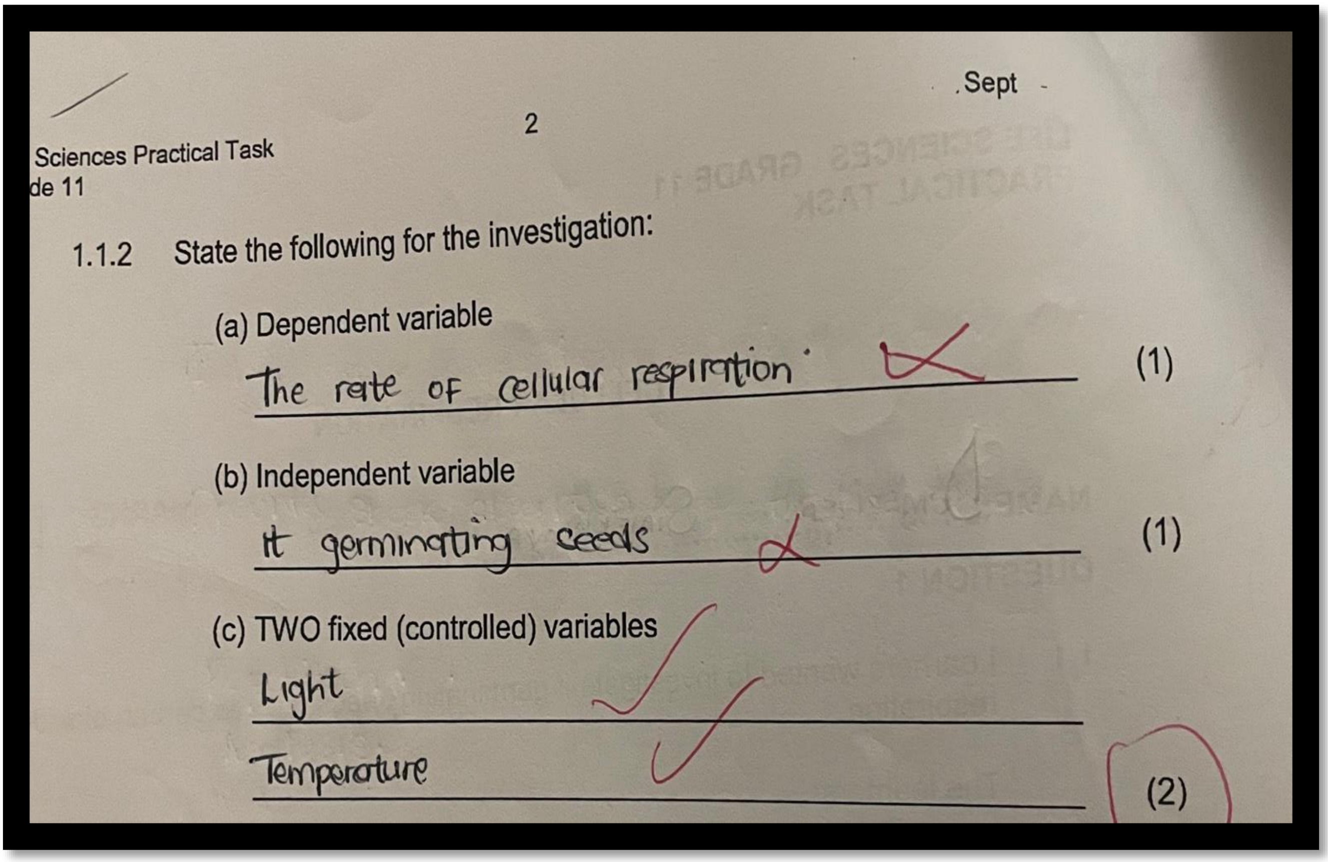
Beaker (1)

(c) TWO fixed (controlled) variables

Amount of water

Rubber stoppers (2)

(b



Sept

2

Sciences Practical Task

de 11

1.1.2 State the following for the investigation:

(a) Dependent variable

The rate of cellular respiration (1)

(b) Independent variable

It germinating seeds (1)

(c) TWO fixed (controlled) variables

Light

Temperature (2)

(c)

Figure 4.5 (b) and (c): Show how learners answered questions relating to variables.

Name of the teacher	Mr Z. Mkhanyiswa
School:	North Face High school
Grade	11
TOPIC 4	EXCRETORY SYSTEM
Lesson Objective(s)	At the end of the lesson, Learners would be able to: • Know what excretion is. • Recall the human excretory organs • Understand which metabolic substances are associated with each excretory organ. • Describe the role of kidneys in the excretory system

Teaching Methods	• a classroom session with teacher and students. • Question and answer

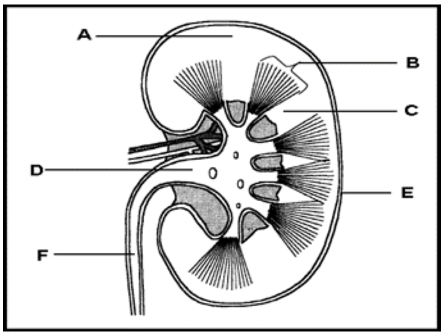
Teachers' action and Learner's activities	• The lesson will be teacher and learner centred since they have prior knowledge on excretion from grade 9 • The teacher will explain the why excretion is necessary. • The teacher will explain how the waste gets excreted in the blood, liver, and kidneys • . .
Teaching Resources	• Textbook • Handouts. • Internet • Powerpoint presentation with videos
Assessment(s)	Learners will be given a take-home test .

TAKE HOME TEST ON HUMAN EXCRETORY SYSTEM
INSTRUCTIONS AND INFORMATION

Read the following carefully before answering the questions:
1. Answer ALL the questions.
2. Number the answers correctly according to the numbering system used in this question paper.
3. Present your answers according to the instructions of each question.
4. ALL drawings should be done in pencil and labelled in blue or black ink.
5. The diagrams in this question paper are NOT necessarily all drawn to scale.
6. Write neatly and legibly.

Question 1

1. Study the diagram below and answer the questions that follow.



1.1 Name the organ represented in the diagram. (1)

1.2 Identify region A and parts B and D. (3)

1.3 Give the function of each of the following parts

(a) E (2)

(b) F (2)

1.4 Give THREE functions of the organ named in QUESTION 1.1. (3)

1.5 State why region A is darker in colour than region C in an actual kidney. (2)

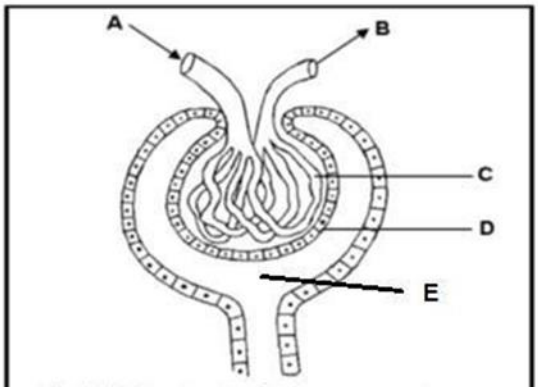
1.6 State the role of the fatty tissue surrounding the kidney. (1)

Describe how the functioning of the kidney will be affected if part F is blocked by a large kidney stone. (2)

[16]

Question 2:

2.L Study the diagram below and answer the questions that follow.



