The Effectiveness of YouTube Videos in Developing Process Skills in Grade 10 Life Sciences Curriculum

By

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Declaration

I, **Nobuhle Priscilla Mbanjwa**, declare that:

i. The research reported entitled, “The Effectiveness of YouTube Videos in Developing Process Skills in Grade 10 Life Sciences Curriculum”, except where indicated, is my original research.

ii. The thesis has not been submitted for any degree or examination at any other university.

iii. This thesis does not contain other persons’ writing, unless specifically acknowledged as being sourced from other researchers. Where other written sources have been quoted, then:

   a. their words have been re-written, but the general information attributed to them has been referenced.

   b. where their exact words have been used, their writing has been placed inside quotation marks and referenced.

iv. The work described in this thesis was carried out in the School of Education, University of KwaZulu-Natal, from June 2020 to December 2022 under the supervision of Dr T. Chirikure.

v. Ethical clearance No. HSSREC/00002810/2021 was granted prior to undertaking the fieldwork.

Signature: [redacted]

As the candidate's super[redacted] r. Tamirirofa Chirikure, agree to the submission of this thesis.

Signed:…… [redacted] ……Date: 24 March 2023

Dedication

I would like to dedicate this dissertation to my late father, Ernest Mkhishwa Mbanjwa, who could have been very proud of me. Ngiyazi ukuthi lendlela angiyihambanga ngedwa kepha ubuhamba nami njenge ngelosi yami.

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Finally, I sincerely thank my participants for making time to be part of my study. I am grateful for all your contributions to the research.

All glory to God, who is able, through his mighty power at work within us, to accomplish infinitely more than we might ask or think.

(Ephesians 3:20)

List of Abbreviations

BSPS:	Basic Science Process Skills
CAI:	Computer Assisted Instruction
CAPS:	Curriculum and Assessment Policy Statement
DoE:	Department of Education
ISPS:	Integrated Science Process Skills
SPS:	Science Process Skills
SPSS:	Statistical Software for Social Sciences
SRL:	Self-Regulated Learners

Abstract

For effective science enquiry and acquisition of concepts in science learning, learners should have a good mastery of the science process skills (SPS). SPS are the fundamental components of problem-solving, critical thinking and enquiry in science. The main objective of this study was to establish the effectiveness of YouTube videos in developing SPS in the Grade 10 Life Sciences curriculum. The study was framed by a model of evaluating the effectiveness of YouTube videos. It was supported by the theories of constructivism and active learning. The pre-test and post-test and a semi-structured questionnaire were administered to 100 conveniently selected Grade 10 Life Sciences learners of a secondary school in KwaZulu Natal. Quantitative data were analysed using descriptive statistics, which comprised a *t*-test. Qualitative data were analysed using a thematic analysis method. The null hypothesis was that there was no statistically significant difference between the performance of learners in the pre-test and post-test. The results of the study revealed that there was a statistically significant difference in the learner's post-test performance. The YouTube videos had a significant impact on the development of skills such as inferring, interpreting data, constructing a hypothesis, communicating and predicting, as these showed an average increase of 40,2%. The learners demonstrated a positive perception of YouTube videos, as they improved their development of SPS. Hence, it was recommended that teachers incorporate relevant YouTube videos and design effective practical tasks to enhance and elevate learners' development of SPS.

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Chapter 1

Introduction

1.1 Introduction

Process skills development is the building block for a solid foundation for acquiring the scientific method. These skills have been taught through practical work and hands-on investigations for decades (Millar, 2004). It is time new methods to teach these skills are explored. We live in a world where global challenges and advancements in technology bring new possibilities and uncertainties, the introduction of virtual classrooms and self-paced learning have changed the narrative for teaching and learning science. However, conflicting views exist and an overall need for more research regarding the effectiveness of YouTube videos in acquiring process skills to cater for this rapidly and continuously evolving education system. This research aims to explore the effectiveness of YouTube videos to see how they could be utilised to acquire process skills without relying on hands-on practical work and depriving learners of crucial process skills (Lee, Choi, Jang, & Lee, 2019).

The fundamental reason for this study is the deficiency of practical work being conducted by teachers in schools resulting in learners being deprived of process skills crucial for their development (Gultepe, 2016). Scholars have identified various reasons why practical work is not being conducted, including a lack of resources and competency (Osborne, 2015). This study identified the role of social media in people's lives, especially the younger generation, which cannot be ignored. Fleck, Beckman, Sternsa and Hussey (2014) posit that a great emphasis on Internet-based platforms like YouTube offers a unique opportunity to supplement classroom learning environments.

The teaching and learning environment should always be stimulating (Nissim, Weissblueth, Scott-Webber & Amar, 2016). This is an indication that the conventional methods of teaching and learning do not have influence on learner motivation and creativity. Digital media brings life into the lesson, making it much more enjoyable. Developing skills and a mentality for self-directed lifelong learning should be at the heart of the curriculum, learning experiences, and entire environment. 21st-century competencies should be thoughtfully woven into the learning activities (Dumont, Instance, & Benavides, 2011). Learners must be prepared with scientific capabilities to fulfil the rising needs of the fourth industrial revolution. Critical thinking and problem-solving abilities are needed for this revolution, and these abilities can only be developed through actual work. South Africa must promote learners who can compete with global trends from all socioeconomic backgrounds. These changes include a rise in interest in artificial intelligence that may be seen in developed nations like China. Coding and robotics knowledge is becoming more popular, and mastering them requires process skills. The Department of Education (DoE) must prioritise the value of learners' learning process skills to boost student accomplishment and prepare them for global competition (Department of Basic Education, 2011). In addition to these defences, the Covid-19 epidemic has demonstrated that the conventional learning approach is rigid and insufficiently adaptable to deal with a state-national catastrophic issue. The brick-and-mortar model of education is so vital to the educational system due to the heightened interaction amongst the learners (Counselman-Carpenter & Redcay, 2019). The study background and context are covered first, followed by the research problem, goals, objectives, questions, significance, and constraints. This chapter then gives a general review of the study.

1.2 Background to the Study

Science is the corpus of human knowledge that entails unbiased observations and systematic experimentation (Chalmers, 2013). Its tentative nature allows humans to continually seek answers and explanations to the unknown and natural phenomena of interest. Gultepe (2016) provides three crucial aspects of science. The first is the content which focuses on scientific knowledge. This is the component that most teachers are concerned about and tend to stress upon when teaching science. Secondly, there are processes. These are the procedures of doing science that encompass the process skills that are a major component of our daily lives. Thirdly, the characteristics and dispositions of sciences form part of the imaginative world and evoke curiosity (Gultepe, 2016).

Science literacy is crucial to everyone living in this evolving world, as it equips people with advanced knowledge and skills and enables us to converse with society at greater lengths. Numerous tasks require these skills on a daily basis, and it is the science process skills (SPS) that contribute vastly to developing such intellectual competencies (Ping, Halim & Osman, 2019).

Basic and integrated SPS are divided into two main groups. The Basic SPS(BSPS) comprises of Observation, measurement, classification, inference, prediction, and presentation of research findings are all examples of fundamental scientific process skills. The Integrated SPS(ISPS) comprises of Identifying and regulating variables, planning experiments, developing a hypothesis, gathering data, and drawing conclusions (Artayasa, Susilo, Lestari, & Indriwati, 2017).

Over the years, science has been better understood through practical work and scientific enquiry, which is a method that provides empirical evidence (Yuniarti, Supriatno & Nureni, 2018). However, global reports show a lack of practical work being conducted in schools for

various reasons (Ping et al., 2019). Amongst other findings, an array of papers posit that science teachers put more emphasis on the conceptual teaching of the subject rather than conducting practical work to upskill learners with process skills (Fadzil & Saat, 2017; Gultepe, 2016). These findings are detrimental to the science discipline, as this alludes to the fact that learners are not acquiring process skills which are an imperative element of the learner's holistic development.

Practical work is the prescribed method to learn and acquire process skills in the Life Sciences curriculum. It is perceived by the DoE to be the most feasible and favourable way for learners to understand and grasp scientific enquiry which comprises the assimilation of process skills (Department of Basic Education, 2011).

Gultepe (2016) asserts that in a transforming world, technology is constantly improving, thus, the acquisition of knowledge has become much easier. Research has shown an increased interest in YouTube videos as a teaching and learning medium (Bardakcı, 2019). It enhances the learning process of science, since it is a relatively simple way to provide audio-visual materials and provides diverse learning styles (Koto et al., 2018).

A profusion of studies reveals that South African schools lack practical work due to poor resources, huge classes, and teachers who lack the abilities to teach practical work, which results in insufficient acquisition of science process skills by learners (Kibirige & Maponya, 2020; Ramnarain, 2014). Abrahams, Reiss, and Sharpe (2013) did a study in the United Kingdom and discovered that a lack of practical work in schools worldwide was a result of instructor incompetence; as a result, learners have been robbed of the opportunity to acquire specific process skills. Due to the pressure of curriculum coverage, Ping et al. (2019) note that many teachers overlook practical work in favour of concentrating on content. The lack of resources for completing practical work in various schools worldwide and locally is also a

subject of concern, according to research (Kasiyo, Denuga, & Mukwambo, 2017; Molefe & Stears, 2014). Molefe and Stears (2014) also stated that there is a deficiency of meticulously supervised engagement in practical work, big groups, an over-reliance on demonstrators, and negative attitudes toward practical work among learners in South Africa.

There is a significant number of studies alluding to learners not obtaining process skills, and this is alarming. Process skills are a crucial development tool, as they enable learners to solve problems personally, socially and globally. There is increasing concern that some learners are being deprived of skills that are meant to enhance their mastery of concepts and cognitive skills which are a prerequisite of the 21st century (Fadzil & Saat, 2017).

The use of YouTube videos for learning has been identified to be very educational in various studies (Gustafsson, 2013; Zaidi, Awaludin, Karim, Ghani, Rani, & Ibrahim, 2018). YouTube videos are a viable alternative to the traditional teaching approach, given the increased internet access and their potential in addressing the reasons for not doing practical work. While the use of YouTube videos in place of hands-on practical activities is gaining traction, the effectiveness of this strategy in developing process skills remains under-researched (Berk, 2009; Gustafsson, 2013). The use of YouTube videos has the potential to mitigate, if not eliminate, the effects of having teachers disregard practical work completely, due to the lack of hands-on resources, as it would be a cost-effective way of experiencing investigations to enable the development of SPS.

Ifenthaler and Tracey (2016) assert that digital devices are ubiquitous in modern societies. The current generation of learners is exposed to many technological devices, mostly smartphones, making information easily obtainable. Therefore, teachers must utilise styles of teaching that incorporate ways that learners are not only familiar with but that are stimulating.

1.3 Research Purpose, Objectives and Questions

1.3.1 Purpose Statement

This mixed-methods study aimed to determine the efficacy of YouTube videos in teaching process skills as part of the 10th grade Life Sciences curriculum.

1.3.2 Research Objectives

1. To determine if there is a significant difference in the performance of the learners before and after using YouTube videos on process skills in Grade 10 Life Sciences.
2. To identify the learners' perceptions of using YouTube videos in practical work.
3. To establish how effective YouTube videos are in developing process skills in Grade 10 Life Sciences curriculum.

1.3.3 Research Questions

1. Is there a significant difference between the learner's performance before and after using YouTube videos on practical work in Grade 10 Life Sciences?
2. What are the Grade 10 Life Sciences learners' perceptions of using YouTube videos in practical work?
3. How effective are YouTube videos in developing process skills in Grade 10 Life Sciences learners?

1.4 Significance of the study

The current study may be helpful to curriculum designers, subject advisers, and, most importantly, Life Sciences educators who find it challenging to teach SPS. In addition, this

study may be necessary for curriculum developers, who may re-evaluate the tools listed in curriculum documents. Including YouTube videos as a tool that teachers can use to teach science process skills may bridge the gap caused by teachers not performing practical work due to a lack of school resources. Different instruction methods could enhance the learners' understanding of science process abilities. The work contributes to the literature on alternative ways of teaching process skills in the science discipline and enhances the current educational system. The study enhanced my understanding of the education and learning of science process abilities.

1.5 Structural Outline of the Thesis

This study is presented in 6 chapters. In Chapter One, the study context is introduced. The research aims, objectives and questions have been acknowledged.

Chapter Two reviews existing literature, emphasising process skills within the scientific context, the significance of YouTube videos and the science teaching strategies for 21st-century learning.

In Chapter Three, the theoretical research dimensions are outlaid by illustrating and discussing the model adopted as a lens through which this study was viewed.

Chapter Four introduces the methodology used for this research. The paradigm, research approach, sampling, data collection methods and data analysis technique will be discussed. Finally, methodological limitations and a concluding summary will be justified.

Chapter Five presents the quantitative results from the pre-test and post-test; the qualitative findings are based on the semi-structured questionnaire administered to all the participants. An analysis of the findings is also presented in this section.

Chapter Six, the final section, draws upon the entire thesis, tying up the various theoretical and empirical elements. In addition, it includes a discussion of the inference of the findings for imminent research in this area.

Chapter 2

Literature Review

2.1 Introduction

This chapter delivers an overview of relevant literature on practical work in general with an emphasis on SPS. This literature further articulates the significance of practical work in science, the effectiveness of practical work, process skills, teaching and learning approaches in science, the use of YouTube videos as a pedagogical tool in science, YouTube videos for learning science and their significance in promoting self-regulated learning

2.2 Practical work and its significance in science

Practical work is crucial for developing learners' scientific knowledge and may be considered a teaching strategy that encompasses involving the learner in witnessing or manipulating natural or remote objects and tools (Millar, 2004). Fadzil and Saat (2017) define practical work as any hands-on and minds-on scientific activity in which learners actively work, either independently or in clusters, to observe any physical experiences. One of the limitations of this definition is that it does not justify hands-on, as this term can be interpreted in various ways. It can be understood as immersing oneself in the subject or the physical process of doing the practical. The scholars should have elaborated on what it means to be hands-on for a more precise definition. Lunetta, Hofstein and Clough (2007) describe practical work as an experience to learn whereby learners interact with the equipment or alternative data sources to observe and assimilate the world around them. Their definition resonates with this study since scholars argue that practical work can be learnt through other data sources to obtain process skills. Millar and Abrahams (2009) define practical work as the compelling showing of things to learners or putting the learners in situations where they can see for themselves. This points

to the understanding that practical work does not necessarily entail physical engagement with the specimen but can be done through observation. Therefore, this research defines practical work as a minds-on pedagogy engaging learners in observing physical phenomena through YouTube videos to acquire process skills.

Roberts (2004) classifies the different forms of practical work as follows: skills-oriented practical work, observation tasks, technology tasks, investigation and exploratory tasks, and illustrative experiments. In addition, Roberts (2004) calls our attention to the fact that any of these sorts of practical activities might serve as illustrations - either for learners to do by following complex procedures or for professors to display. The emphasis is thus left to the discretion of the teacher, who may highlight substantive or procedural concepts as he or she sees fit in the given situation (Roberts, 2004). This is crucial because it means that the teacher can choose any instructional approach they judge appropriate for imparting knowledge.

The current research focuses on YouTube videos to develop process skills. Each practical work should be aligned with the process skills the teacher wishes to address for the expansion of knowledge and comprehension. The assessment of practical activities is said to be based on specific aims 1 and 2, which are based on subject knowledge according to the Life Sciences Curriculum and the investigation of phenomena in Life Sciences (Department of Basic Education, 2011). The Curriculum and Assessment Policy Statement (CAPS) paper reads, "Although conducting practical investigations requires a distinct set of abilities, learners' knowledge of the subject matter and comprehension of science can and should be examined in the context of cognitive domains" (Department of Basic Education, 2011, p. 15).

Numerous academics share a shared philosophy regarding the purpose of practical activities, which is to advance SPS. The objectives of diverse scholars are shown in Table 2.1 below. Nonetheless, there is no consensus on how to conduct practical work.