Malpighian body of a human nephron

2.1 State the region of the kidney where you would find this structure? (1)

2.2 Name the process in urine formation that occurs in this structure. (1)

2.3 Identify part C. (1)

2.4 Describe TWO structural adaptations of part C for the process in QUESTION 2.2 above. (4)

2.5 Give ONE advantage of the difference in diameter between the structures labelled A and B. (2)

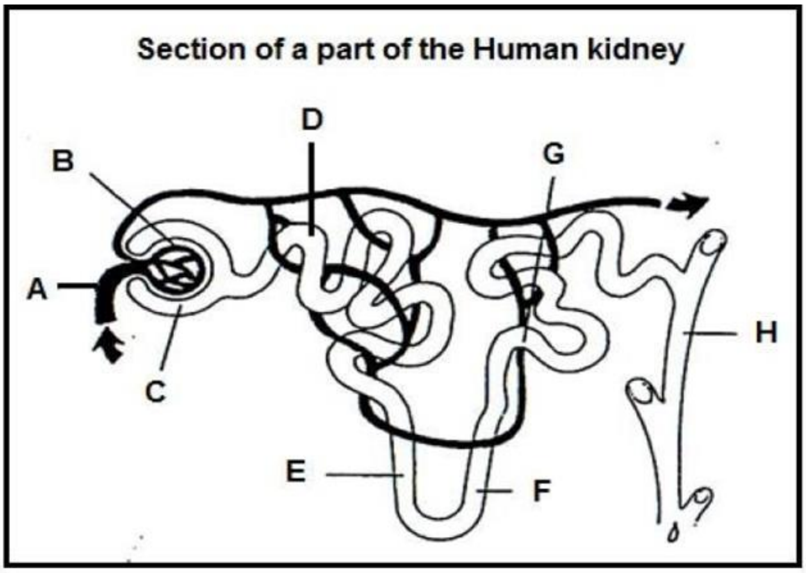
2.6 Name the liquids present in parts C and E respectively. (2)

2.7 Which blood vessel (A or B) contains more urea? (1)

2.8 Explain why heart failure can sometimes lead to kidney failure. (4) **[16]**

Question 3:

3. Study the following diagram and answer the questions. (Free State Nov 2016 P1)



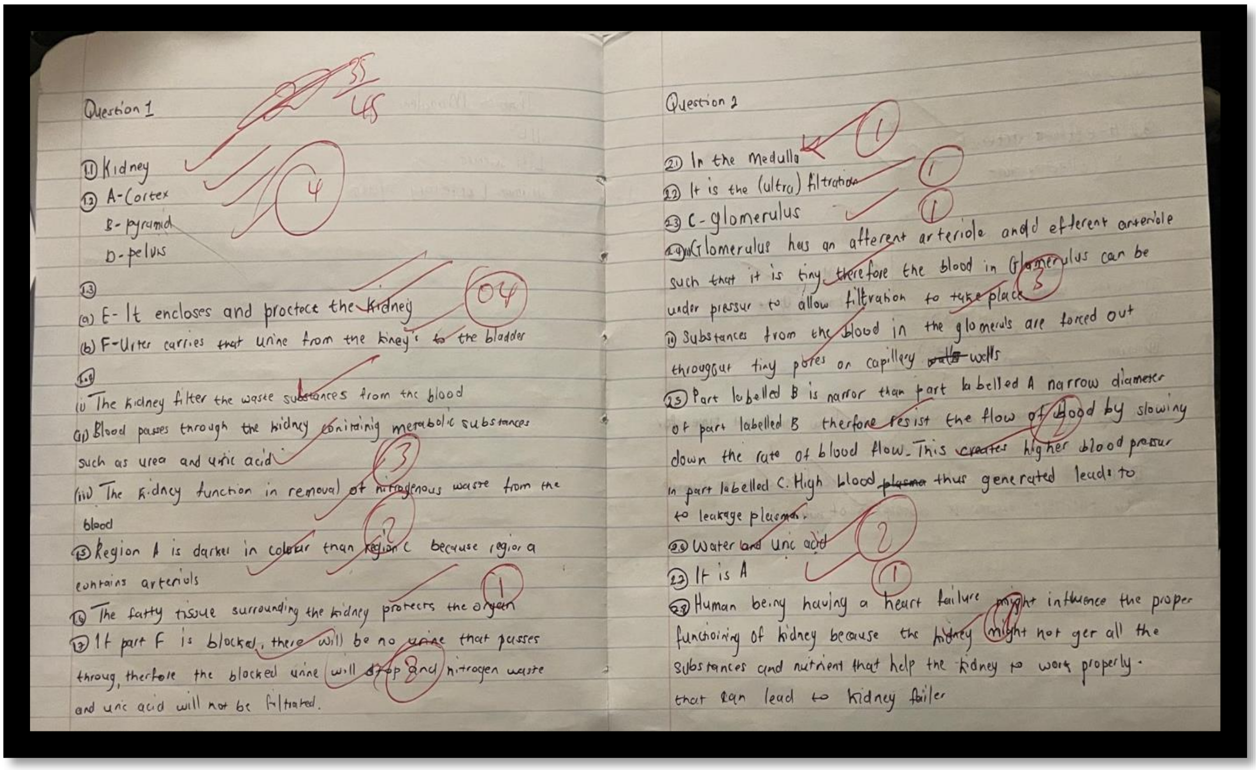
3.1 Identify parts A and H. (2)

3.2 Tabulate THREE differences between the fluids in A and in H respectively. (7)

3.2 Name TWO structural adaptations of region D for its function. (4)

[13]

GRAND TOTAL: 45



Question 1

35/45

1.1 Kidney
1.2 A-Cortex
B-pyramid
D-pelvis

4

1.3
(a) E- It encloses and proctect the kidney
(b) F-Uriter carries ~~that~~ urine from the kiney's ~~to~~ the bladder

04

1.4
(i) The kidney filter the waste substances from the blood
(ii) Blood passes through the kidney coniraining metabolic substances such as urea and uric acid
(iii) The kidney function in removal of nitrogenous waste from the blood

3

1.5 Region A is darker in colour than region C because region a contains arteriols

2

1.6 The fatty tissue surrounding the kidney protects the organ

1

1.7 If part F is blocked, there will be no urine that passes throug, therfore the blocked urine will stop and nitrogen waste and uric acid will not be filtrated.

8

Question 2

2.1 In the Medulla

1

2.2 It is the (ultra) filtration

1

2.3 C-glomerulus

1

2.4 (i) Glomerulus has an afferent arteriole and efferent arteriole such that it is tiny therefore the blood in Glomerulus can be under pressur to allow filtration to take place
(ii) Substances from the blood in the glomeruls are forced out througout tiny pores on capillary ~~walls~~ wells

3

2.5 Part labelled B is narror than part labelled A narrow diameter of part labelled B therfore resist the flow of blood by slowing down the rate of blood flow. This ~~creates~~ higher blood pressur in part labelled C. High blood ~~plasma~~ thus generated leads to to leakage plasma.

2

2.6 Water and uric acid

2

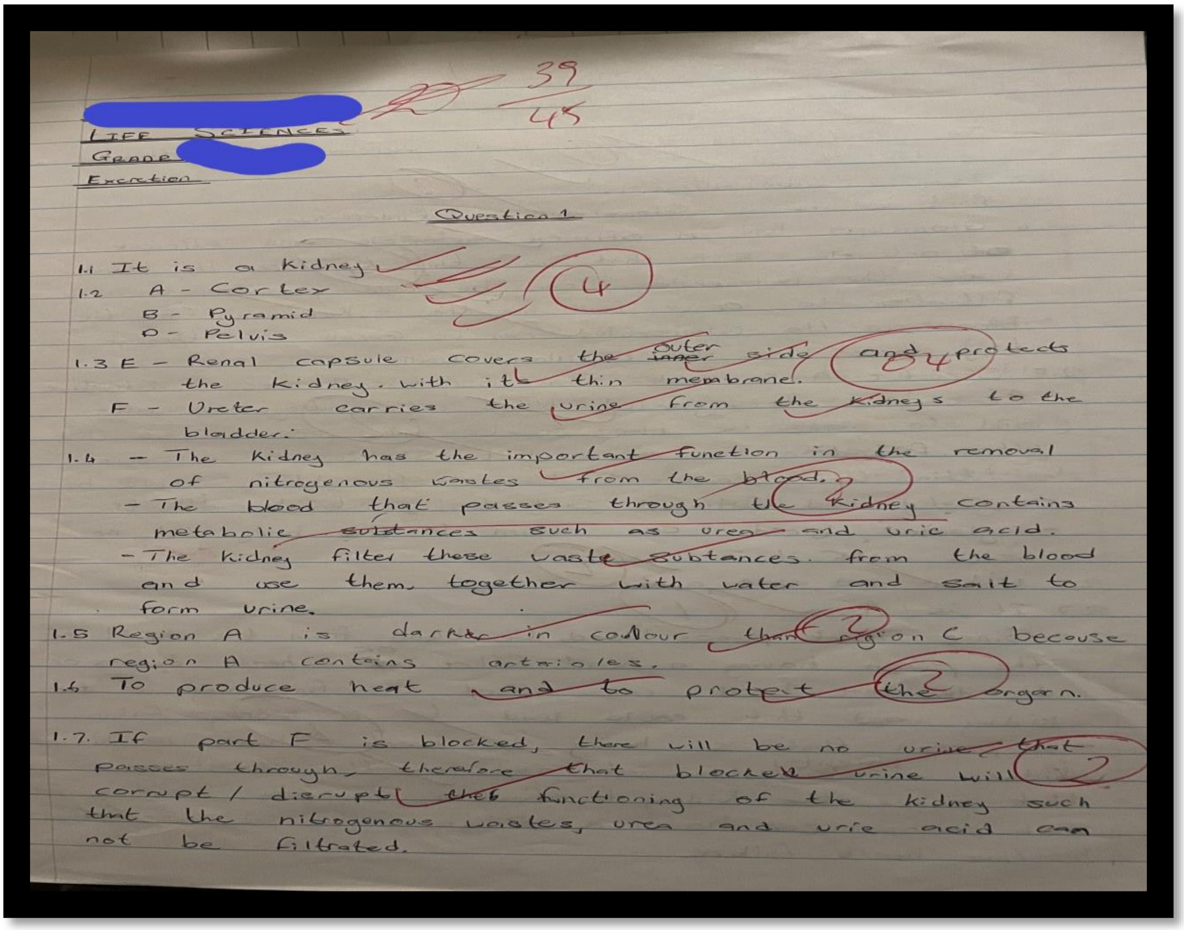
2.7 It is A

1

2.8 Human being having a heart failure might influence the proper funchoining of kidney because the kidney might not ger all the substances and nutrient that help the kidney to work properly. that can lead to kidney failer

1

(a)



[redacted]
LIFE SCIENCES
Grade [redacted]
Excretion

39/48

Question 1

1.1 It is a kidney
1.2 A - Cortex
B - Pyramid
D - Pelvis
1.3 E – Renal capsule covers the outer side and protects the kidney. with it thin membrane.
F – Ureter carries the urine from the kidneys to the bladder.
1.4 – The kidney has the important function in the removal of nitrogenous wastes from the blood.
– The blood that passes through the kidney contains metabolic substances such as urea and uric acid.
– The kidney filter these waste substances from the blood and use them together with water and salt to form urine.
1.5 Region A is darker in colour than region C because region A contains arterioles.
1.6 To produce heat and to protect the organ.
1.7. If part F is blocked, there will be no urine that passes through, therefore that blocked urine will corrupt / disrupt the functioning of the kidney such that the nitrogenous wastes, urea and uric acid can not be filtered.

(b)

Figure 4.6 (a) and (b): Shows that learners did well in the take home test on excretion

Name of the teacher	Mr Z. Mkhanyiswa
School:	North Face High school
Grade	11
TOPIC 5	HUMAN IMPACT ON THE ENVIRONMENT (FOOD SECURITY)
Lesson Objective(s)	At the end of the lesson, Learners would be able to: • Explain how human activities influences the environment • Understand how food security is influenced by human activities on the environment. • Use Toulmin's Model of Argumentation to write essays related to human impact and food security
Teaching Methods	• A dialogue between a teacher and students. • Group discussion • Brainstorming • Work in groups • Question and answer

Teachers' action and Learner's activities	• The lesson will be teacher and learner centred since it will be a dialogue. • The teacher will explain Toulmin's model of Argumentation and link it with human impact on the environment. • Learners will argue among themselves about the human impact on the environment. • .
Teaching Resources	• Textbook • Handouts.
Assessment(s)	Learners will be given a task where they will argue about the impact of human population on FOOD SECURITY guide by Toulmin's Model of Argumentation and will be required to share their work with the class **(Refer to Food security group Task)**. There will be also question session between learners and teacher as well.

ARGUMENTATION ESSAY

Educator: Mr Z. Mkhanyiswa
Write an argumentation using Toulmin's Model on the Impact of Human Population on Food Security. (50 Marks).

MICROSOSFT TEAMS LESSON (ICT INTERGRATION)

Name of the teacher	
School:	North Face High school
Grade	11
TOPIC 6	Animal nutrition (Dentition for herbivorous, carnivorous and omnivorous lifestyles, human nutrition)
Lesson Objective(s)	At the end of the lesson, Learners would be able to: • Explain the differences in dentition for herbivorous, carnivorous and omnivorous lifestyles • Know the macro-structure of the alimentary canal and associated organs and functions • Describe the processes of ingestion, digestion, absorption, assimilation and egestion

Teaching Methods	The lesson will be learner-centred since a teacher will ask probing questions from learners because they have prior knowledge on animal nutrition from grade 10. Teacher will then proceed to explain some important terms for the topic. Learner's action will be to ask questions and answer questions
Teaching Resources	• Microsoft teams • PowerPoint presentation • Videos on PowerPoints
	Learners will be given class activities and they will write a test on animal nutrition **(Refer to class activities and Animal nutrition Test).**

CLASS ACTIVITIES

Give the correct biological term for each of the following descriptions

1. The breaking down of complex molecules into their simplest forms to be absorbed into the body to sustain life.

   Digestion ✓

2. A ball of chewed food that mixed with saliva.

   Bolus ✓

3. A process of biting and grinding of food by teeth to make it easier to swallow.

   Mastication ✓

4. A group of enzymes that break down proteins.

   Proteases ✓

5. The involuntary constriction and relaxation of the muscles of the gut wall, creating wave-like movements that push food down.

   Peristalsis ✓

ACTIVITY 2

1. Briefly describe the digestion of food that contains only carbohydrates.(7)

-Food is broken down to smaller size by teeth ✓

-Salivary amylase ✓ (carbohydrase) starts the digestion of starch into maltose ✓

- and the stomach churns/ mixes the food ✓to become a liquid

-which is known as chyme ✓. Amylase in the saliva ✓

-in the pancreatic juice ✓

-and intestinal juice ✓ break down the

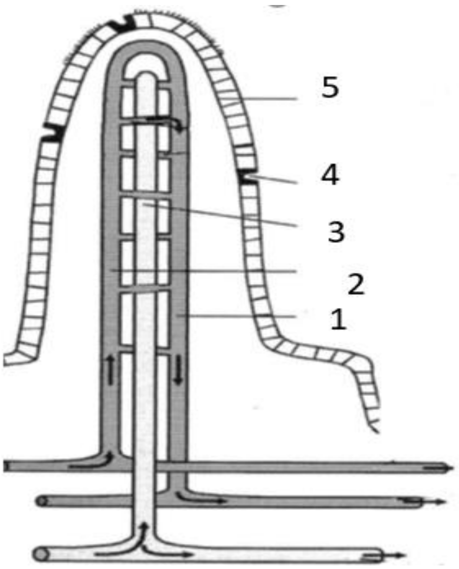
-polysaccharides (starch) ✓

-to disaccharides ✓ and

-eventually to monosaccharides (glucose) ✓

-in an alkaline ✓ medium (Any 7)

2. The diagram below illustrates the microscopic structure of a villus. Study the diagram and answer the following questions.