Table 2.1

Aims/Purposes of Practical Work

Aims/Purposes	**References**
Developing practical skills and methodologies, becoming a scientist who can solve problems and gaining a "feel for phenomena."	(Roberts, 2004)
Providing learners with opportunities for meaningful learning and the acquisition of appropriate skills and attitudes.	(Edomwonyi-Otu & Abraham, 2011)
Extends learners' comprehension of the natural world and encourages the growth of their grasp of theories, models, and concepts.	(Millar & Abrahams, 2009)
Develops knowledge of scientific procedures and the nature of science.	(Shana & Abulibdeh, 2020)

2.3 The effectiveness of Practical Work

Some researchers doubt the efficacy of practical work in the education and learning of science, which has sparked numerous controversies. Several researchers have reported that the conventional method of teaching practical work is ineffective, but new technologies such as smartphones introduce a multitude of possibilities for practical work in schools (Burland, 2018; Hofstein & Kind, 2012; Millar & Abrahams, 2009; Svensson, 2018). Incorporating technology

into practical work can bridge the gap between traditional science apparatus and technology familiar to learners, and it could even educate learners on how to conduct experimental work outside the traditional setting of a laboratory, expanding the horizon for endless possibilities to acquire process skills.

Millar and Abrahams (2009) evaluated 25 lessons in secondary schools in England to establish the effectiveness of hands-on science learning. They realised that practical work plays a crucial role in the science field, but the problem was to make it more effective as a teaching and learning strategy than it is today. Similarly, Hofstein and Kind (2012) say that the most significant trial for practical work is to change the practice of manipulating apparatus, not philosophies,' and that the typical laboratory involvement in school science consists of hands-on, but not mind-on, practices. This demonstrates the necessity for innovation to guarantee that practical tasks are carried out effectively and thoroughly.

Koirala (2019) conducted a study measuring the effect of practical practice on secondary-level science student achievement. The study revealed a significant difference between those taught using traditional methods and those taught through practical application. This is noteworthy since it is evident that hands-on experience is helpful in science education. Important is how the teacher complements the practical work to make it successful, as well as finding ways to make practical work more powerful, as opposed to simply demonstrating the experiment and expecting learners to receive SPS. In this study, the technique of data collecting was a limitation, as it would have been more advantageous to gain insight into what caused the learners' improved performance when taught through practical work.

In Nepal, Lee and Sulaiman (2018) determined the effects of practical practice on learners' motivation and comprehension of physics. Lee and Sulaiman examined 66 classes of six learners and found that there was a substantial difference in the learners' comprehension but

not in their motivation for practical work. These findings indicate the need for novel methods to inspire learners in their practical job instruction. According to Rahmatika, Yusuf, and Agung's (2021) study on the usefulness of YouTube videos as an online learning medium, teachers can use YouTube as a learning tool to help learners learn. To deepen and add rigour to their research, the researchers may have acquired quantitative data to complement the qualitative data.

Overall, these studies highlight the need for innovation in conducting practical work. The notions on the effectiveness of practical work demonstrated by many of the researchers resonate with the scope of this research in that practical work can be acquired using YouTube videos rather than fiddling with apparatus. Practical work can be restructured in a way that makes it more captivating and productive to the teacher and the learners, thus making it more valuable. The onus lies with the education system to introduce unorthodox and modernised styles of teaching practical work, as it is highly significant in teaching process skills. In all that has been mentioned so far, one may argue that granting learners more responsibility for their learning is the perspective of 21st-century learning. Therefore, adapting to new ways of practical work that are accessible, cost-effective, yet significant keeps them motivated.

2.4 Process skills

In his seminal article, Özgelen (2012) understands SPS as a driving factor for scientific enquiry by enabling learners to develop cognitive, enquiry, problem-solving and reasoning skills. Numerous studies identify SPS as the elementary skill crucial in mastering science since learners utilise these skills to explore the world around them as well as construct science concepts (Gultepe, 2016; Molefe & Stears, 2014; Prayitno, Corebima, Susilo, Zubaidah, & Ramli, 2017; Siahaan, Suryani, Kaniawati, Suhendi, & Samsudin, 2017). SPS is defined as the

mental and physical skills that learners need to master science and technology and to address personal and societal challenges (Akinbobola & Afolabi, 2010). This is vital because it informs us of the significance of learners developing process skills, which are crucial not only in the science domain but also in the learner's overall capacity to decode life difficulties.

Some scholars argue that in order to comprehend science fully, one must have a comprehensive understanding of SPS, as this enables learners to construct an understanding of the nature of science based on the scientific concepts, procedures, phenomena, apparatuses, philosophies, theories, laws, and models (Kahar & Sani, 2018). SPS are divided into two categories by the American Association for the Advancement of Science (AAAS): BSPS and ISPS (Siahaan et al., 2017). The BSPS includes six skills: observation, inference, measurement, classification, communication, and prediction. ISPS is comprised of six skills: manipulating variables, creating hypotheses, evaluating data, conducting experiments, and formulating models. Table 2.2 below demonstrates the classification of each SPS and the rationale for its classification.

Table 2.2

SPS Categories and Explanation

Category	SPS	Explanation
Basic Science Process Skills	Observation	utilising your senses to gather data about an object or event.
	Inferring	formulating assumptions or probable descriptions based on observations.
	Measuring	using regular measures or approximations to define specific magnitudes of an object or event.
	Communicating	defining an object, activity, or event with words, symbols, or images.
	Classifying	use the five senses (hearing, smell, sight, taste and touch) to gather information about objects and events, including their qualities, properties, differences, similarities, and changes.
	Predicting	predicting the most probable results of a future occurrence based on indication patterns.
Integrated Science Process Skills	Controlling variables	The manipulation of one factor to examine the result of an event while other factors are kept constant.
	Making operational definitions	generating a definition by defining what is done and observed.
	Constructing hypothesis	forming educated hypotheses based on evidence that may be tested experimentally.
	Interpreting data	recognising errors, assessing the hypothesis, formulating conclusions and commending further testing where necessary.
	Conducting experiments	constructing an experiment to verify a hypothesis with procedures to collect reliable data.
	Formulating models	identifying patterns in data and comparing them to known things or concepts.

This study investigated the following SPS: measuring, inferring, communicating, predicting, identifying variables, controlling variables, observing, interpreting data, formulating models and constructing a hypothesis. It must be noted that this study focused on something other than SPS classifying, making operational definitions and conducting experiments. These skills were chosen because of the reality that YouTube cannot address all the process skills, as it is a demonstrative tool. Some skills require physical presence to obtain, such as classifying, since it requires all five senses to comprehend and acquire. Making operational definitions and asserting how to quantify a variable in an experiment observed on YouTube is possible, although challenging since the videos chosen needed to demonstrate how the variables were measured more.

As the (Department of Basic Education, 2011, p. 12) reminds us:

The teaching and learning of science contain the development of a series of process skills that may be used in everyday life, in the public and in the workplace. Learners can gain these skills in an environment that supports creativity, responsibility and growing confidence. Learners develop the ability to think objectively and use different types of reasoning while they use process skills to investigate, reflect, synthesise and communicate.

Research demonstrates that teachers should only teach science after ensuring that the SPS are addressed, as they are mandatory for learners to know in the science discipline (Netshivhumbe & Mudau, 2021). Learners are said to gain SPS in an environment that taps into their inquisitiveness concerning the world, and that supports innovation, responsibility and growing confidence (Artayasa et al., 2017). It is crucial to note that the laboratory setting is not the only environment set for acquiring SPS. A teacher can use their creativity to generate an environment that will deliver the SPS to the learners at his/her discretion as long as it is effective and the learners demonstrate an understanding (Prayitno et al., 2017).

In a study conducted in Turkey which set out to determine the teachers' views on SPS, Gultepe (2016) discovered that biology teachers did not see the significance of science process skills. The study further asserted that teachers do not value SPS due to a lack of time because of curricular and a national-examination-focused education system, insufficient teaching of basic process skills, a deficiency of laboratories and equipment, pedagogical inadequacy of teachers in SPS, crowded classrooms and inadequate sample activities in course books. This study highlighted some of the problems faced by South African teachers, which lead to practical work not being conducted and therefore depriving learners of SPS. The challenges that stood out were those of inadequate laboratories and equipment, thus products of insufficient resource provision by the DoE.

The literature suggests that learners are deprived of process skills due to various reasons, which are mostly teacher-related (Artayasa et al., 2017). Perhaps YouTube videos can bridge this gap and provide a solution for both teachers and learners, as they do not require laboratory equipment, and they do not need the presence of the teacher but the learner's full autonomy to navigate and assimilate.

2.5 Teaching and learning approaches in science

Teaching and learning strategies are crucial to the development of knowledge and the grasping of concepts. Educators must implement tactics with a constructive influence on the academic growth of learners. It must be recognised that each teacher and student is unique. Different preferences exist regarding teaching and learning methodologies. Gengle, Abel and Mohammed (2017) posit that learning is a self-motivated process during which individuals make internal modifications independently and develop the desirable skills. Learners must not be taught using one strategy as concepts differ and therefore require alternative ways for content

to be unpacked. Learners have the role of making the necessary adjustments to formulate and understand the subject matter taught.

Learning encompasses a set of principles and skills that, if understood and utilised, assists learners to learn more effectively and become lifelong learners (Higgins & Moeed, 2017). It shows that for learners to learn, there are a set of skills and behavioural patterns they need to acquire, and these may be attained in different ways, but they can contribute to the learners' lifetime understanding. The skill to learn is possible and doable with the necessary artistry.

Traditionally, it has been argued that most learners enter the science classroom with fragments of knowledge or ideas regarding the phenomena to be taught. Only a tiny percentage acquire an understanding of the science concept after teaching. It demonstrates that learners carry their assumptions and expectations into the science classroom, which hinders their ability to grasp new topics (Crawford, Saul, & Mathews, 2005; Duit & Treagust, 2003). Active learning has a demonstrated benefit over passive learning in the teaching space. Active learning demands learners to be involved in building knowledge, and the cognitive theory of interactive program learning influences the cognitive load theory, given that a functional memory has two canals for acquiring and processing information. The visual and auditory channels maximise the working memory capacity; hence, designing strategies that employ both channels can improve learning (Brame, 2016).

Giannakos and Chrisochoides (2014) state that the purpose of every teaching method is to increase the learners' performance. In their study on collecting and making sense of video learning data present video navigation, learner performance, and attitudes, Giannakos et al. (2014) assert that active participation in the learning process, as opposed to passivity, is crucial. Teaching and learning extend beyond the two major learner- and teacher-centred strategies. It

refers to an outline of essential norms and regulations for effective problem-solving and decision-making. Omowunmi and Oloyede (2007) identified the following science teaching and learning strategies: problem-based learning which encompasses problem-solving, inquiry methods, gamification and simulations, obliging learning made up of student-student interaction, inductive which are questioning strategies, computer-assisted instruction (CAI), and similar approaches. These tactics are thought to strengthen and develop learners' talents as they teach them process skills. However, these solutions have advantages and downsides that must be considered.

Yuliyanto, Basit, Muqodas, Wulandari and Amalia (2020) researched the expansion of verbal-linguistic and visual-spatial intelligence through the use of YouTube videos amidst the COVID-19 epidemic. They discovered that YouTube videos allowed learners to access education anywhere and anytime. The authors further found that YouTube videos assisted learners in developing skills and supported their intelligence during non-contact periods. However, the authors did not outline their methodology to show how they conducted the data. It would have been riveting to see how many participants were in the study and the instruments used to collect the data from critiquing and giving prospects on the survey. There were also no recommendations made for future studies.

Contrary to past researchers, "there is no perfect teaching strategy just as there is no wrong teaching method" (Gengle et al., 2017, p. 3). According to these academics, teaching and learning styles differ depending on the issue. In addition, they say that teachers must be inventive in selecting tactics to guarantee that they are appropriate for the activity.

The most effective strategy to teach and learn is the incorporation of stimulants, which are proven to yield a better learning experience (Forbes et al., 2016). Teaching and learning are not one-size-fits-all but involve planning, trial and error, innovation and adaptation.

Nevertheless, it is imperative to ensure that learners are constantly involved and in charge of formulating their knowledge. Learners must be stimulated by utilising methods that invigorate them outside of the classroom setting. Teaching and learning approaches should be reconstructed in the formal, monotonous and fearful classroom context.

According to Rosenthal (2018), various disciplines use YouTube videos to deliver, dissect, and enhance the teaching and learning process. Furthermore, his study determined that YouTube videos are effective teaching and learning tools due to their visual capabilities. It is, therefore, prominent that there are various strategies for teaching science, and those that are effective are prompted by stimulation.

2.6 The use of YouTube videos as a pedagogical tool

Many writers characterise YouTube videos as a video-sharing platform that allows users to submit customised content. The channel permits users to track and accomplish a good record of viewers. Both professionals and amateurs generate these videos (Chorna, Hamaniuk, & Uchitel, 2019; Olasina, 2017). Kleftodimos and Evangelidis (2016) define YouTube videos as interactive videos that can be viewed linearly. Buzzetto-More (2014) identifies YouTube videos as the Goliath of video sharing and describes how registered users can submit audio-visual clips, television clips, composition videos, novel short videos, documentaries, animated shorts, and mobile-captured videos.

On the contrary, Fleck et al. (2014) define YouTube videos as a social media website that can be used as an educational tool. These scholars believe that YouTube videos are a user-generated video-sharing platform around which communities form and have discussions and interactions. YouTube videos allow people to establish, observe and distribute created videos, providing a platform to associate, inform and encourage others worldwide. The content shared

on the YouTube platform is not uniform to all viewers, but it is composed of variations, and the audience varies across the age spectrum. YouTube videos are accessed through Internet-connected smart devices such as smart televisions, tablets, iPods, computers, laptops and smartphones (Olasina, 2017).

Several authors have conducted various studies on the effect of YouTube videos as a pedagogical tool (Carmichael, Reid, & Karpicke, 2018; Chooprayoon & Sa-Ngiamwibool, 2020; Koto, 2020). In addition, other studies were conducted regarding the perception of learners about YouTube videos (Buzzetto-More, 2014; Eick & King Jr, 2012; Fleck et al., 2014; Kostereliogl u, 2016), while others researched on video-clips and practical work (Higgins & Moeed, 2017). Besides, there is research against YouTube videos due to various limitations (Jones & Cuthrell, 2011; Kohler & Dietrich, 2021; Richtberg & Girwidz, 2019).

Rajpal (2017) explored the usage of digital media to endorse scientific instruction and learning in South African high schools. The study indicates that the usage of digital media devices is the future of education and highlights that around 3.5 million people accessed YouTube daily in 2011. Further, it is asserted that the type of videos that users watch and interact with significantly affects their cognitive state, which could, in turn, affect their behaviour. YouTube receives roughly 30 million unique visits per day, according to data from 2019 (Mitchell, 2019).

Brame (2016) emphasises that instructors' use of YouTube videos as an educational instrument is strengthened when they address three factors: how to control the perceptive capacity of the video, how to amplify learner involvement with the video, and how to encourage active learning from the video. Using videos as a teaching tool highly depends on how the teacher employs them and requires much planning. The teacher cannot utilise any video without ensuring it is connected with the lesson objectives and enriches the lesson. Everhart (2009)

reaffirms in the same breath that the selected YouTube video must meet the following criteria: it must be age-appropriate, connected with instructional purposes, meet audio and video standards, be precise and free of misconstructions, and be compatible with teaching space time constraints.

In the medical faculties, YouTube videos are not just for teaching theory. They are used to show learners how to perform procedures and broadcast teacher-led demonstrations of practical work and not just to teach theory (Gedera & Zalipour, 2018). The authors discovered that educators favour the use of interactive videos in teaching and learning and discovered that interactive videos stimulate the learners' thinking, increase conversations, and promote independent learning. These results demonstrate the importance of equipping learners with digital tools to support the educating and learning process in the learning space, as this improves their comprehension and performance. However, the scholars used manipulated videos and not the existing videos on YouTube, which may have yielded the positive results they found. The study would have been more helpful had they used existing videos to obtain the significance of YouTube in teaching and learning.