2.1 Identify the part labelled 3 and its function. (2)

3 – Lacteal✓

-Absorption and transport of fatty acids and glycerol. ✓

2.2 Which labelled part contains blood with relatively higher amounts of glucose and amino acids? (1)

Part Labelled 1 ✓

2.3 Name the process that enables humans to absorb the nutrients mentioned in QUESTION 2.2 (1)

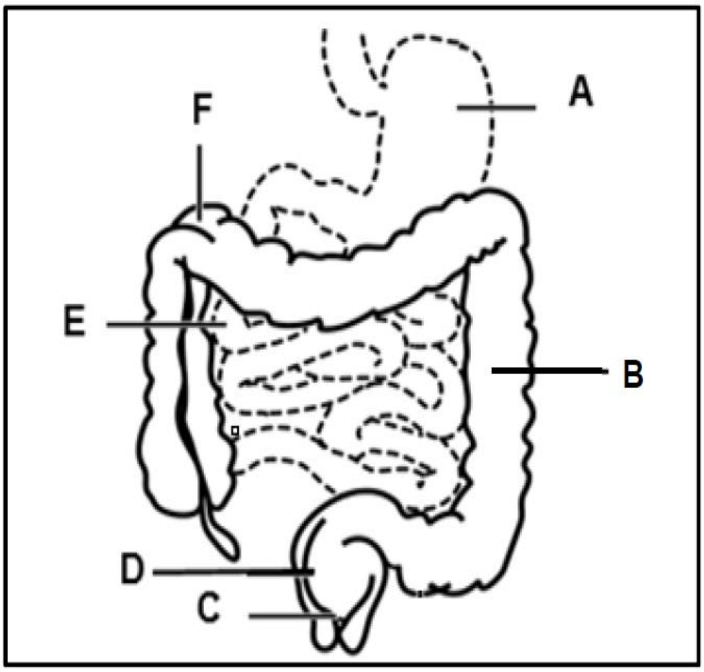
-Active transport ✓

2.4 Explain how the villus is structurally adapted to enhance the absorption of digested nutrients from the small intestine. (3 x 2) (6)

- It is only one cell thick / thin ✓ so the nutrients can pass through quickly and easily. ✓
- It is richly supplied with mitochondria ✓
- to supply energy for the active transport of many nutrients. ✓
- It also secretes mucus ✓
- that serves as a carrier-fluid for nutrients ✓
- Moist membrane ✓
- to enhance the diffusion of nutrients.
- It has microvilli ✓
- that further increases the surface area for absorption. ✓

(Any 3 x 2)

Study the following diagram about a part of the human digestive system.



3.1 Give labels to the following parts:

(a) A (1)

-Stomach ✓

(b) B (1)

-Colon/ Large intestine (1) ✓

(c) E (1)

-Small intestine/ Duodenum ✓

3.2 Give the LETTER of the part with the following function:

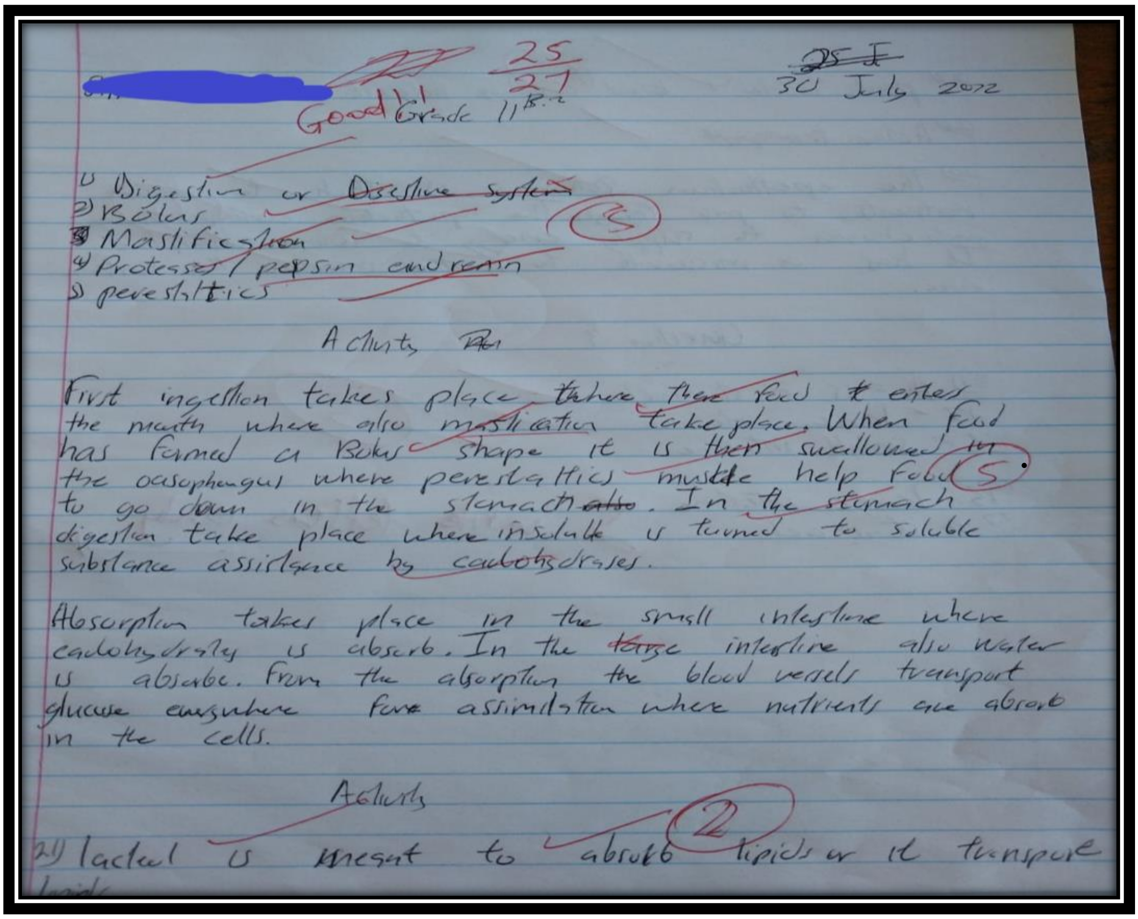
(a) Responsible for the absorption of most water (1)

-B ✓

(b) Responsible for breaking down of food molecules by mechanical and chemical digestion (1)

-A ✓

TOTAL MARKS= 27


~~22~~ 25/27

[redacted]

Good!! Grade 11B.2

~~25~~ 30 July 2012

1) Digestion or ~~Digestive system~~
2) Bolus
3) Mastification
4) Protesse / pepsin and renin
5) pereshltics

Activity

First ingestion takes place where the food enters the mouth where also mastication take place. When food has formed a Bolus shape it is then swallowed in the oesophagus where peresltaltics muscle help food to go down in the stomach ~~also~~. In the stomach digestion take place where insoluble is turned to soluble substance assistance by carbohydrases.

5

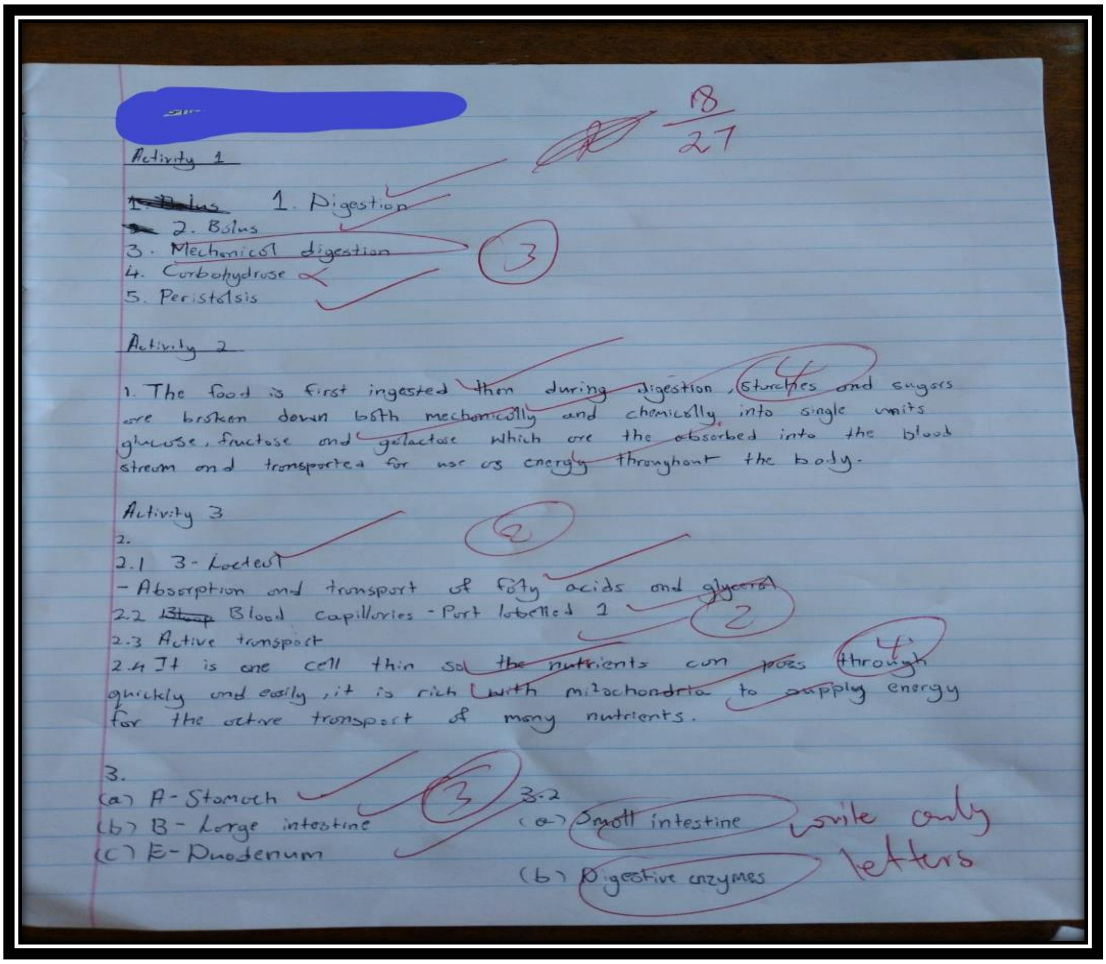
Absorption takes place in the small intestine where carbohydrates is absorb. In the ~~large~~ intestine also water is absorbe. From the absorption the blood vessels transport glucose everywhere fore assimilation where nutrients are absorb in the cells.

Activity

2.1) lacteal is present to absorb lipids or it transport lipids

2

(a)


[redacted]

18/27

Activity 1

~~1. Bolus~~ 1. Digestion
2. Bolus
3. Mechanicol digestion
4. Carbohydrase
5. Peristalsis

(3)

Activity 2

1. The food is first ingested then during digestion, starches and sugars are broken down both mechanically and chemically into single units glucose, fructose and galactose which are the absorbed into the blood stream and transported for use as energy throughout the body.

(4)

Activity 3

2.
2.1 3 - Lacteal
- Absorption and transport of faty acids and glycerol

(2)

2.2 ~~Bloop~~ Blood capillaries - Part labelled 1
2.3 Active transport

(2)

2.4 It is one cell thin so the nutrients can pass through quickly and easily, it is rich with mitochondria to supply energy for the active transport of many nutrients.

(4)

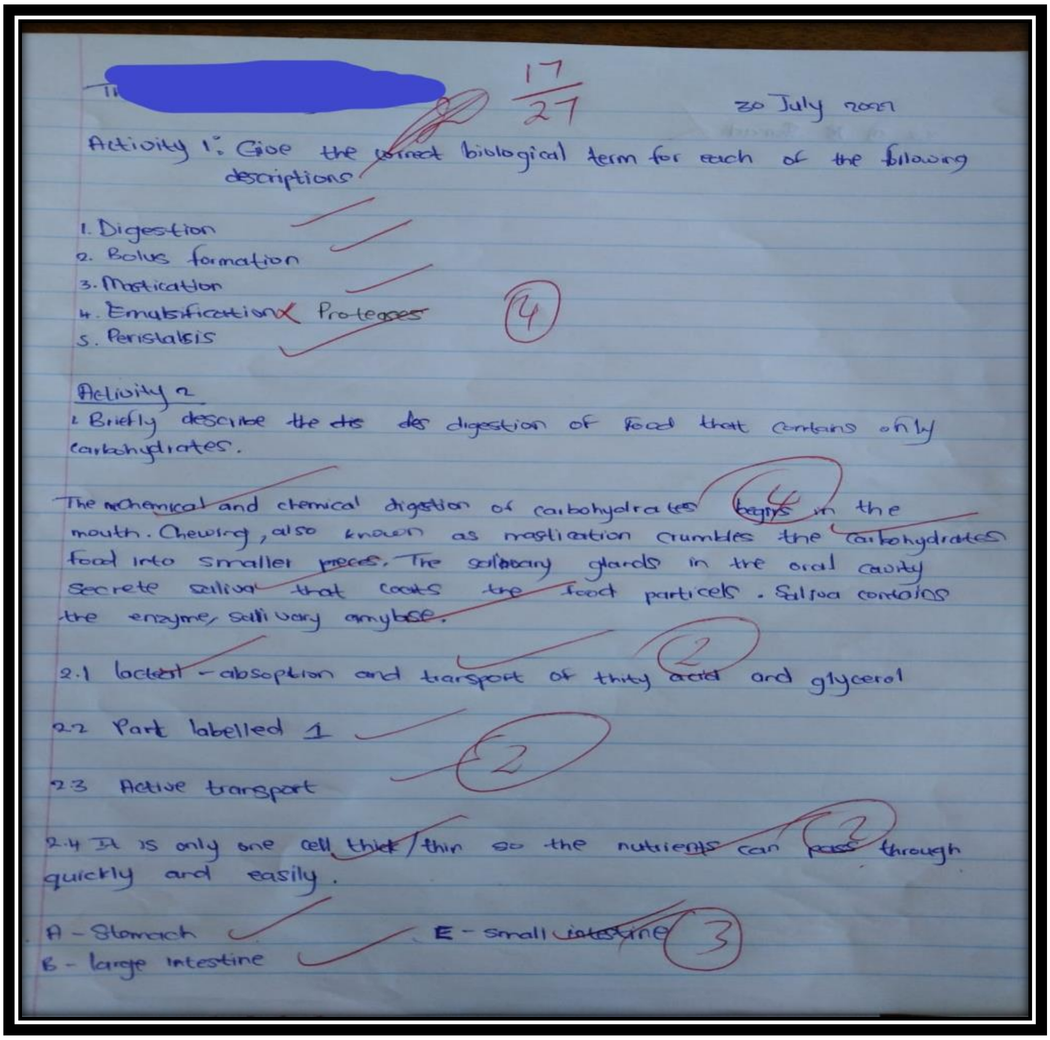
3.
(a) A - Stomach
(b) B - Large intestine
(c) E - Duodenum

(3)

3.2
(a) Small intestine
(b) Digestive enzymes

write only letters

(b)


T[redacted] 17/27 30 July 2021

Activity 1: Give the correct biological term for each of the following descriptions

1. Digestion
2. Bolus formation
3. Mastication
4. Emulsification Proteases
5. Peristalsis

4

Activity 2

1 Briefly describe the ~~des~~ digestion of food that contains only carbohydrates.

The mechanical and chemical digestion of carbohydrates begins in the mouth. Chewing, also known as mastication crumbles the carbohydrates food into smaller pieces. The salivary glands in the oral cavity secrete saliva that coats the food particles. Saliva contains the enzyme, salivary amylase.