This research draws upon an essential point of introducing innovation in teaching styles. Such dynamics not only improve the learners' understanding of concepts but also sharpen the teachers' skills and allows them to be more competent in the classroom. YouTube videos are used in developed countries and are being used worldwide to enhance learners' learning and understanding. Teachers can also use them to develop themselves through viewing videos created by other teachers who are experts in their subjects. Using YouTube videos can help various fields of study to build collaborative knowledge (Orús, Barlés, Blanche, Casaló, Fraj, & Gurrea, 2016). Gedera and Zalipour (2018) suggest that using videos in teaching and learning tends to be discipline-specific. As a result, this kind of teaching and learning tends to be more

beneficial in education and science than in the humanities. This viewpoint is debatable because YouTube channels exist for the humanities discipline. This view can be debated because there are YouTube channels for the humanities discipline. The empirical nature of science and education as a practice regards YouTube videos as beneficial to Education and Science disciplines, as they are more demonstrative and require the viewers to use their observation skills. According to Orús et al. (2016), it is possible to access the average display time per view, the number of views, the overall amount of hours the video has been viewed, and the comments sent on the YouTube website. This type of data is beneficial to the educator to use when selecting videos to utilise for their lesson preparation, it would assist them in choosing the most suitable video in terms of duration, and the usefulness of content as well as how it has benefitted others through reading the comments section which is readily available on all YouTube videos posted. Pan, Yan, Wand, and Hua (2015) and Thelwall, Kousha, Weller, and Puschmann (2012) argue that YouTube video view sum does not appear to be a reasonable evaluation of the value of the videos in question. It rather reflects a blend of the potential viewers size for the subject, the quality of the video, and whether it gains popularity.

Olasina (2017) assessed the influence of YouTube videos on academic writing and its skills on 40 learners in matric. The methodology adopted in the study was significant because it drew a comparison between two groups of learners, traditional and YouTube-facilitated. Olasina (2017) found that YouTube videos improved the experiences of communication between teachers and learners, as well as among learners. Furthermore, the learners were more focused and eager to learn due to the visual impact and relaxed environment created through video facilitation, which triggered group discussions and aroused curiosity. It is worth noting, as it tells us that YouTube videos can teach communication and academic writing skills. Higgins and Moeed (2017) assert that using videos as an instructional tool in conjunction with

practical work can be an effective strategy to engage learners in science concepts that they would not otherwise have access to through practical work. However, they caution that there may be complexities with watching videos to instil scientific literacy. Videos are an excellent tool to enhance the teaching process, but teachers should not rely on them as a pedagogical tool alone to promote learning. According to Brame (2016), seeing a video might be a passive experience; therefore, teachers must support learners with the processing and self-evaluation that will result in the desired learning.

It is crucial to note the significance of incorporating videos into the classroom setting. It is undeniable that videos integrate the outside world into the lesson and create an experience for learners that they cannot easily forget (Jones & Cuthrell, 2011). Moreover, Yousef, Chatti and Schroeder (2014) believe that videos incorporate different sounds which have an emotional impact on the learners, and they can uplift the mood by improving the attention to the subject and constitutes a positive impact on the learners' motivation.

Yousef et al. (2014) makes reference to the Blended Theory and Information Processing Theory to justify how best to implement and integrate YouTube videos in the classroom. These two theories provide insights into the successful combination of technology into the classroom. These authors highlight the importance of selecting suitable and relevant media and using the media appropriately as an object to increase teaching and learning. The integration of YouTube videos into classroom teaching increased comprehension and enhanced discussions which enabled learners to engage in the topic by being intrigued by the visual representation of the work. There is extensive evidence in the literature supporting YouTube videos providing factual, procedural and conceptual knowledge to learners (Koto, 2020). Fleck et al. (2014) conducted a study on learners' perceptions of YouTube videos by giving the learners a pre-test on a psychology chapter and, after that, used the YouTube video to facilitate the lesson by

paying close attention to the relevancy of the chapter and presenting a post-test. The research findings were that the learners associated their experiences with adjectives such as entertaining, engaging, fun and beneficial to learning. These discoveries regarding the use of YouTube were anecdotal but lacked educational theoretical foundations. Fleck et al. (2014) also indicate that not all YouTube videos are suitable for usage in the classroom as a teaching aid. Thus, the instructor must sift and opt for a video that is effective and suitable for their discipline to intensify the assimilation of phenomena to learners.

YouTube videos as a teaching tool positively contribute to learning outcomes and contentment. The act of learning is best reinforced when learner engagement is an active and interactive exercise using technical tools that provide intellectual support. When videos are utilised to enhance learning, the learning process becomes learner-centred which is what 21st-century learning advocates. Therefore, the teacher should not be the dictator and instructor but merely a facilitator through creating an inclusive environment and providing clear guidelines to the learners. The YouTube videos should be used in a manner that complements and coheres with the standardised methods of teaching and learning science, as stipulated by the CAPS. The policy states that the learner has to be in control of formulating their knowledge and use the scientific enquiry to acquire knowledge (Department of Basic Education, 2011).

Learners' performance is considered an indicator of the learning experience. It is, therefore, crucial to note that good performance demonstrates a learner's understanding of the content, which is a result of learning, according to the South African school curriculum. Kleftodimos and Evangelidis (2016) noted that the learners' performance goes hand in hand with the learners' engagement with the video content. These authors claim that the time one spends viewing the video also impacts performance. An evaluation of the educational values of YouTube videos for academic writing was conducted. It was established that the YouTube-

facilitated groups achieved better than the conventional learning technique groups. In the same breath, YouTube videos have a positive impact on the learners' performance, which means that YouTube videos have a optimistic impact on the learners' learning (Olasina, 2017).

When learners are interactive and engaged, they perform better in science. The advantage of using YouTube videos is that the instructor can replay the video for learners to watch again, which drills into the learners' memory. The video can also be paused to further elaborate or add to the video content (Riley, 2017). Whereas, if the instructor is only delivering content, they may need to remember specific essential points, and as a result, the learners miss out on relevant information. In addition, the learners are also exposed to extra information to enhance their conceptual understanding of the content. Yousef et al. (2014) add that video-based learning is a powerful tool in technology-enhanced learning, as it enables teachers to reflect on their teaching and enrich their lessons by viewing other ways to deliver content in the classroom. However, Chapman (2015) cautions on the appropriateness of YouTube videos for academic instruction due to the misinformation often found on the internet. The concern raised by Chapman (2015) is crucial to note, as the internet contains unreliable sources of information that may be misleading and lead to misconceptions. For this reason, the teacher must be involved in selecting information before sharing it with the learners.

Overall, there is a constant appraisal of the incredible impact that YouTube videos have as a pedagogical tool. For these justifications, one cannot dwell on the misinformation on the internet. Instead, the teachers must ensure that their YouTube video is appropriate and aligns with their lesson. As with any other system, there will be advantages and disadvantages. Thus, it is essential to focus on the advantages and objectives of the system.

2.7 YouTube videos for learning science

Since "YouTube.com" was created in February 2005, it has become the most popular and frequently visited online video-sharing website worldwide (Riley, 2017). Examples of what YouTube is used for are channel creation and video creation. Addressing digital education for digital natives, teachers can use YouTube videos to teach and learn science in the classroom. It is a reasonably straightforward approach to delivering audio-visual content in the classroom. As science learning resources, YouTube videos are stated to provide teachers with more auditory and visual learning options (learning styles) for learners (Riley, 2017).

A plethora of research demonstrates that countless websites are devoted to science topics, and these appeal to diverse audiences depending on personal interests. YouTube has become a popular source of science videos (Rosenthal, 2018; Welbourne & Grant, 2016). These YouTube channels are said to yield videos on a wide range of topics, including natural, biological and physical sciences. Rosenthal (2018) points out that while YouTube videos are widely available in Singapore, they are rarely used for academic viewing. The researcher further suggest that searching for science videos on YouTube is a reasonable act, a free choice learning option and an informal learning tool. The latter suggestion resonates with this research, as it firmly believes it relies on the video's context. However, the main area for improvement of the study is the inability to address why YouTube videos are not popularly used in the science discipline. Rosenthal's (2018) paper might have been more helpful if he addressed why YouTube videos are not very popular in learning science.

Furthermore, Rosenthal (2018) states that YouTube videos are an informal tool. If learners are to learn through the videos on their own, then it would be considered an informal learning tool. However, with an instructor using the videos to enhance the lesson, it is a standard tool for learning since the instructor is present to elaborate on what the video displays. It is the

instructor's responsibility to choose the video observed in the classroom and eliminate any confusion from the learners. It also allows the learners to watch the video outside the classroom context, as often as they wish, until the concept is fully understood. It cannot be done in a traditional classroom due to time constraints.

Incorporating YouTube videos into science lessons is found to energise the teaching and motivate learners. It stimulates them by feeding their appetite for self-paced and visually stimulating learning (Rosenthal, 2018). Furthermore, it shows that YouTube videos effectively teach and learn science. Ndihokubwayo, Uwamahoro and Ndayambaje (2020) conducted a quantitative study on the effectiveness of YouTube videos as an instrument to teach chemistry and found them to increase the learner's performance. They further claim that YouTube videos can be used to substitute laboratory experiments in cases where schools lack the resources in the laboratories since YouTube videos are beneficial. However, a question that needs to be asked is whether learners prefer incorporating YouTube videos in their learning process. Ndihokubwayo et al. (2020) did not gain insight into the participants to understand their preferences thoroughly. It is of paramount importance to loop in the learners when choosing a style of teaching so that they oversee their learning. Wang, Ye and Ye (2021) conducted a study on learning from YouTube videos with a focus on these factors: learning attitude, learning interest, self-efficacy and learning satisfaction and found these factors to be positively related. They further stated that YouTube videos provide a step-by-step learning platform. Their study would have been most beneficial had it focused on practical science work.

There needs to be more literature on YouTube videos' effectiveness in learning science. In addition, more research would be beneficial regarding YouTube videos for learning science and developing SPS. However, a few existing studies exemplify that YouTube videos are

helpful in teaching and learning science, as they tap into learners' curiosity and enhance the lesson.

2.8 YouTube videos for promoting self-regulated learning in science

Panadero and Alonso-Tapia (2014) confer Zimmerman's cyclical model of self-regulated (SRL) knowledge and define SRL as the willpower that the learners have over their behaviour, emotions, cognition and motivation to achieve their goals. However, it is crucial to note that for the learners to self-regulate their learning, they must have the necessary tools to use during the learning process (Al-Jarf, 2022).

Most scholars concur that YouTube videos allow learners to regulate their learning (Harahab, Wijayanto, & Supriyadi, 2020; Urmilah, Miftakh, & Ridwan, 2021). Harahab et al. (2020) studied the strength and weaknesses of SRL through YouTube. They discovered that YouTube provided various learning materials and the flexibility of time and place, enabling learners to regulate their learning. The study may have been more beneficial had it investigated various subjects, including science. Urmilah et al. (2021) also conducted a study to investigate the learners' perceptions and experiences of YouTube-mediated SRL. Their study focused on the various components of SRL, including a goal-commitment parameter, affective principles, culture learning regulations, metacognitive regulation and social regulation. They found that YouTube videos did not boost metacognitive and social regulations. Therefore, a mixed methods study that investigates the practicality of YouTube videos in improving SRL and further investigates the learners' perceptions is necessary. Rahmatika et al. (2021) discovered that YouTube videos allow learners to work independently since they can be accessed anytime and anywhere. Although the scholars did not premise their paper on SRL, their findings prove that YouTube videos promote SRL. They could have zoomed into the aspect of YouTube videos

in developing SRL to provide more insight into their topic, which sought to explore the effectiveness of YouTube as an online learning medium.

A study was conducted by Putri, Muqodas, Sasqia, Abdulloh and Yuliyanto (2020) on SRL through concrete-pictorial-abstract and SRL through the traditional learning style. The study aimed to understand the incline in SRL students who applied concrete-pictorial-abstract. The scholars had a sample of 27 students for each learning style. The findings were that students who received concrete-pictorial-abstract learning were not significantly better than those with traditional learning. These findings diverge from the previous scholars who discovered visuals to have a significant impact. The research gathered by Putri et al.(2020) may have been beneficial to the current study had its focus been channelled on concrete-pictorial-abstract of YouTube videos. However, it explored WhatsApp and Google forms support, making the study findings less useful.

Most of the research shows that YouTube videos are effective in promoting SRL and most perceptions obtained from the subjects show that YouTube has a positive impact on SRL. However, debatably, there needs to be more literature concerning YouTube videos promoting SRL in the science discipline.

2.9 Summary

In this chapter, the literature concerning the study was reviewed. The significance of YouTube videos in teaching and learning process skills in science was outlined. Findings by other scholars declare YouTube videos as a powerful pedagogical tool in science, they further reported the advantages YouTube videos have as a pedagogical instrument. The theories used as a lens through which the study was reviewed will be conversed in the proceeding chapter.

Chapter 3

Theoretical Framework

3.1 Introduction

This chapter will present the model and supporting theories adopted to establish the feasibility of this study. This section will evaluate the effectiveness of YouTube videos in developing SPS by connecting the study with existing knowledge. The theories will explain, predict and understand the phenomena of effectiveness in practical work. The framework will identify the critical variables in this study, which are YouTube videos and their effectiveness in developing SPS. The theoretical underpinning of this study is a model developed by Abrahams and Millar (2008). The supporting theories used are constructivism and active learning.

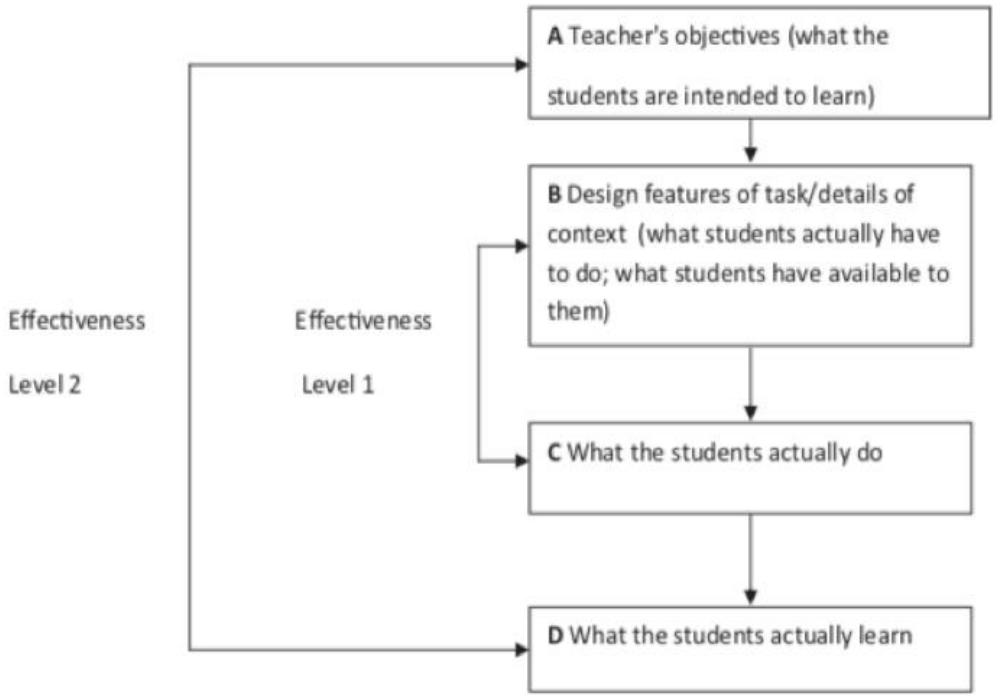
3.2 A model for evaluating the effectiveness of YouTube videos in developing process skills in Life Sciences

Practical work is a significant component of science, but its effectiveness is always questioned when assessing what learners have learnt. The current research established the effectiveness of YouTube videos in developing SPS. Abrahams and Reiss (2012) stress the effectiveness of practical work and refer to a model developed by Abrahams and Millar (2009), which considers the effectiveness of each practical activity. They believe that the focal point should not be on how the practical task is conducted but on how effective it is in learning. The model draws upon the teacher's objectives of the practical task and what the learners learn from the task. It also looks at the design strategy the teacher uses to outlay the task, the details of the context, and what the learners do during the task.

The model by Abrahams and Millar (2009) aligned with this research in that the effectiveness of the YouTube videos on practical work was tested through the practical task to establish effectiveness of YouTube videos. It was done by deducting from the learner's performance in the practical task. Abrahams and Reiss (2012, p. 1039) remind us that "evidence for learning, at both levels, is obtained by observing what learners do during a task and how they respond to questions posed by both the teacher and the researcher during the observed practical lesson".

Figure 3.1

Model for the Evaluation of the Effectiveness of Science YouTube Videos



Note. This model considers the effectiveness of the practical task of the teachers' aims of the practical task (Abrahams & Millar, 2009, p.60).

The model is divided into four boxes (A-D). Box A is about the teachers' objectives which are basically what the teacher wants the learners to learn during the practical, and these objectives are only sometimes met:

Learners had to understand the concept of osmosis when responding to the questions and formulate hypotheses based on the investigation.

Learners had to analyse data presented in the table (question 2 in Appendices F and G) to show an understanding of how to interpret the data.

Learners had to demonstrate the ability to identify variables illustrated in the able by communicating their interpretation.

The learners had to demonstrate improvement in observation, inference, measurement, communication, classification, prediction, variable control, operational definitions, hypothesis formulation, data interpretation, and model formulation.

The development of these abilities was inferred from their responses to the practical task questions, as each question targeted a specific SPS.

Box B is the design of the task, which is the actual plan of what the learners must do during the task. The practical task questions were structured strategically to understand whether the learners developed the BSPS and ISPS when they observed the YouTube videos showing the osmosis process. Learners had to figure out through reasoning what would happen during the investigation presented in the first question of Appendices F and G.

In their responses, learners had to demonstrate that osmosis is the transfer of water from a location of high concentration to a location of low concentration through a membrane with differential permeability. They had to apply this definition to what was happening in the potato and make relevant predictions as to what would happen. The learners had to communicate their responses using logical explanations and formulate hypotheses concerning the concept of

osmosis. In the second question of Appendices F and G, the learners had to refer to the data given to provide their analytical responses. It would show that they had developed data interpretation and communication skills. The third question of the practical task demonstrated an image where learners had to demonstrate through drawings the effect of osmosis on the potato cells. The pre-test and post-test had a similar structure of questioning; although they differed, they sought similar SPS development.

Box C is what the learners do during the task, which is only sometimes in coherence with the plan and the teachers' objectives, as learners may do the task according to their understanding. The learners' responses to the pre-test displayed poor knowledge of the process of osmosis. Therefore, there was no development of the SPS in the responses. The learners wrote according to their interpretation and understanding of the questions. The responses to the post-test revealed a greater understanding of the osmosis process, and this change may have been due to the observation of YouTube videos before writing. Learners responded to the questions based on the knowledge they had acquired from the videos, which resulted in the development of SPS.

Box D is what the learners learn from the task, and this also depends on how the learners formulate knowledge and is not necessarily based on the teachers' objectives, as it may vary from learner to learner. For example, learners understood the osmosis process in the post-test responses instead of the pre-test responses. In addition, learners responded to the post-test questions logically, exemplifying that knowledge was formulated and SPS were developed. On the other hand, the learners' responses to the pre-test practical task showed no formulation of knowledge and development of SPS.

The teachers' objectives may not be met because the learners need to understand the teachers' instructions in the practical task. In addition, the learners may not engage mentally

with the task at hand, and the learners might have needed to be more attentive during the YouTube video playback and missed some vital information. The last stage of the model (Box D) focuses on what the learners learn from the task, and this can be measured by how effective the task is. Hence, the model demonstrates two levels of effectiveness, 'Effectiveness Level 1', which draws a link between Box B and C if the teacher-designed practical task is what the learners did. The pre-test practical task was influential because the learners did what the teacher expected. They completed the practical task and followed the design layout of the task.

'Effectiveness Level 2' draws a link between Box A and D - if the learning outcomes were what the teacher intended to achieve with the learners. For example, the effectiveness of a task can be drawn from the feedback the teacher gets after the task by reflecting on the learners' submissions. If the learners did what was expected of them or not and if they learnt from the task.

This model (Figure 3.1) was used to design the semi-structured questionnaire to prompt the participants to reflect on the effectiveness of YouTube videos in learning SPS. The same model was utilised to analyse the data and findings to answer the respective research questions underpinning the study.

3.3 Constructivism Theory

Various theories and models have been used and applied to rationalise the teaching and learning process. For example, Jean Piaget developed the cognitive constructivist theory on the premise that knowledge is not a self-acting reality but has an adaptive resolution (Fosnot, 2013). Piaget's principles imply that children should be encouraged to seek information by exploring their environment. Lev Vygotsky, after Piaget, emphasised social constructivism, which focuses on creating opportunities for children to learn alongside the teacher or more capable

peers (Fosnot, 2013). Social constructivists think humans seek to comprehend their environment and establish subjective meanings from their experiences (Creswell & Creswell, 2018).

Bada and Olusegun (2015) define constructivism as a teaching and learning technique grounded on the idea that cognition is the outcome of mental construction and personal experiences. The authors further posit that constructivists think that context influences learning. Therefore, they include the environment in which a concept is taught and the beliefs and attitudes of the learners. Therefore, the pedagogical objectives in a constructivist classroom are to improve the environment. To encourage constructive learning, diverse modalities of representation, such as videos, auditory, and manuscript, must be used in the teaching and learning process (Khamo & Johnson, 2019). These promote communication and social skills among learners by fostering an environment that emphasises the exchange of ideas and teamwork. This notion is supported by the current study, which focuses on acquiring process skills that employ a visual and auditory learning style.

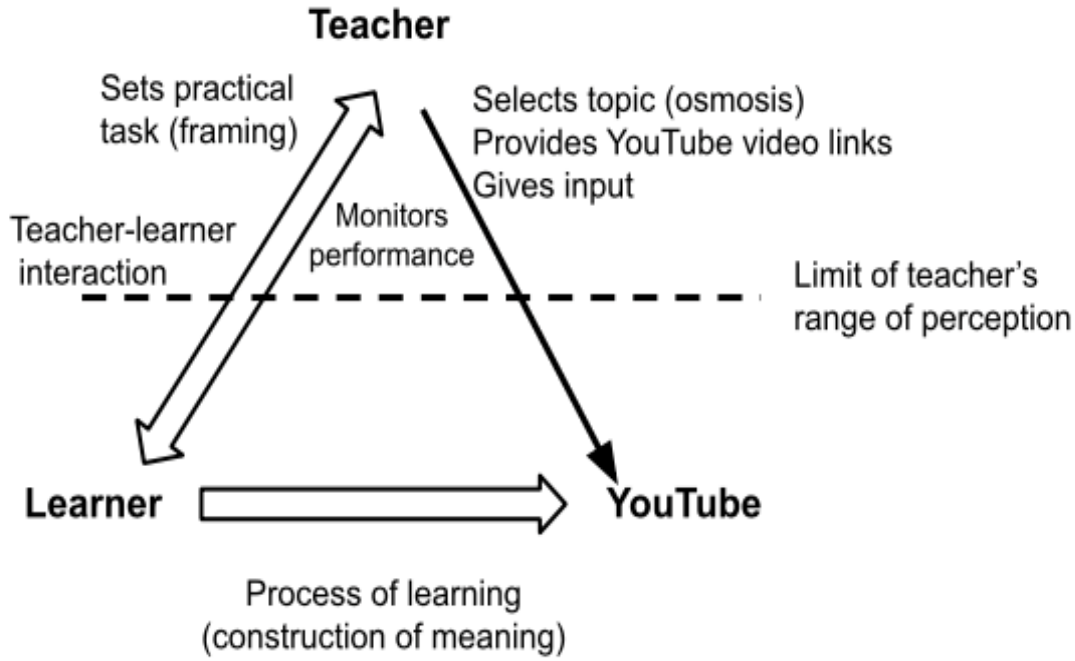
The constructivism theory is believed to help learners construct their knowledge and is dynamic and ever-changing based on the teacher's and learners' creativity. The YouTube videos on the process of osmosis were used to enhance the teaching and learning process to develop SPS. Learners were allowed to develop SPS using multiple modes of presentation as they watched the videos, listened to the audio and were able to read the subtitles.

Figure 3.2 depicts how constructivist learning takes place. The learner is in charge of constructing their understanding of the learning objects. The construction occurs in the learners' minds beyond the teacher's awareness (Dewey, 2007). The only thing the instructor sees is the outcome, which is the product of the learner. The learner decides what they find interesting, worth learning and what they will remember for eternity or forget. The teacher's primary duty

is to provide support and guidance to the learner (Gollob, Krapf & Weidinger, 2010). In the context of this study, the teacher was responsible for choosing the topic of osmosis guided by the Life Sciences curriculum and selecting the videos in line with the topic. The teacher gave the learners input on the topic, set the practical task, and used it to monitor their performance. Figure 3.2 below shows a teacher-learner interaction, as the teacher explained.

Figure 3.2

Constructivist Didactic Triangle



Note. The model was created by Living Democracy learning in EDC/HRE(2014). Interactive constructivist learning in EDC/HRE is a Zurich University of teacher education. https://www.living-democracy.com/textbooks/volume-4/introduction-2/

Various elements contour the constructivist theory (Kurt, 2021). These principles describe the theory as a whole and how it influences the learners' learning in regard to this study.

- *Knowledge is constructed.* All the learners began with some pre-existing knowledge of SPS and built their understanding of the SPS by learning about the osmosis process using YouTube videos. While constructing knowledge, they selected pieces to add to their existing knowledge, resulting in their unique understanding and development of SPS.
- *Learning is a social activity*. Learners interacted with each other through discussions after watching the YouTube videos. The learners also interacted with the teacher to obtain knowledge and create an understanding of the content which then enabled them to develop the skills.
- *Learning is an active process*. Learners interacted with each other through discussions after watching the YouTube videos. The learners also interacted with the teacher to obtain knowledge and create an understanding of the content which then enabled them to develop the skills.
- *Education is contextual.* Isolation is not the most effective technique to recall information. We learn through copying relationships between what we believe and existing data. Learning also occurs in the context of our life or in conjunction with the rest of our understanding. We consider our life and categorise the new knowledge per our current perspective.
- *Individuals learn how to learn as they learn.* As each learner progresses through the learning experience, their ability to pick and organise material improves. They can

classify concepts more effectively and develop more meaningful systems of thought. They also begin to recognise that they are simultaneously acquiring multiple concepts.

- *Learning is a mental process.* Physical experience and mental and physical exercises are insufficient to retain knowledge. Active participation and reflection are essential to the learning process. In order to get comprehensive knowledge, pupils must also investigate their minds.
- *Knowledge is individual.* Every student brought their own experiences to the learning exercise and took away individual lessons. The constructivist view of learning is based only on each learner's perceptions and experiences.
- *Motivation is essential for learning.* If learners are unwilling to reflect on prior information and stimulate their mental processes, they cannot learn. The learners had to be encouraged to view YouTube videos often for their education.

3.4 Active Learning

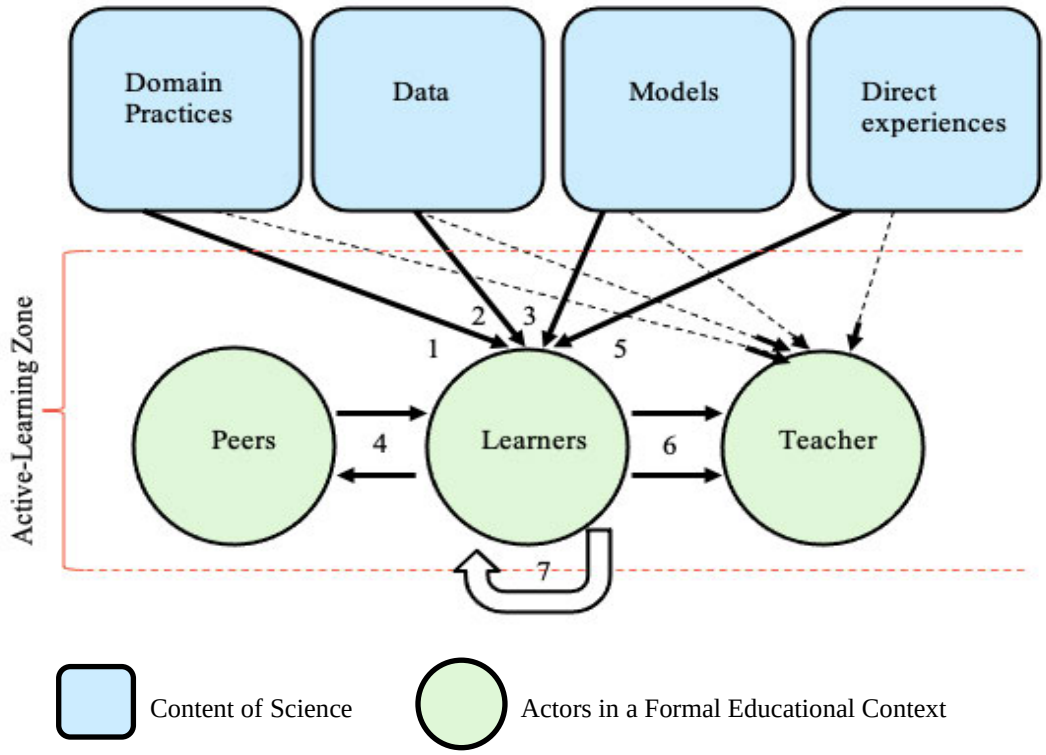
Dewey (2007) defines *active learning* as teaching learners to learn more enjoyably through active thinking and incorporating hands-on experiences. Some scholars adopted a social-constructivist position when assessing active learning (Lombardi, Shipley, Bailey, Bretones, Prather, Ballen,… & Docktor, (2021). It informs us that knowledge is constructed when learners actively engross the subject matter with other learners. The teacher's duty in the process is to provide and afford suggestions while still directing learners to acquire knowledge. Lombardi et al. (2021) identify active learning as a theory that expands learner participation in the classroom or laboratory. However, they need to express the right ways this can be achieved. Therefore, the onus lies on the teacher to creatively discover ways to enhance the learning experience for the learners. Multiple researchers have contributed to learners' need to engage

in their quest for knowledge (Lombardi et al., 2021). The active learning theory opposes passive learning, whereby the teacher is the sole bearer of information, and the learners are recipients (Pardjono, 2002). The Active learning theory emphasises that the teacher provides the learners with the autonomy to watch YouTube videos outside of the classroom setting. This strategy allowed the learners to engage with the SPS and learn on their own actively. The teacher provided a guideline by providing the necessary YouTube links to prepare them for the practical task. Lombardi et al. (2021) streamlined the definition of active learning in Biology to be a cooperative and engaging process instigated through strategies involving metacognition, discussion, group work and live-action visuals, to mention a few. YouTube videos represented the live-action (in real-time and recorded) visuals as learners watched the practical work on osmosis on a live platform.

Figure 3.3 below illustrates the active learning model Lombardi et al. (2021) adopted. In an active learning environment, learners create an understanding of SPS by the mediation of domain activities (path 1), information about osmotic phenomena gathered from YouTube videos (path 2), and scientific models (path 3) in collaboration with their counterparts (path 4). Path 5 also involves learners explicitly reflecting on the science they have experienced in an active-learning domain, with the teacher facilitating this process (path 6). Finally, path 7 concludes with the student reflecting on their grasp of the idea of osmosis.

Figure 3.3

Construction of Understanding SPS: Active Learning



3.5 Summary

This chapter explained the theoretical framework utilised to interpret the study's findings. A model illustrating the levels of effectiveness and supporting theories was used as a lens through which the study was observed. The succeeding chapter is on the research methodology used to complete this study.

Chapter 4

Research Methodology

4.1 Introduction

This chapter will justify the sampling strategy and the research methods used to respond to the research questions: Is there a significant difference between the learner's performance before and after using YouTube videos on practical work in Grade 10 Life Sciences? What are the Grade 10 Life sciences learners' perceptions of using YouTube videos on practical work? How effective are YouTube videos in developing process skills in Grade 10 Life Sciences learners? This section will provide a synopsis of the research paradigm, methodology, design, sample procedures, and data collection tools.

This mixed-methods study aimed to examine the effectiveness of YouTube videos in developing process skills as part of the 10 grade Life Sciences curriculum. The objectives were: to determine if there is a significant difference in the performance of the learners before and after using YouTube videos to develop process skills in Grade 10 Life Sciences, To identify the learners' perceptions of YouTube videos for practical work, and To establish how effective YouTube videos are in developing process skills in the Grade 10 Life Sciences curriculum.