4

2.1 lacteal - absorption and transport of fatty acid and glycerol 2

2.2 Part labelled 1

2.3 Active transport 2

2.4 It is only one cell ~~thick~~/thin so the nutrients can pass through quickly and easily. 2

A - Stomach E - Small intestine 3

B - large intestine

(c)

Figure 4.7 (a), (b) and (c): Shows how learners responded to class activity on Animal nutrition.

TIME: 40MINS

INSTRUCTIONS AND INFORMATION

Read the following carefully before answering the questions:

1. Answer ALL the questions.
2. Write ALL the answers on the ANSWER SHEET.
3. Start the answers to EACH question at the top of a NEW page.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Present your answers according to the instructions of each question.
6. ALL drawings should be done in pencil and labelled in blue or black ink.
7. The diagrams in this question paper are NOT necessarily all drawn to scale.
8. Write neatly and legibly.

1.1 Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number.

1.1.1 Which of the following substances can directly be absorbed by blood without further digestion?

A proteins
B starch
C glucose
D fats

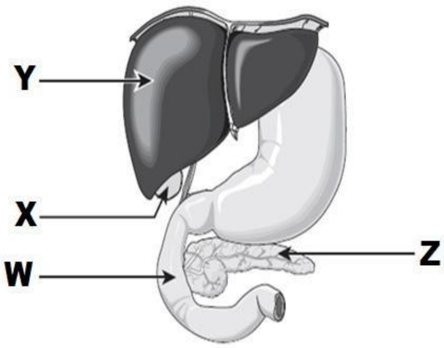
1.1.2 The concentration of which of the following substances are normally higher in the hepatic portal vein than in most other veins in the human body?

A oxygen
B glucose
C urea
D carbon dioxide

1.1.3 Where does the emulsification of fat occur?

A In the liver
B In the colon
C In the gall bladder
D In the small intestine

1.1.4 Which labelled structure secretes a hormone which causes an increased production of glycogen?



A W
B X
C Y
D Z

(2X4)=8

1.2 Indicate whether each of the statements in COLUMN I applies to A only, B only, both A and B or none of the items in COLUMN II.

Coulumn I	**Column II**
1.2.1 A lymph vessel in the villus of the intestine	A: lacteal B: lymphatic node
1.2.2 The structure that prevents the passage of food particles in the lungs	A: epiglottis B: glottis

(2X2=4)

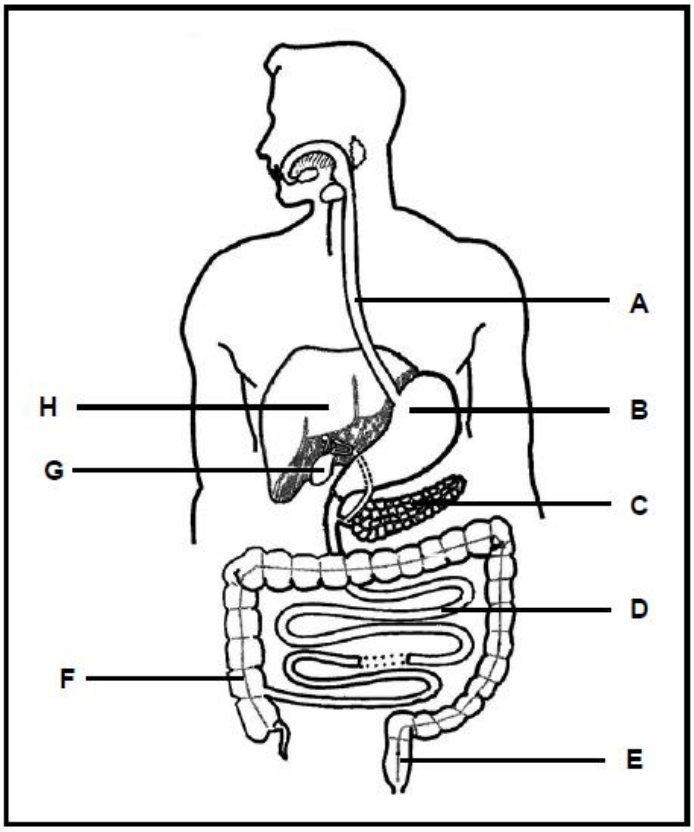
1.3 Give the correct biological term for each of the following descriptions.

1.3.1	The breaking down of complex molecules into their simplest forms to be absorbed into the body to sustain life.
1.3.2	A ball of chewed food that mixed with saliva.
1.3.3	A group of enzymes that break down proteins.
1.3.4	The involuntary constriction and relaxation of the muscles of the gut wall, create wave-like movements that push food down.

(4X1= 5)

Question 2

2.1 Study the diagram below which shows the human digestive system.



2.1.1 Label parts **A**, **C**, **E** and **H**. (4)

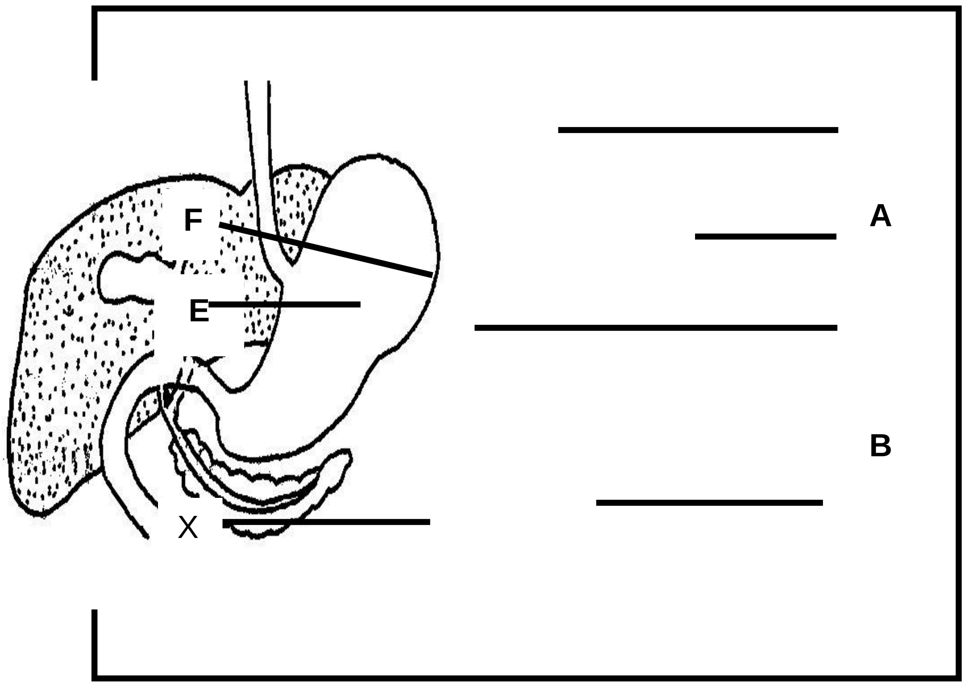
2.1.2 Write the LETTER only of the part:

(a) That stores bile (1)

(b) Where chemical digestion of protein begins (1)

(c) Where most water and mineral salts are absorbed (1)
(7)

Question 3
Study the diagram below and answer the questions that follow.