4.2 Research Paradigm

A research paradigm is a set of opinions that express an individual’s position in a worldview (Guba & Lincoln, 1994. A paradigm gives a researcher the latitude to adopt research methodologies that work to collect or generate the desired data. This research has adopted the pragmatism paradigm as its research paradigm. It is argued that the pragmatic paradigm allows researchers to take multiple perspective in collecting all kinds of data to provide the best

answers to the research topic (Cohen, Manion, & Morrison, 2018; Creswell, Plano, & Vicki, 2017). The pragmatic paradigm resonated with this study in that it sought to measure the effectiveness of YouTube videos in developing SPS and explain the observed level. Mertens (2015) and Tashakkori and Teddlie (2010) identify pragmatism as a central philosophical underpinning of mixed-methods research. It allows the researcher to select an appropriate combination of methodologies to answer the study questions (Mertens, 2015).

In pragmatism, the 'meaning' of something is demonstrated by its practical, apparent significance and success in practises, with its connection to experience, as opposed to, for instance, immaterial philosophy with little applied import, ideology, or inflexible adherence to a specific value system or epistemology (Cohen, Manion, & Morrison, 2018). Therefore, it is evident that the pragmatism paradigm subscribed to the conception of practical work and applied research philosophy (Denzin, 2018). The existence of multiple realities goes beyond starting with a theory like post positivism and addressing the process of interaction among individuals as defined by interpretivism/constructivism (Creswell & Creswell, 2018; Creswell, 2015). For this reason, the research questions for this study aimed to quantify and comprehend the value of YouTube videos for the development of scientific process skills, propelling the collection of both quantitative and qualitative data. This utilisation of differing approaches to collecting data echoes how Creswell and Creswell (2018) view pragmatism as a paradigm that is unrestricted to data collection and analysis methods.

The four guiding components of a paradigm are ontology, epistemology, axiology, and methodology (Guba & Lincoln, 1994). The ontological stance of this study was governed by the views of Creswell et al. (2017), which state that it is the nature of reality. This study formulated a hypothesis before conducting the pre-test and the post-test. The prediction made by the researcher was that YouTube videos would be effective in developing process skills. The

reason for making this hypothesis was based on findings in the literature outlined by numerous scholars that YouTube videos were compelling. However, the reality of this study was multifaceted since the reality was not based on the differences in the test scores but also the learner's experiences of YouTube videos.

According to Mertens (2015), epistemology reflects that research occurs in communities. Therefore, the researcher has to engage with community members to assimilate the problem. Maarouf (2019) posits that the stance the researcher chooses may be an interchange between subjective and objective. Wahyuni (2012) perceives epistemology as a set of beliefs on generating, assimilating and utilising the knowledge that is rooted to be acceptable and valid. To this end, an extraction of objective meanings were obtained from the pre-test and post-test results to provide quantitative data. The subjective meanings were derived from the learners' experiences of YouTube videos to learn process skills. Taking this stance enabled the researcher to obtain a detailed understanding of the significance of YouTube videos through the test scores as well as through the learner's experiences.

The pre-test and post-test analysis provided an in-depth understanding of the effectiveness of YouTube videos at both levels of the theoretical framework used. The effectiveness of level one was derived from analysing the responses to the test questions and establishing if learners were displaying an understanding of the instruction given. Level 2 effectiveness was derived from determining whether learners learned what they were supposed to learn—furthermore, analysing the semi-structured questionnaire responses provided an in-depth comprehension of why the YouTube videos were compelling.

Biddle and Schafft (2015) and Creamer (2018) refer to axiology as the role of values in social enquiry, which links research to practice. Maarouf (2019) referred to the axiological position as the required bias principle. During the quantitative data collection, there was

minimal interference by the researcher, as learners wrote the pre-test and post-test, thus adopting the etic stance. The only interference was briefing the learners about the two seating's for writing the tests. During the qualitative data collection, the learners wrote their responses on the questionnaire and asked questions where clarity was required. Therefore, the interaction did occur. The only bias during this research was the choice of questions on the questionnaire.

The pragmatic paradigm allowed for optimum flexibility and liberation in that data were collected in two methods, thus enabling the researcher to fully explore the effectiveness of YouTube videos and in the validity and reliability of the results (Cohen et al., 2018).

4.3 Research Methodology

This study was appropriate for a mixed-methods approach. According to Creswell et al. (2017), a mixed-methods strategy involves gathering both quantitative and qualitative data and integrating the two types. Johnson, Onwuegbuzie, and Turner (2016) reaffirm that the mixed methods approach is when the researcher blends aspects of qualitative and quantitative research methodologies for in-depth comprehension and evidence. The reason for selecting the mixed methods strategy for this study was that it allowed for the optimisation of various data kinds and minimised the limits of the quantitative and qualitative techniques (Creswell & Creswell, 2018). The employment of combined methodologies offers a greater depth of understanding than either quantitative or qualitative data alone. The two research methodologies permit combining the approach's various analytic powers. The qualitative case studies permit the detection of trends and analysis of the internal dynamics of the YouTube videos' effectiveness from the learners' perspectives (White, 2011). This study attempted not only to comprehend the learners' impressions of YouTube videos for learning process skills but also to integrate the two kinds of data to explain the findings better.

According to Cohen et al. (2018), mixed methods research emphases on gathering, analysing, and combining quantitative and qualitative data within the same study or successions of studies. In addition, they say that its core premise is that quantitative and qualitative methodologies working in tandem provide a better grasp of research problems and concerns than either way alone.

Denscombe (2014) suggests that mixed-method studies can provide a more nuanced understanding of the overall phenomenon and research question than qualitative and quantitative approaches alone. For example, the qualitative part of the study consisted of a semi-structured questionnaire. Hence, learners replied to questions on their perceptions of YouTube videos for learning process skills and why YouTube videos had or did not influence building SPS. It provided an answer to the study's third research question.

The quantitative portion of the research included a pre-test and a post-test. These tests produced quantifiable data. Notably, the qualitative data were also quantified to increase the study's depth and comprehension of the effectiveness of YouTube videos in building SPS. In addition, it would address the first and secondary research questions.

According to Creamer (2018), the mixed methods approach provides an interactive insight into the qualitative and quantitative data, thus offering a comprehensive comprehension of the research.

4.4 Research Design

This study adopted an explanatory sequential mixed design. According to Creswell and Creswell (2018), in an explanatory sequential mixed design, researchers first conduct quantitative research, analyse the results, and then use qualitative research to elaborate on data descriptions.

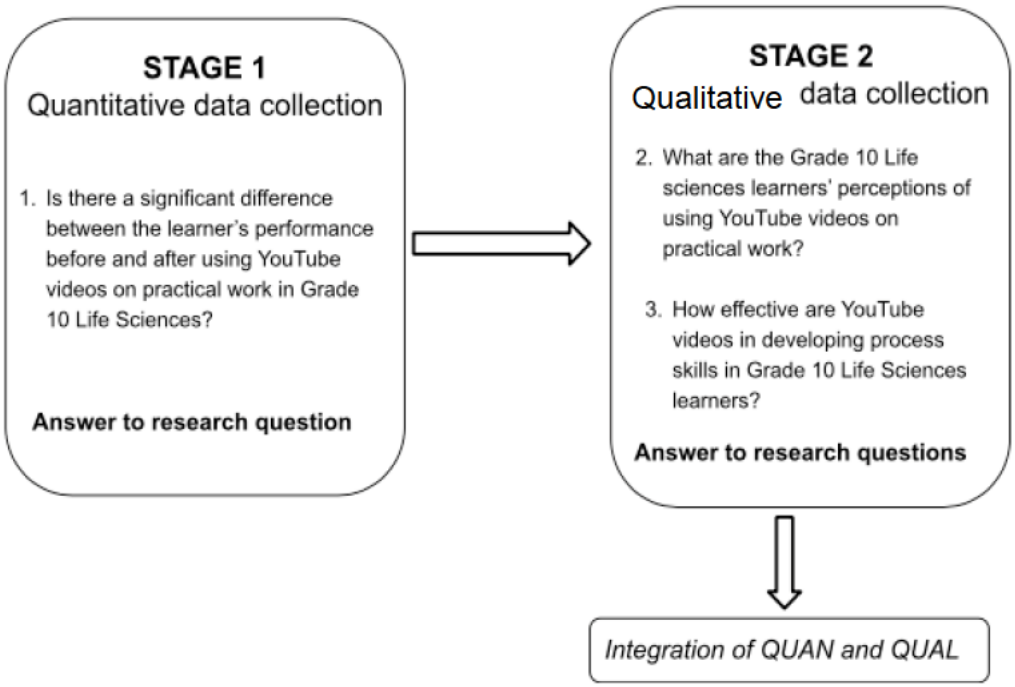
In the initial quantitative phase of the study, pre-test and post-test data were obtained from the school's learners to measure their understanding of osmosis, thereby determining whether process skills were acquired by watching YouTube videos. As a follow-up to the quantitative results, the second qualitative phase was undertaken by utilising semi-structured questionnaires to help explain the quantitative results.

The reason for opting for this mixed-method design is that it enabled the researcher to collect and analyse the two databases to understand best the effectiveness of YouTube videos on learning process skills. Figure 4.1 below represents the explanatory sequential design used in this study.

This diagram depicts the steps involved in doing this research. Stage one displays the gathering of quantitative data for research question one, whereas stage two demonstrates the collection of qualitative data for research questions two and three. Therefore, quantitative data, which replied to study questions one and three, were collected first, followed by qualitative data, which addressed research question two. Quantitative data were then utilised to show YouTube videos' significance in developing process skills (Cohen et al., 2018).

Figure 4.1

The Explanatory Sequential Design



4.5 Sampling

The participants were Grade 10 Life Sciences learners from a school in KwaZulu-Natal. Then, 100 learners were recruited to participate in this study. They have spread across 3 Grade 10 Life Sciences classrooms. Thirty participants are the minimum number to conduct a statistical analysis (Creswell et al., 2017). The sample for the current study was a non-probability sample. Cohen et al. (2018) define it as targeting a particular population that cannot be generalised. The researcher opted for this sample because it is of small scale, thus cannot be generalised, and for its convenience to the researcher. The subjects were also selected because they were in Grade 10 and doing Life Sciences as a subject since this was the focus of the study.

Convenience sampling was employed in this study. Cohen et al. (2018) define convenience sampling as a technique that involves opting for the nearest individuals to serve as respondents and whom the researcher has access. The learners that partook in this research were conveniently chosen due to their accessibility since they were all Life Sciences learners in Grade 10 at the researcher's school. It was, therefore, compelling to utilise convenient sampling as a suitable method for this research. The topic used to conduct the study aligned with the curriculum for Life Sciences Grade 10, of which the learners were due to learn. Therefore, this study benefited them, as it kept their focus in school.

As per the Department of Basic Education (2011), Grade 10 is the foundation phase of the Life Sciences subject. At this grade, learners are supposed to gain foundational knowledge and acquire process skills in depth. Thus, Grade 10 learners were best suited and chosen for this study due to their undeveloped knowledge of process skills. As a result, they would not have influenced the results.

4.6 Data Collection Methods and Instruments

According to Hox and Boeije (2005), the researcher may employ a variety of data collection methodologies. Data was collected using tests (pre-test and post-test) and semi-structured questionnaires. The exams were utilised for quantitative data collection, while the semi-structured questionnaires were employed for qualitative data collection.

According to Dimitrov and Rumrill (2003), design measures influence the outcomes of experimental treatments and allow the researcher to compare data. The pre-test and post-test allowed the researcher to measure the effectiveness of YouTube videos quantitatively. The usefulness of YouTube videos for developing process skills was then determined. This method of data gathering addressed the first research question.

The semi-structured questionnaires aided the researcher in obtaining a comprehensive understanding of why the YouTube videos were effective in developing process skills, as learners' responses were based on their perspectives and experiences of learning with YouTube videos.

4.6.1 YouTube videos

Four YouTube videos were selected, and the learners were shown the videos in class so that they would know which videos to watch alone. These movies were selected under the following SPS: observing, inferring, communicating, predicting, identifying variables, controlling factors, forming models, measuring, evaluating data, and developing a hypothesis.

These videos were also chosen for their appropriateness and ability to unpack the topic of osmosis in the Grade 10 curriculum.

The learners were allowed to watch the video/s inside and outside the classroom setting, with the freedom to view each video as many times as they deemed sufficient to prepare them for the post-test. The motive behind watching the videos in the classroom was to improve interaction and allow the learners to pose questions for clarity (Carmichael, Reid, & Karpicke, 2018). Carmichael et al. (2018) raise a question found in most studies about the importance of the instructors' presence during video watching. The cognitive theory states that the instructor may overload the learners with excess information. In contrast, the social theory states that the instructors' presence improves engagement through eye contact and physical gestures. For this reason, the researcher had to strike a balance between the two opposing theories and opted to be present to watch the videos and allow the learners to observe the videos outside of the classroom setting.

The school had free internet connectivity and a computer laboratory that learners could access freely, making it easy for all the learners to view the videos.

Table 4.1

YouTube Video Title, Creator, Link and Duration

Number	Title of YouTube video	Creator	Link	Duration (Minutes: seconds)
1	Osmosis using Potato tubers and known concentrations of Sucrose solution.	Easy style science	Link	10:22
2	Study of Osmosis	Amrita create	Link	3:52
3	Osmosis and water potential	Amoeba sisters	Link	9:49
4	Osmosis in potato At-home experiment	Science with Sheridan	Link	20:16

4.6.2 Tests

Testing is identified by Cohen et al. (2018) as a data collection instrument where the pre-test is at the beginning of the research, trailed by the post-test to measure the effect. Cohen et al. (2018) further state that tests can be used to see what skill a student has mastered. In the current research, testing was conducted to determine the effectiveness of YouTube videos in developing SPS.

The tests (Appendix F and G) assessed the following process skills: observing, inferring, communicating, predicting, identifying variables, controlling variables, formulating models, measuring, interpreting data and constructing a hypothesis. The reason for this selection of

process skills was that process skills are vast. The researcher acknowledged the reality demonstrated by the literature that YouTube videos can be used as a learning instrument. However, they are limited in terms of what they can teach. Hence, the process skills they can address are limited.

The purpose of the tests was to determine the difference between the pre-and post-test scores to respond to the first research question on the significance of YouTube videos in developing process skills and to evaluate the effectiveness of YouTube videos (the second research question).

The pre-test and post-test questions differed but still addressed the same SPS. The contexts were changed to avoid familiarity. The familiarity issue affects what the observer sees (Cohen et al., 2018). Changing the context of the questions was also meant to enhance the reliability of the tests.

The tests were written at different periods, with the pre-test written first before the learners watched the YouTube videos. All 100 learners wrote the pre-test. Then, the learners watched YouTube videos on osmosis before writing the post-test.

4.6.3 Semi-structured Questionnaires

The learners completed semi-structured questionnaires. The semi-structured questionnaire is said to set the agenda but does not presume the nature of the response (Cohen et al., 2018). This type of questionnaire comprises a series of questions, and the respondents are requested to answer them as they wish, granting them the freedom to elaborate on the responses on their terms (Creswell & Creswell, 2018).

The responses were, therefore, indefinite yet directed by questions to ensure that the responses stayed within the focus of the study. Cohen et al. (2018, p. 475) further state that "open-ended questions can catch the authenticity, richness, depth of response".

The semi-structured questionnaire (Appendix H) was based on the learners' experience of YouTube videos and whether they benefitted from learning practical work via the YouTube videos. Tashakkori and Teddlie (2010) assert that this data collection method elicits the participants' attitudes, judgements, beliefs or other attributes. Therefore, they obtained responses for the semi-structured questionnaires from each learner-generated positive and negative insight into whether they benefitted from the experience. It enlightened the study with a realistic view of whether this method of acquiring process skills was effective. Table 4.2 below shows the sources of data and the research questions addressed by each source.

Table 4.2

Research Questions and Data sources

	Research Question	Data Source
1.	Is there a significant difference between the learner's performance before and after using YouTube videos in practical work in Grade 10 Life Sciences?	Pre-test and Post-test
2.	How effective are YouTube videos in developing process skills in Grade 10 Life Sciences learners?	Pre-test and Post-test
3.	What are the Grade 10 Life Sciences learners' perceptions of using YouTube videos in practical work?	Semi-structured questionnaire

A pilot study with 10 Grade 10 Life sciences learners was conducted before collecting the data, and these learners did not partake in the study. The learners used to pilot the study were from different schools. It was done to ensure the quality of the results, as the pilot sample had no communication with the actual participants of the study. According to Tashakkori and Teddlie (2010), a pilot study is a research phase where a small amount of data is collected to test processes and identify potential difficulties before the actual study. Conducting a pilot study helped improve the readability of the test items, reduced ambiguity and improved the reliability of the tests. Two Life Sciences teachers were appointed as evaluation experts to evaluate the tests and the semi-structured questionnaires to ensure that the questions were straightforward.

The appointed teachers made relevant suggestions before the learners obtained the instruments. They checked if the questions posed in the tests aligned with the specified process skill they intended to test. One of the shortcomings highlighted in the tests was a lack of personal creativity in the instruments. The questions posed in the tests assessed the development of specific SPS.

The first and third questions were changed based on the participant's reactions to the test questions, and the researcher displayed images of the actual investigation. It entailed more personalised investigations where the researcher included images of an investigation carried out by the learners. It allowed the researcher to be hands-on and gave authenticity to the study. Further changes were made to the tests to include the SPS assessed by each question posed. Further refinements were made to the questionnaire after consultation with the supervisor to streamline the questions, and ultimately they addressed the third research question of the study.

All data were captured in a Microsoft Excel spreadsheet and stored in a google cloud for safety. It was crucial to store the results safely to protect the participants and maintain confidentiality, non-traceability, privacy and data control (Cohen et al., 2018).

4.7 Data Analysis Techniques

Quantitative and qualitative data were independently analysed. First, quantitative data were analysed to determine the significance of YouTube videos in developing SPS. The descriptive statistics (median, mean, mode, and standard deviation) were calculated using statistical software for the social sciences (SPSS). Determining descriptive statistics provided a broad and micro perspective of the data. Finally, a *t*-test was applied to the data. A *t*-test is a form of statistical test used to contrast the means of two groups, and a paired t-test is utilised when the two groups being compared are dependent on one another. A paired-sample *t*-test was

employed to determine whether or not a significant difference existed between the learner's performance before and after seeing the YouTube videos.

Thematic network and framework analysis were used to analyse the semi-structured questionnaire responses. A thematic network analysis takes a more exploratory perspective, thus allowing for data to be openly coded (Attride-Stirling, 2001).

Question 2(e) in Appendices F and G required visual representation as responses, and these were then analysed as visual data to measure the significance of YouTube videos in developing SPS. Cohen et al. (2018) posit that researchers can also draw on visual media to provide extended use of triangulation. The visual data provided an outstanding feature to the data, demonstrating the significance of the YouTube videos supporting the rest of the results.

The pre-test and post-test responses were qualitatively analysed through the lens of the theoretical framework adopted for this study. First, the responses were evaluated using the model adopted by Abrahams and Millar (2008) to measure the levels of effectiveness of the pre-test and post-test. The responses were further analysed through the scope of the supporting theories identified for the study, which were constructivism and active learning.

4.8 Ethical Considerations

Prior to providing data, Creswell and Creswell (2018) note that informed consent from study participants is required. Therefore, ethical approval was requested and granted by the school's committee on research ethics. Before data collection, permission from the principal of the school where the study was conducted and obtained informed consent from the participants was acquired. Since the learners were minors, parental approval was obtained (Connelly, 2014).

The learners were informed about the research and what was expected of them. It was made clear that they were not obligated to partake in the study, and should they wish to

withdraw at any point, and they were allowed to do so. The entire study was made voluntary for each learner.

The learners were assured that confidentiality and anonymity would apply. Therefore, only pseudonyms would be used in place of their names, if necessary. Learners were made aware that all the data collected would be safely stored for five years, thus following the University of KwaZulu Natal code of good research practice. Data were stored in an encrypted format and on devices with password protection. Learners were assured that all personally identifiable data would be disposed of with no traces linking to them once it was no longer needed for the study. Cohen et al. (2018) reiterate the vitality of the researcher to be beneficent and non-maleficent.

4.9 Delimitations

As with most studies, the current study design had limitations, one of which was the language barrier. The YouTube videos were made by educators whose accents were unfamiliar to the participants. Hence, they may have struggled to hear every word spoken. It might have impacted the learners' understanding of the experimental procedures and acquisition of the relevant SPS. The participants were encouraged to watch each video more than once to mitigate this challenge. Secondly, varying levels of internet access took much work. Some learners might have had more access to the internet than others, thus enabling them to watch YouTube videos more than others and giving them a more significant advantage in responding to the post-test items. To mitigate this challenge, the videos were shared via WhatsApp so that the learners only needed to download the videos once and then watch them at a convenient time, even after running out of data.

4.10 Summary

This study employed a pragmatic approach to elicit objective and subjective reality on the usefulness of YouTube videos in fostering SPS in 10th-grade Life Sciences learners. A sequential explanation mixed-methods design was utilised. Pre- and post-tests were used to collect quantitative data, while a semi-structured questionnaire was used to acquire qualitative information. Utilising qualitative insights to explain quantitative outcomes enabled integration. The results are provided in the following chapter.

Chapter 5

Findings and Discussion

5.1 Introduction

This chapter presents the findings through the instruments outlined in the previous chapter, namely, a pre-test (Appendix F) and post-test (Appendix G) and a semi-structured questionnaire (Appendix H). The tests were designed under the topic of osmosis, which is covered in the Grade 10 Life Sciences curriculum. Each test question was practical-based and sought to measure a specific process skill. SPSS was used to analyse the scores from both tests. The semi-structured questionnaire was designed to obtain the learners perceptions on using YouTube videos to develop SPS. A thematic analysis was used to formulate themes that emerged from the learners responses. In this chapter, the quantitative data-derived findings are given first. Then, the qualitative results are provided to explain the quantitative outcomes.

5.2 Quantitative Results

This study's primary research question was: Is there a statistically significant difference between the learner's performance before and after using YouTube videos for practical work in the 10th grade Life Sciences curriculum? A paired samples *t*-test for the null hypothesis was conducted using data from the pre-test and post-test to answer this question.

Null hypothesis

There is no statistically significant difference between learners' pre-test and post-test performance.

The mean score on the post-test was considerably higher than the mean score on the pre-test (Table 5.1). In addition, the post-test exhibited a lower standard deviation than the pre-

test. It shows that the scores were more dispersed on the pre-test than on the post-test. These figures indicate that the learners' performance on the post-test was superior to that on the pre-test.

Table 5.1

Descriptive Statistics for Pre-test and Post-test Scores

	Mean	**Median**	**N**	**Mode**	**Standard deviation**
Pre-test	8.7000	9.0000	100	9.00	4.43015
Post-test	15.1800	16.0000	100	18.00	4.40243

A paired-sample *t*-test was undertaken to evaluate whether there was a statistically significant difference between the learner performance before and after using the YouTube videos (see Table 5.2). There was a statistically significant difference in the performance of the learners after they viewed YouTube videos t (99) = -10.744, 95% confidence interval range from -7.68 to -5.28, p.05) (two-tailed). The average gain in test scores was 6.48 points. As seen in Table 5.2, the null hypothesis is therefore not supported.

Table 5.2

Results of Paired Samples t-test Analysis of Pre-test and Post-test

	Mean	**Standard Deviation**	**Std. Error Mean**	**95% Confidence Interval of the Difference**		***t***	***df***	**Sig.(2-tailed)**
				Lower	Upper			
Pre-test/ Post-test	-6.480	6.031	.5888	-7.677	-5.283	-10.744	99	.0001

Since the difference was statistically significant, the effect size was evaluated using Cohen's *d* to standardise the mean difference and establish the magnitude of the effect.

Equation 5.1

Cohen's d Calculation

$$Cohen's\ d = \frac{M_1 - M_2}{\sqrt{S^2_{pooled}}}$$

$$Cohen's\ d = \frac{15.18 - 8.70}{4.42}$$

$$Cohen's\ d = 1.46$$

The guidelines for interpreting this value are 0–0.20 = weak effect, 0.21–0.50 = modest effect, 0.51–1.00 = moderate effect, >1.00 = strong effect (Cohen et al., 2018). This result shows that YouTube videos strongly affected learning process skills.

Appendix E shows the results obtained from the tests and the difference between the test scores for each learner. One hundred learners wrote the pre-test and post-test. The pass percentages were calculated based on the subject pass mark requirement of 30% (Department of Basic Education, 2011). Sixty per cent (60%) of the learners passed the pre-test whilst 95% of the learners passed the post-test, thus registering a 35% increase. Eighty-five per cent (85%) of the learners improved their marks, 5% performed the same, and 10% achieved a lower mark.

Plots of the normal distribution of the pre-test and post-test scores show continuous probability distributions that are generally symmetrical on both sides of the mean. Sixty-eight per cent of the data falls within the first standard deviation from the mean. It indicates a 68% chance of selecting a random score between -1 and +1 standard deviations from the mean.

Figure 5.1

Distribution of Pre-test Scores

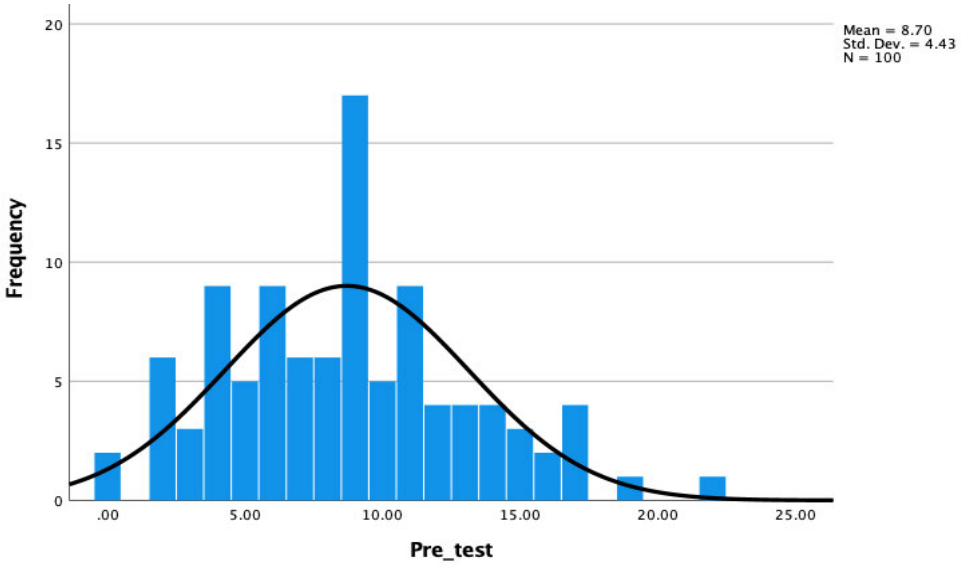
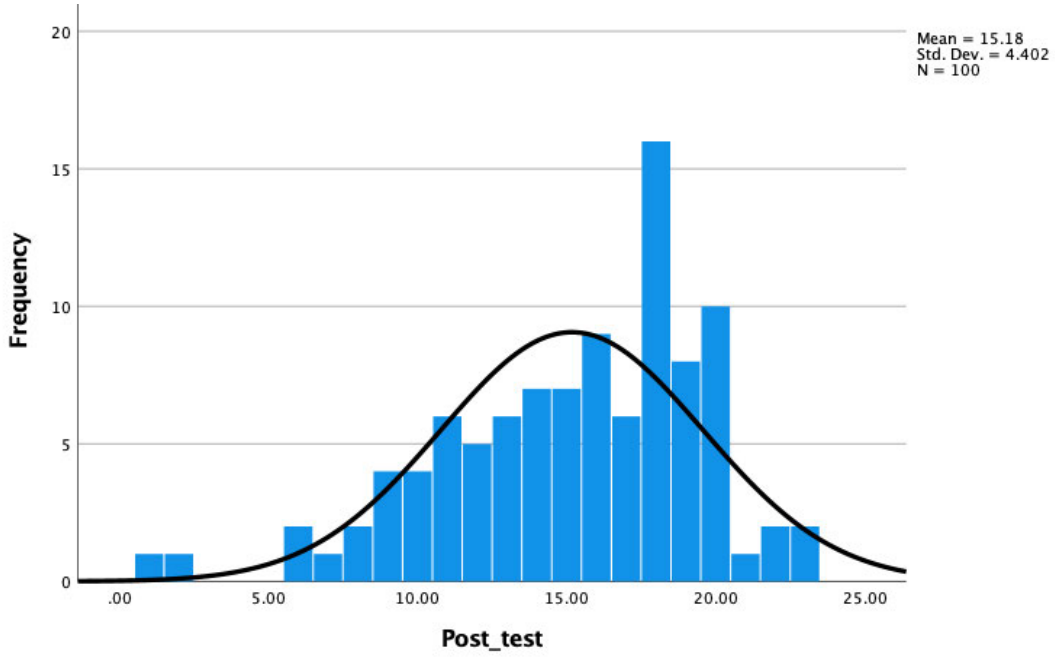


Figure 5.2

Distribution of Post-test Scores

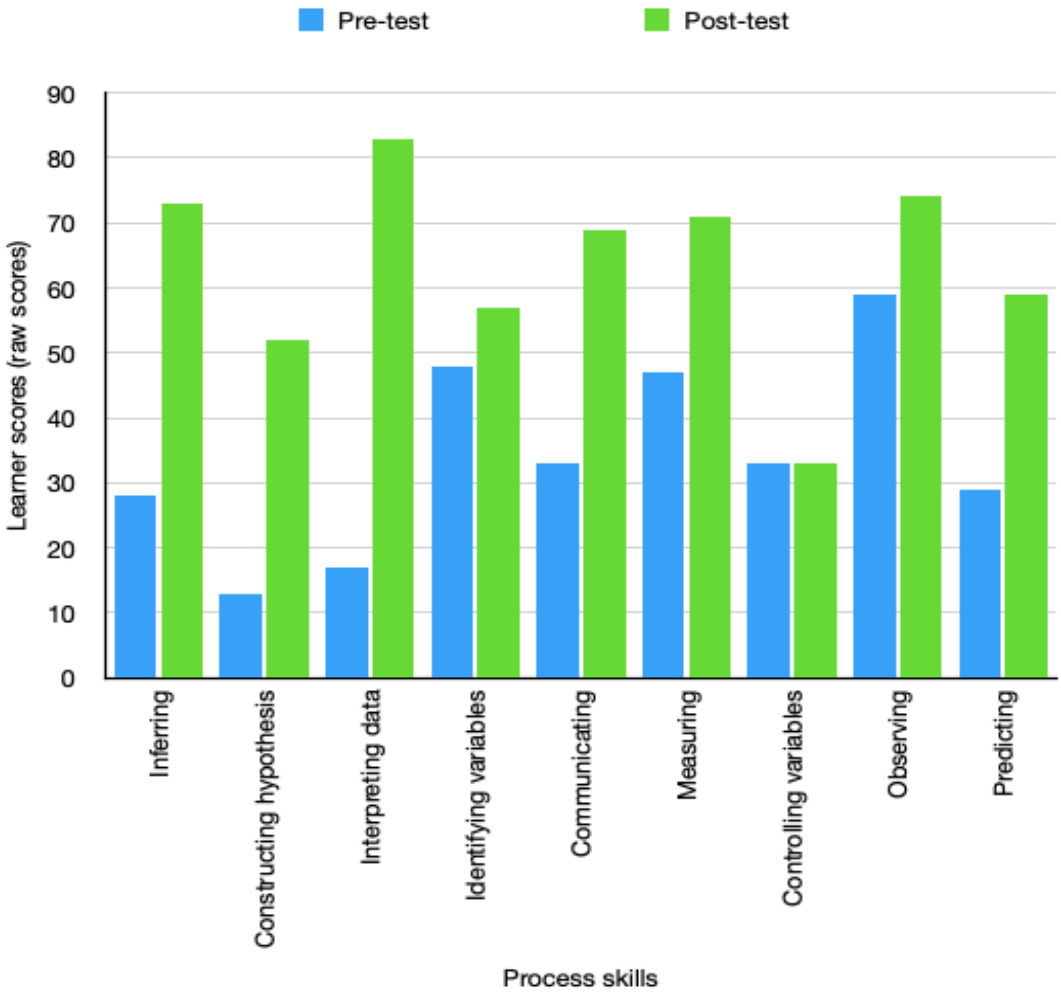


It was noted that the learner's pre-test performance was less than the post-test knowledge, which further supports that the YouTube videos significantly impacted the learner's acquisition of knowledge (Bardakcı, 2019). The average performance of the learners in each process skill was better in the post-test compared to the pre-test (Figure 5.3). It can be observed that some SPS were acquired better than others in the post-test, although they all demonstrated an increase. The data illustrates that the YouTube videos had a significant impact, particularly on skills such as inferring, interpreting data, constructing a hypothesis, communicating and predicting, as these had an average increase of 40,2%. Skills such as identifying variables, measuring and observing showed an average increase of 15%, below the 30% pass rate benchmark in Life Sciences (Department of Basic Education, 2011).