3.1 Give the labels for parts **A**, **B** and **F**. (3)
3.2 State TWO functions of hydrochloric acid in part **B**. (2)
3.3 Describe the role played by **D** and **E** in reducing the blood sugar level in humans. (5)
3.4 Explain THREE ways in which part **X** is suited for its function. (6)

GRAND TOTAL: 40

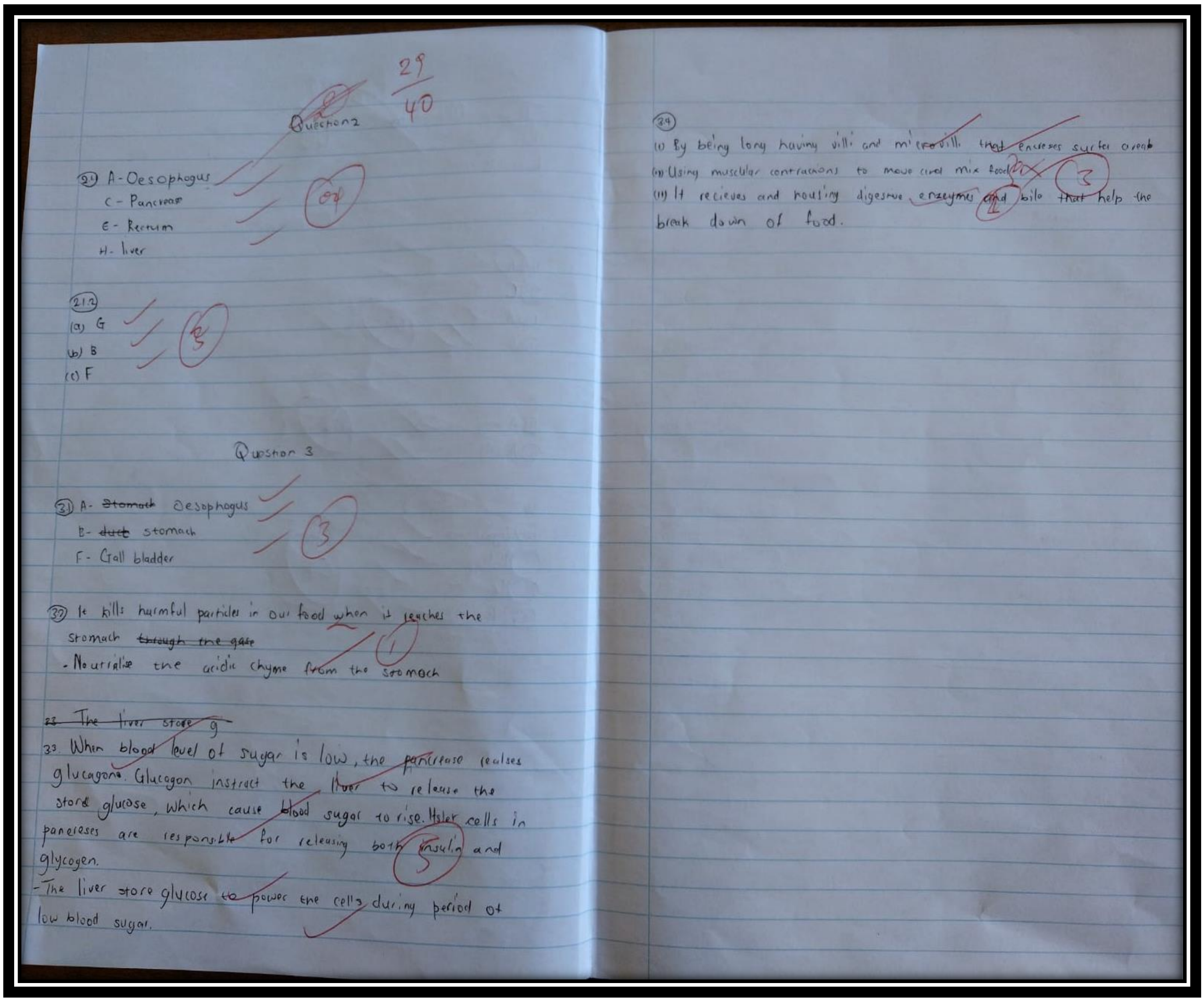


Figure 4.8 (a): Shows that learners did well on the test.

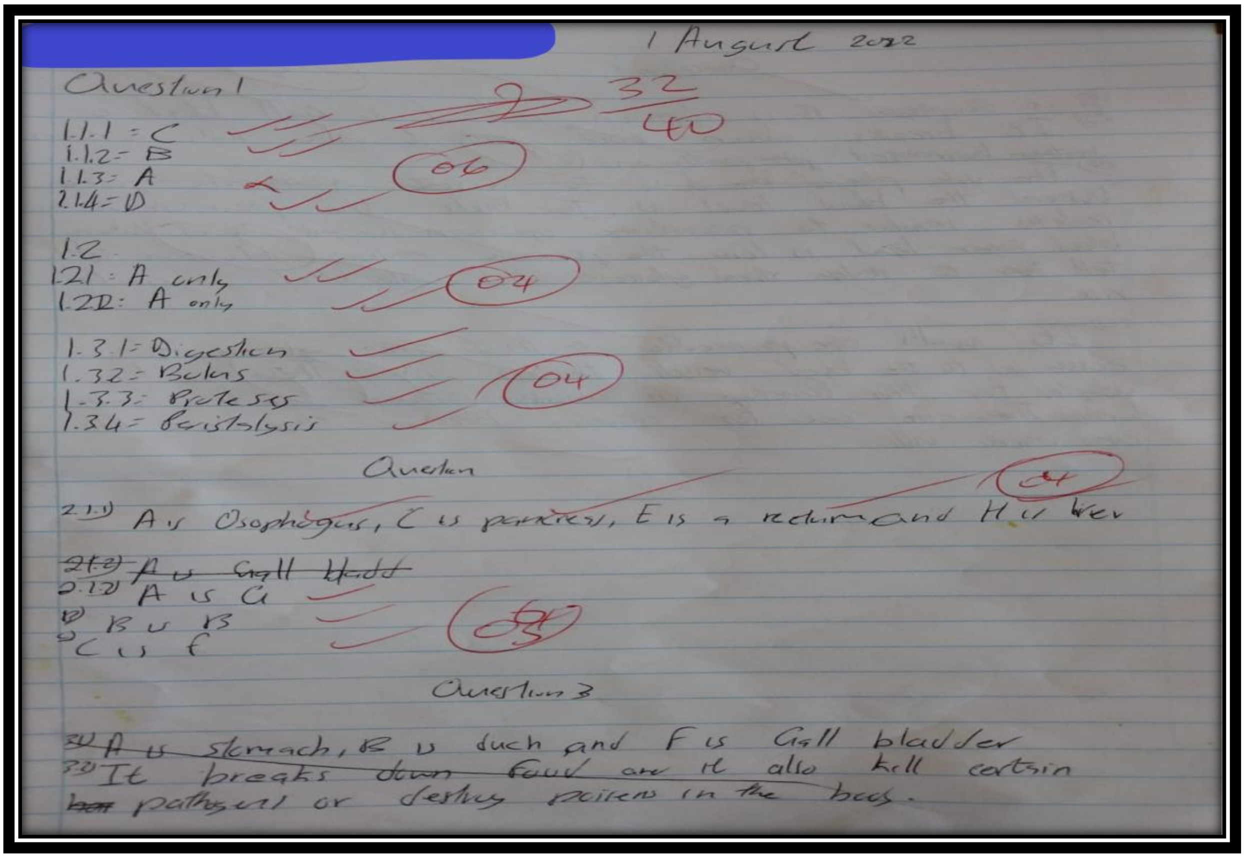

[redacted] 1 August 2022
Question 1
32/40
1.1.1 = C
1.1.2 = B
1.1.3 = A
1.1.4 = D
06
1.2
1.2.1 : A only
1.2.2: A only
04
1.3.1 = Digestion
1.3.2 = Bolus
1.3.3 = Proteases
1.3.4 = Peristalysis
04
Question
2.1.1 A is Osophogus, C is pancreas, E is a rectum and H is liver
04
~~2.1.2 A is Gall bladd~~
2.1.2 A is G
B is B
C is F
03
Question 3
3.1 A is stomach, B is duct and F is Gall bladder
3.2 It breaks ~~down~~ food and it also kill certain ~~bas~~ pathogens or destroy poisons in the body.

Figure 4.8 (b): Shows that learners did well in the test.