Inferring, interpreting data, and creating hypotheses showed the most significant improvement, with over 51% of learners correctly answering questions testing these SPS. These results contradict the notions of Ongowo and Indoshi (2013), who stated that learners demonstrate a greater comprehension of fundamental process skills than integrated process skills.

Figure 5.3

Average Scores for Each SPS in the Pre and Post-test



As shown in Table 5.3, the learners' performance in developing BSPS and ISPS showed that they developed the ISPS better than the BSPS. The BSPS had an average of 31%, whereas the ISPS had an average percentage of 44%. These results were unexpected since the BSPS should be easier to grasp and develop, while the ISPS are more complex, therefore, more challenging to develop. The implications of these results could indicate that learners had prior knowledge of responding to questions seeking to develop ISPS, possibly from the pre-test.

Table 5.3

Percentage Differences Between Learners' Performances in Post-test to develop BSPS and ISPS

	Basic Process Skills	%	Integrated Process Skills	%
1.	Observing	15	Constructing hypotheses	39
2.	Inferring	45	Interpreting data	67
3.	Measuring	24	Controlling variables	60
4.	Communicating	36	Identifying variables	11
5.	Predicting	30		
	Total	31	Total	44

5.3 Qualitative Results

The quantitative findings indicate a statistically significant difference between the pre- and post-test performance of the learners. This section will discuss the results obtained from the quantitative data utilising the semi-structured questionnaires' qualitative data.

The second and third research questions were: What are the Grade 10 Life Sciences learners' perceptions of using YouTube videos for practical work? How effective are YouTube videos in developing process skills in the Grade 10 Life Sciences curriculum?

Eight broad themes emerged from the data analysis:

1. YouTube videos were a convenient instruction mode, allowing multiple viewing as per need.
2. YouTube videos promote self-regulated learning.
3. YouTube videos offered a variety of examples from which the learners could process skills.
4. The length of the videos allowed for sustained engagement.

5. YouTube videos provide entertainment value.
6. YouTube videos provided a step-by-step demonstration.
7. YouTube videos provided a safe environment.
8. They impacted the development of SPS.

5.3.1 Convenient mode of instruction which allows multiple viewing as per need

The responses revealed that most learners watched the videos multiple times. Five learners watched the videos once, 66 watched the videos between two to five times, whilst the remaining 29 watched the videos 6 to 10 times. The 95 learners who viewed the videos more than once indicated they wanted to understand the topic of osmosis better. For example, L38 said, "*I watched the videos five times because I wanted to understand what was happening in the investigation, and I also wanted enlightenment on the videos*". Learners who watched the videos >4 times stated they wanted to understand the osmosis process fully. The learners who viewed the videos expressed that the ability to watch them multiple times gave them the opportunity to comprehend and assimilate the concept of osmosis.

The learners who watched the videos once indicated that they had trouble with internet connectivity, which manifested in their results. These learners had an average performance score of 8, which was poor compared to those who viewed the videos multiple times. The learners who viewed the videos more than twice performed better in the post-test, averaging 12 and 21. The exciting finding about this aspect of the results was that the learners who watched the videos ten times could have had a better average. These results could be due to learners watching the videos because of the intended learning outcomes. They may have been interested in the sound prospects of the videos but should have awarded more attention to the educational

aspect of the videos, hence the decrease in the average performance. Table 5.4 illustrates the number of times the learners viewed the videos and the post-test averages.

Table 5.4

Number of Times Learners Viewed YouTube Videos

Number of video views	**Number of learners**	**Average post-test performance out of 25**
1	5	8
2-3	57	12
4-5	15	14
6-7	6	14
8-10	3	21
>10	14	18

Ninety-eight (98) learners responded to the question on what they learnt from the YouTube videos. This question was posed to obtain the learners' understanding of the osmosis process. Those learners who watched the videos multiple times understood the process better. The multi-viewing of the videos had a direct impact on the understanding of the content.

A learner, L14, viewed the videos thrice and remarked on "*the process of osmosis and how to set up the experiment for it."* Another learner (L34) viewed the videos ten times and indicated *"osmosis is the movement of water from a region of high concentration to a region of low concentration through a semi-permeable membrane".*

Although 10% of the learners performed poorly in the post-test, they still learnt something from the YouTube videos. For example, L95, whose post-test score declined, said, "*When experimenting, the specimen in comparison has to be equal in size for accurate results*".

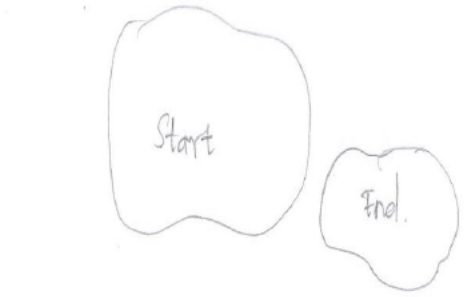
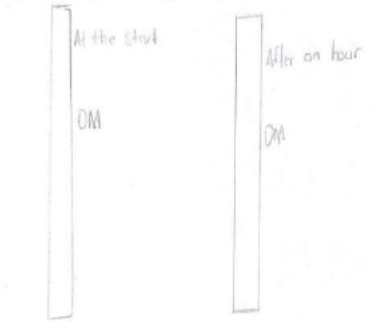
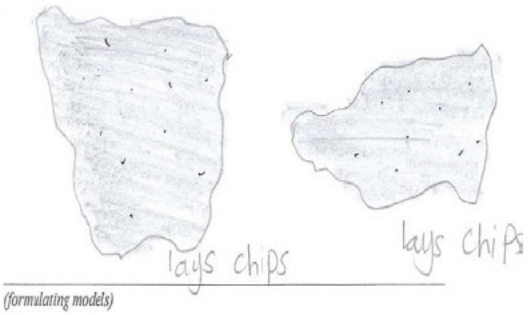
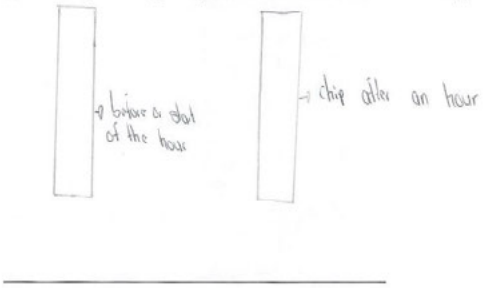
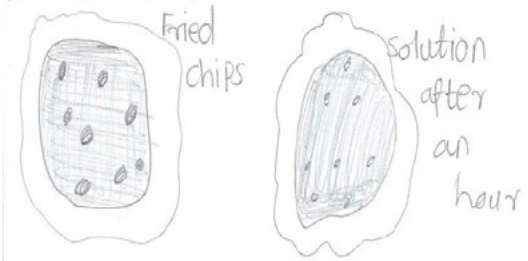
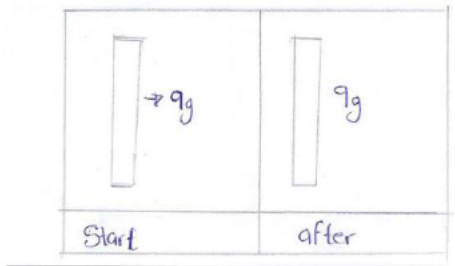
It demonstrates that although the learner could not interpret the questions, he/she could still demonstrate the process skills of observation and inferring.

Six (6) learners' responses to a question about formulating models were chosen (Table 5.5). These learners were selected based on their performances in the post-test: two performed poorly in the post-test (L9 and L95), two showed no improvement in the post-test (L6 and L47) and two performed exceptionally well in the post-test (L13 and L75). Due to insufficiency of comprehension of the idea of osmosis, the pre-test demonstrates that the learners needed a more excellent grasp of how to formulate models, as evidenced by their drawings. However, the post-test drawings demonstrate a higher level of understanding. The observed change in these visual illustrations could be attributed to the learners' understanding of the YouTube videos, and it may be that these learners benefitted from learning process skills on YouTube. The learners' drawings of the pre-test further demonstrate that all learners, regardless of their cognitive level, could not produce correct biological drawings, but the post-tests show that after watching the YouTube videos, they did better. It suggests that the YouTube videos were effective in helping learners develop the process skill of formulating models. The biological drawings must adhere to the following rules:

1. Drawings, label lines and underlining must be done using a pencil.
2. Labels and the title must be written in pen.
3. All labels must be printed horizontally to the right of the drawing.
4. Drawings must not be shaded/sketched.

Table 5.5

Learners' Pre-test and Post-test Drawings

Learner	Pre-test	Post-test
L9	(e) Draw a diagram showing the chip in 2M solution at the start and after an hour.(3)  *(formulating models)*	(e) Draw a diagram showing the chip in 0M solution at the start and after an hour. (3)  *(formulating models)*
L95	(e) Draw a diagram showing the chip in 2M solution at the start and after an hour.(3)  *(formulating models)*	(e) Draw a diagram showing the chip in 0M solution at the start and after an hour. (3)  *(formulating models)*
L6	(e) Draw a diagram showing the chip in 2M solution at the start and after an hour.(3)  *(formulating models)*	(e) Draw a diagram showing the chip in 0M solution at the start and after an hour. (3)  *(formulating models)*

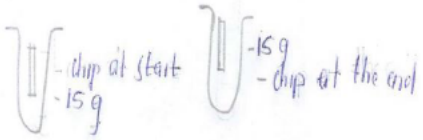
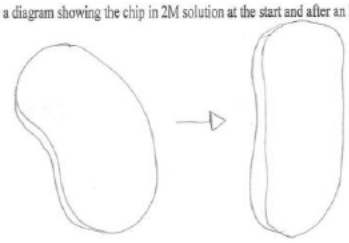
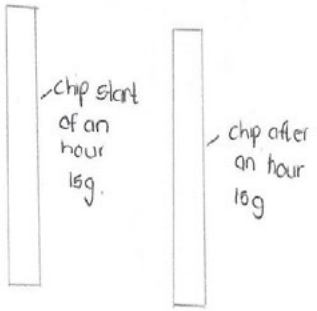
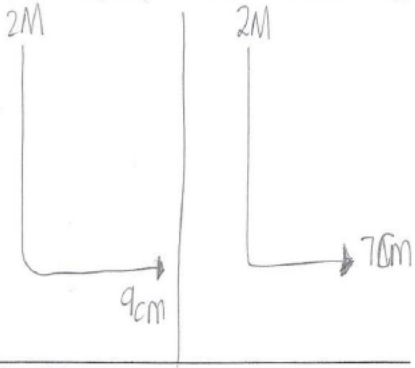
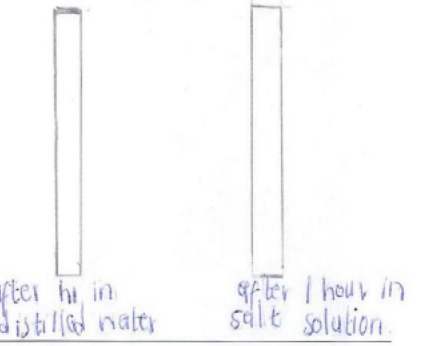
L47	(e) Draw a diagram showing the chip in 2M solution at the start and after an hour.(3)  *(formulating models)*	(e) Draw a diagram showing the chip in 0M solution at the start and after an hour. (3)  The mass of the chip at start is equivalent to the mass of the chip at end *(formulating models)*
L13	(e) Draw a diagram showing the chip in 2M solution at the start and after an hour.(3)  *(formulating models)* Start 9cm End 7cm	(e) Draw a diagram showing the chip in 0M solution at the start and after an hour. (3)  *(formulating models)*
L15	(e) Draw a diagram showing the chip in 2M solution at the start and after an hour.(3)  *(formulating models)*	(e) Draw a diagram showing the chip in 0M solution at the start and after an hour. (3)  *(formulating models)*

Table 5.5 illustrates the inferences derived from the pre-test and post-test drawings of the learners and Table 5.6 details whether or not they were able to develop the process skill of formulating models after seeing the YouTube videos.

Table 5.6

Learners' Ability to Formulate Models in the Pre-test and Post-test

Learner	**Pre-Test**	**Post-Test**
L9	The learner needed a better interpretation of the question and could not formulate the expected model.	The learner could interpret the question with an understanding showing there was a development of SPS.
L95	Learner demonstrates their interpretation of the term "chips" and shows no development of SPS.	The learner could apply knowledge of osmosis to formulate the correct model.
L47	Learner showed no development of SPS.	Learners demonstrated the development of SPS, as they were able to formulate the correct model.
L13	The learner's interpretation of the chip shows a lack of development of SPS; hence the correct model was formulated.	Learners showed the development of SPS as they formulated the correct model.
L15	The learner's interpretation of the question showed a lack of SPS development and therefore formulated the incorrect model.	Learners showed good development of the SPS as they applied the knowledge to formulate the correct model.

5.3.2 YouTube videos promote self-regulated learning

Learners disclosed that they were intrigued by the teaching approach, which incorporated YouTube videos into their learning process. It evoked eagerness to learn using YouTube videos independently. Learners further expressed that they were captivated by the effects of the videos, which kept them focused and keen to watch the videos with understanding. When learners were asked if they would like to watch more videos on practical work for Life Sciences, 82% of the learners agreed because they could obtain more understanding on their own before going to the classroom. Two of the learners stated:

L60: *because I uncover more information and gain more knowledge.*

L62: *because when I watch more videos when I go to class, I will know everything.*

The responses indicated that learners developed SPS from self-regulated learning. The learners could engage and discuss what they saw in the videos to construct knowledge. The results also show that the learners constructed their knowledge even outside the classroom setting when they repeatedly viewed the videos without the assistance of a teacher. This was evident in the post-test responses, as they were structured in the learners' words. This was a demonstration that YouTube videos promote self-regulated learning.

5.3.3 Variety of examples from which learners could develop process skills

The result alluded that the YouTube videos provided various examples when demonstrating the osmosis process. These examples included the use of household equipment that learners are familiar with, which may have resulted in the development of process skills. Most learners liked that the videos had examples to help them grasp the concept of osmosis and aided in the preparation for the post-test. L12 said, *"I liked the videos because they showed*

examples". The examples used in YouTube videos may have resulted in the learners developing SPS and their performance in the post-test improving.

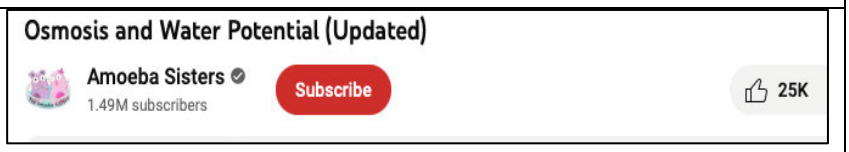
5.3.4 Length of videos allowed for sustained engagement

The results revealed that the length of the video had an impact on learner engagement. The learners were more engaged when the videos were shorter. It was an indication that learners enjoy the incorporation of YouTube videos to enhance their learning process. They were keener to watch shorter videos as opposed to longer videos. L91 stated, "*I liked the shorter videos; they were easy to follow and understand"*. The learner's concentration span plays a significant role in their learning, and these results show that it is a vital factor to consider when delivering content. How long a lesson takes impacts how much the learner grasps.