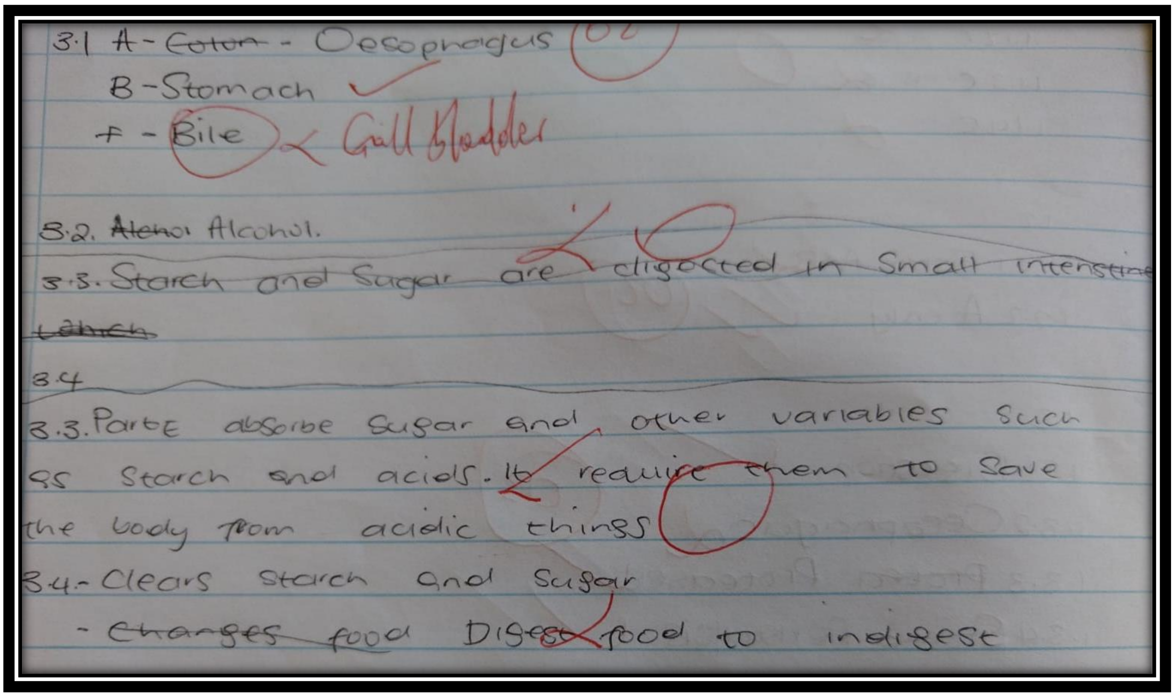

3.1 A - ~~Colon~~ - Oesophagus
B - Stomach
F - Bile Gall bladder
3.2. ~~Alcho~~ Alcohol.
3.3. Starch and Sugar are digested in Small intestine
~~Starch~~
3.4
3.3. Part E absorbe sugar and other variables such as starch and acids. It require them to save the body from acidic things
3.4 - Clears starch and sugar
- ~~changes food~~ Digest food to indigest

Figure 4.8 (c): Illustrate how question 3 was poorly answered by a learner.

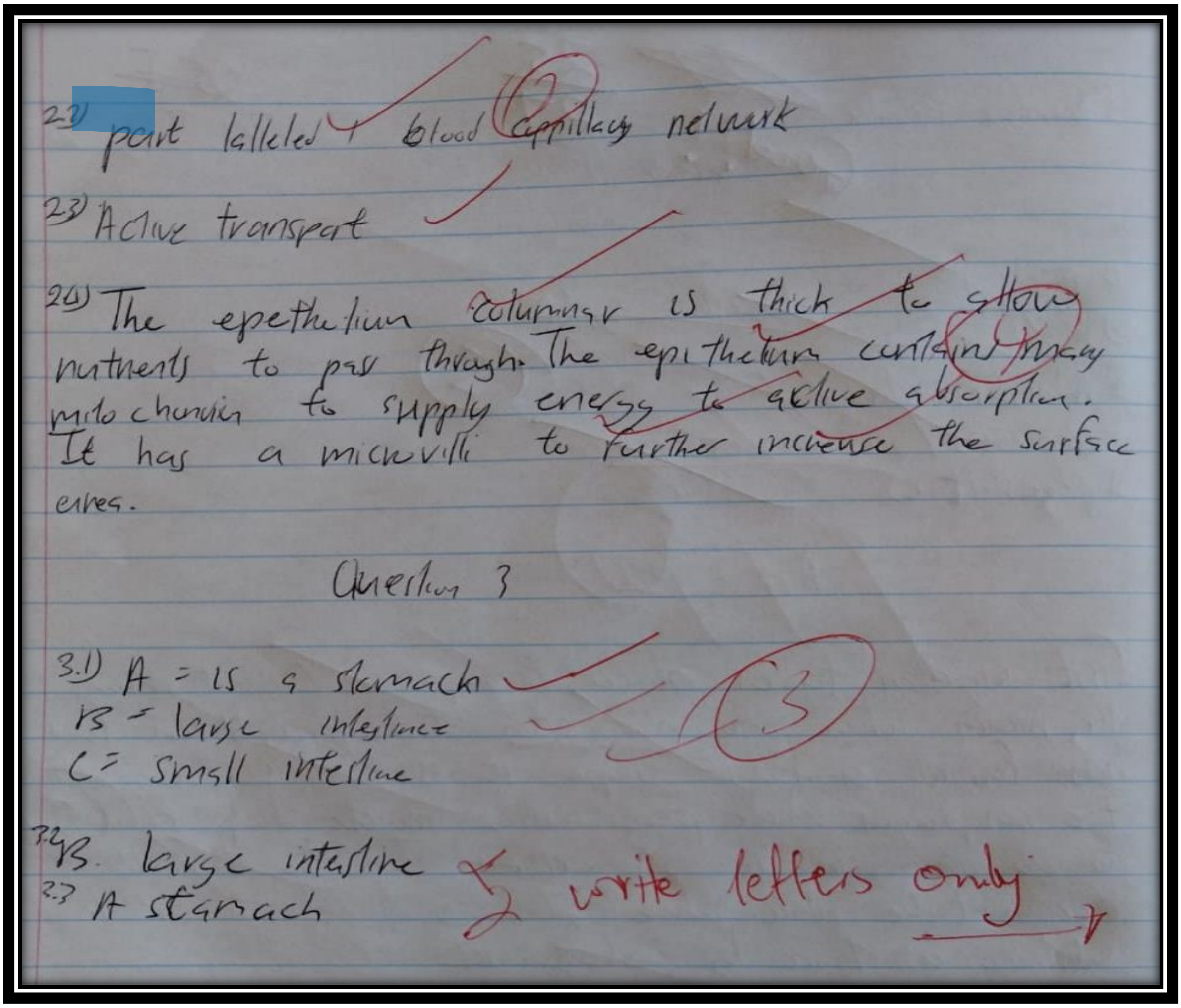

2.2) part lalleled blood capillary network
(2)
2.3) Active transport
2.4) The epethelium columnar is thick to allow nutrients to pass through. The epithelium contains many mitochondria to supply energy to active absorption. It has a microvilli to further increase the surface eres.
(4)
Question 3
3.1) A = is a stomach
B = large intestine
C = small intestine
(3)
3.2 B. large intestine
3.3 A stamach
write letters only

Figure 4.8 (d): Illustrate how question 3 was poorly answered by a learner.

APPENDIX E: PROOF OF EDITING

Certificate of Editing

This is to certify that the dissertation

Exploring Alternative Pedagogies for Teaching Grade 11 Further Education and Training Life Sciences

by

Zukisani Mkhanyiswa

has been proofread and edited for English language usage.

Date: 24 September 2022

LHugo

Lianne Hugo

Language Practitioner
B.A. (HMS)
PGCE