When the chosen videos were analysed according to the number of likes they had and their length, it was discovered that the videos' length did not impact the number of likes. What had an impact was the content features the videos possessed. The videos were eye-catching to the viewers and provided a fun yet the informative style of teaching that seemed to have the most likes regardless of the length. It is demonstrated in Table 5.7 that the longer videos, in this case, had the most likes, but the reason for this is still being determined. Perhaps learners found them more exciting, or they had been on the YouTube platform for longer and therefore had been viewed by a more significant number of people.

Table 5.7

Video Length vs Number of Likes

Video Length	Video Likes
20.16sec	
10.22sec	
9.49sec	
3.52sec	

5.3.5 YouTube videos provided entertainment value

The YouTube videos offered educational value, as learner performances increased with a mean score of 6,48. However, there were other contributing factors, such as the entertainment value. When learners were asked to state what they liked about the videos, some stated that they enjoyed the background music and the graphics they saw in the videos. For example, L86 reported, "*In fact, I have no dislike of the videos; they were quite enjoyable and nice to watch. I liked the quality of the videos".*

Ninety-five (95%) of the learners who watched the videos multiple times were not watching them for educational purposes but for entertainment. For example, L49 watched the video 10 times "*because they helped me to understand more about that particular subject, and I like the music and energy it gave me"*. The learners who watched the videos multiple times

significantly improved in the post-test (Table 5.4). The musical aspect of the videos kept them engaged and entertained and motivated them to learn more about osmosis.

5.3.6 YouTube videos provided a step-by-step demonstration

The YouTube videos provided the learner with educational value. The results indicated that the YouTube videos offered a detailed demonstration of how to conduct an osmosis experiment. These findings align with Wang, Ye and Ye (2021), which elucidate that YouTube videos provide a step-by-step learning channel. The video creators provide insight into how the process occurs using the potato, as they took measurements of the water throughout the experiment and showed the permeability of the potato membrane. Two learners reported: L61: *I learnt the osmosis method,* and L83 noted: *They helped me to be very observant and know the procedure"*. The observation skills were developed through watching the YouTube video. Learning science is often associated with hands-on and mind-on experimenting. However, the results demonstrate that some SPS can be developed from watching the video demonstration/improvisation.

5.3.7 YouTube videos provided a safe environment

The results revealed that YouTube videos are a safe environment to learn from concerning conducting hands-on experiments in the laboratory. The learners alluded that this experiment created a safe space for them, as they did not have to worry about taking precautionary measures as they would typically do in a laboratory setting. It was a simple way to experiment with third-party observation. When learners were asked what they learnt from the videos, L78 reported, *"because I can learn how to conduct experiments safely"*. The laboratory apparatus are often unfamiliar to learners, giving the impression that investigations

can only be carried out in a laboratory setting. The videos show experiments learners can do using resources available in their home contexts. Learners were asked to indicate what they liked and disliked about the selected YouTube videos. In response to the question, almost 60% said they liked the ease of accessibility to the videos, how informative the videos were and the thorough explanations of the concept of osmosis. L98 reported, "*I liked the YouTube videos because they are helpful and make you understand better, and you can see all the experiment with your own eyes".*

5.3.8 The choice of YouTube videos has an impact on developing SPS

The choice of videos was said to have an impact on the learners grasping the concept of osmosis. Some learners found specific videos to be more valuable as they were able to formulate a better understanding of osmosis. The learners commented immensely on the type of videos chosen and how they were presented to enhance their understanding and boost the learning process. L44 stated, "*The pictures and diagrams that were used to present the concept assisted in their understanding of the process of osmosis".*

L56 commented on the video creators "*They are very skilled, prepared, and organised".* The choice of videos plays a significant role in the learner's understanding, as they pay particular attention to what the creators do. It is therefore, crucial to ensure that the videos chosen are of good quality and deliver a great teaching experience for the learners to learn from.

It is worth noting that only some of the learners shared the same sentiments about the videos, as some learners had different experiences. When some learners were asked to state a reason for a dislike of YouTube videos, 40% indicated the following reasons: L13: "*because I prefer a live practical".* L40 reiterated: "*YouTube videos do not grant the opportunity for us to ask live questions and get live responses".*

These somewhat contradictory responses were due to the learner's reluctance to change and their preference for conventional methods of obtaining knowledge. A possible reason for these opposing views could be that learners may view YouTube as a playful, colourful and fun platform, not a platform to learn. It is critical to note that not all learners prefer technology. Some learners thrive in the traditional classroom environment and prefer routine over spontaneity.

When learners were asked if they would watch YouTube videos on practical work for Life Sciences, 84% of the learners said yes, they would. L10 reported, "*because these videos are interesting and easy to understand"*. The learners enjoyed the incorporation of YouTube videos in their lessons. Eighty-four per cent (84) of the learners' responses indicated they are fascinated by YouTube videos' educational capacity.

5.4 The effectiveness of YouTube videos in developing process skills

The tables below show how the effectiveness of YouTube videos on practical work was tested in the practical task, and a deduction was made from the learners' performances in the practical task (Abrahams & Reiss, 2012). To measure the effectiveness of the practical work, the teacher formulated a list of objectives to check whether the learners did/learnt what was expected of them.

The objectives of the pre-test and post-test are for learners to learn:

- the process of osmosis
- the interpretation of data presented in a table
- to formulate models based on data
- to apply knowledge to an unfamiliar context
- to measure the difference in data provided

- to communicate an understanding of the data presented

- to make predictions based on investigation

- to make observations

- to identify variables

Table 5.8 summarises the effectiveness level 1 of YouTube videos on the scores from the pre-test. Table 5.9 summarises effectiveness level 2 of the post-test scores after watching the YouTube videos.

Table 5.8

Analysis of Learners' Performances Based on Effectiveness Level 1

Process skill	**Pre-test Effectiveness Level 1**			**Post-test Effectiveness Level 1**		
	Test items	**Number of learners who did what was expected**	**Number of learners who did not do what was expected**	**Test items**	**Number of learners who did what was expected**	**Number of learners who did not do what was expected**
Observation	3a	59	41	3a	74	26
Inferring	1a	28	72	1a	73	27
	2a{ii)	35	65	2a{ii)	67	33
Measuring	2c	47	53	2c	71	29
Communicating	3b	33	67	3b	69	31
Constructing Hypothesis	1b	13	87	1b	52	48
	3c	29	61	3c	67	36
Interpreting data	2a(i)	17	83	2a(i)	83	17
Formulating Models	2e	24	76	2e	90	10
Identifying Variables	2b	48	52	2b	69	31
	2d	33	67	2d	38	62
Average		34%	66%		68%	32%

Table 5.8 shows that most learners still need to develop the expected SPS in the pre-test. The only process skill most learners showed competence in the pre-test was the *observation* skill, with a higher number of learners who did what was expected of them. It may have been due to the phrasing of the question being too easy to respond to. Therefore, many learners could meet the teacher's objective in this regard. The skill of *identifying variables* did not show an improvement during the post-test phase, as most learners needed to do what was expected of them. During the pre-test, when learners were asked to describe what they saw in the diagrams to check the observation skill development, L58 stated, "*I see that in the distilled chip and the chip stays the same, but in the salt solution, it denatures"*. When learners were asked what influence osmosis has on the water level in the potato to check the development of the *inferring* skill, L20 stated, "*It will loosen up and scatter; it gains moisture"*. It indicates that the learners could not make the intended observation or infer.

The post-test performance shows an improvement in scores, as most learners could do what was expected of them to develop process skills. The teacher's objectives for effectiveness level 1 were mostly met during the post-test. This improvement may have been due to the learners having watched the YouTube videos before writing the post-test. When learners were asked during the post-test to describe the water content in the potato strips to check the *observation* skill, L58 stated, "*In chip A, the water level is high, and in chip B, the water level has decreased, so it became small in size"*. When learners were asked what would happen to the water level in the bowl and the potato during the investigation due to osmosis to check the *inferring* skill, L20 reported, "*The distilled water will move through the potato to the salt solution with lower water content"*. It indicates that learners did do as per the learning objectives, which signals that there was a development of the SPS during the post-test.

Table 5.9

Analysis of Learners' Performances Based on Effectiveness Level 2

Process skill	**Pre-test Effectiveness Level 2**			**Post-test Effectiveness Level 2**		
	Test items	**Number of learners who learnt what was expected**	**Number of learners who did not learn what was expected**	**Test items**	**Number of learners who learnt what was expected**	**Number of learners who did not learn what was expected**
Observation	3a	59	41	3a	74	26
Inferring	1a	28	72	1a	73	27
	2a{ii)	35	65	2a(ii)	67	33
Measuring	2c	47	53	2c	71	29
Communicating	3b	33	67	2b	69	31
Constructing Hypothesis	1b	13	87	1b	52	48
	3c	29	71	3c	64	36
Interpreting data	2a(i)	35	65	2a(i)	83	17
Formulating Models	2e	24	76	2e	90	10
Identifying Variables	2b	48	52	2b	69	31
	2d	33	67	2d	38	62
Average		35%	65%		68%	32%

Data shown in Table 5.9 demonstrates that most learners needed to learn what was expected of them, which was to learn when they wrote the pre-test. The only process skill most learners improved during the pre-test was the *observation skill*, with a higher number of learners who developed the expected SPS. All the skills in the post-test showed that an average of 68% of the learners did develop the SPS they were expected to develop in the post-test.

5.5 Discussion of Findings

In the sections that came before, the findings were provided. In this section, the findings are summarised under three subheadings derived from the study's research questions: Is there a significant difference between the learner's performance before and after using YouTube videos on practical work in Grade 10 Life Sciences, Learner's perceptions of YouTube videos on practical work, and how effective YouTube videos were on developing SPS. The discussion is cognisant with the literature to accentuate the current study's findings. Succeeding this section is a further discussion of the findings concerning the theoretical frameworks that informed the current study, that is, the model for evaluating the effectiveness of YouTube videos, constructivism and active learning.

5.5.1 Significant difference between the learner's performance before and after using YouTube videos.

Before and after using the YouTube videos, there was a statistically significant difference in the student's performance. This finding resonates with that of Olasina (2017) that YouTube videos have a positive impact as a pedagogical tool. Although the literature needed sufficient evidence on whether YouTube videos are effective as a pedagogical tool in developing SPS, the current study verifies that they are effective but only for some SPS. The

undeveloped skills are identifying variables, measuring and observing. Abbas and Qassim (2020) concluded that YouTube videos supplement the learning process, which is supported by the current study's findings.

Various components may have contributed to the significant difference in the learners' performances: prior knowledge of the content and the question phrasing or pre-test questions may have resulted in some learners learning more about the content before writing the post-test.

In comparison to the pre-test, the average performance of the learners in each process skill improved on the post-test. It was discovered that YouTube videos significantly impacted the following SPS: inferring, interpreting data, constructing a hypothesis, communicating and predicting, with an average increase of 40%. This study's results do not explain why certain SPS is being developed more than others. Surprisingly, ISPS were found to have a higher performance rate as opposed to BSPS. The reason for this is still being determined, as literature asserts that BSPS are easier for learners to acquire (Siahaan et al., 2017). Some authors have speculated that YouTube videos enhance learning (Fleck et al., 2014; Ndihokubwayo et al., 2020).

Abrahams and Reiss (2012) assert that to evaluate the success of the practical work at both levels, the teacher must observe how learners answer the questions provided. The replies to the post-test indicate that the practical work on YouTube videos benefited the practical task's effectiveness. Learners were able to react to the provided questions. The post-test results demonstrate a substantial improvement over the pre-test. According to these scores, level 2 effectiveness in the post-test was 68%, indicating that most learners learned what the teacher expected them to learn.

This difference in test scores can be attributed to the effectiveness of the YouTube videos because the learners did not physically do practical work on osmosis in the laboratory. These results are consistent with those of Wang, Ye and Ye (2021), who found YouTube videos to be effective as an integral and supplementary part of the learning process. In his study, Koirala (2019) also found that YouTube videos effectively teach science to learners.

5.5.2 Learners' perceptions of YouTube videos on practical work.

The findings alluded to the affective value of You Tube videos. The implication of these findings may be that learners prefer the directness of the videos as opposed to lengthy laboratory experiments. They could pause the video, replay and read the subtitles for clarity. Themes have been used to unpack the findings concerning the literature.

Convenient mode of instruction which allows multiple viewing as per need.

The findings demonstrated that most learners viewed the videos multiple times. The findings further exposed that the more videos the learners watched, the better they performed in the post-test. There was a correlation between the learner's performance and the number of video viewings. Most of the multiple viewings were for a better understanding of osmosis. It reverberates with a study by Riley (2017), which states that YouTube videos positively impact understanding due to their multiple viewing capabilities.

This study found that learners viewed videos multiple times outside of the classroom to improve understanding and construct knowledge, and a similar finding was discovered by Gustafsson (2013) and Almurashi (2016) in each of their studies. In addition, in their study, Eick and King (2012) found that visuals improved the learners' understanding. However, the findings also elucidated that only some of the learners' performances were improved. This

finding aligns with the current study's findings, as it was found that although there were multiple views, it was only some of the multiple viewers whose marks improved. The implication of this finding may be that the learners were repeatedly viewing the videos not for educational purposes but for other reasons, such as entertainment.

YouTube videos promote self-regulated learning.

It appeared in the findings that the videos promoted self-regulated learning. It is about the learner's ability to engage with the videos solitarily to construct knowledge without dependence on the teacher's presence. This finding aligns with Harahab et al.'s (2020) study, which found that YouTube provided various learning materials and the flexibility of time and place, which enabled learners to regulate their learning. In the 21st century, one of the essential skills is to be a critical thinker. It is well achieved when the learner can construct knowledge independently without being constantly told what to do. Unlike Urmilah et al. (2021), this study did not explore the promotion of the metacognitive and social aspects of self-regulated learning.

Variety of examples from which learners could learn process skills.

The videos provided various examples that enabled the learners to learn process skills. These findings resonate with those of Koto (2020), who revealed that YouTube videos aided in the acquisition of practical, theoretical and practical knowledge through their ability to visually present concepts.

The variety of examples in the videos could create an in-depth understanding of the concepts that stretch far beyond the laboratory setting.

The length of videos allows for sustained engagement.

The findings also gave prominence to the significance of the length of the video to enable prolonged engagement. It resonates with Abbas and Qassim (2020), who established that the teacher must have the length of the YouTube videos in mind when planning to ensure that learners stay captivated. The learners should be kept intrigued to safeguard optimum assimilation and comprehension of knowledge. These findings are further echoed by Rosenthal (2018) that the videos chosen should constantly be visually stimulating.

YouTube videos provide entertainment value.

The videos cultivated an immense development of SPS through visuals. These findings validate the ideas of Edache-Abah, Odachi, Dike and John (2019) that incorporating YouTube videos enhances learners' interest in Biology. A positive effect could be that the learners autonomously utilise the YouTube platform for educational purposes and to reinforce their understanding of practical work whilst enjoying the visual representation of the content. A study by Gustafsson (2013) predicates that YouTube videos are an arena that can be reclaimed by teachers to utilise when teaching science due to their educational and fun capabilities. It can be deduced from this finding that YouTube videos provide entertainment whilst being educational, which is commonly lacking in the traditional science classroom. The incorporation of the videos promotes visual and auditory learning channels whilst conveying educational content through real-life situations (Brame, 2016; Fleck et al., 2014).

It should also be noted that some learners did not benefit from the entertainment value that the videos provided, as their performance did not improve. In addition, the learners were distracted by the background music, which resulted in them focusing more on the entertainment aspect rather than the educational aspects of the videos.

YouTube videos provide a step-by-step demonstration.

It emerged from the findings that the videos provide a step-by-step demonstration. These findings align with those of Gedera and Zalipour (2018), who found that YouTube videos are used to demonstrate procedures in the medical field. For videos to demonstrate such critical processes, the demonstration must follow a set method for viewers to understand and assimilate thoroughly.

YouTube videos provide a safe environment to learn.

The present study found that the videos provide safety, and as the specimen usage is minimised, only the creator uses the specimen, and the viewers passively learn from the viewers' demonstrations and improvisations. It tallies with Lunetta et al. (2007), who define practical work as a process whereby learners network with equipment or other data sources to learn. It is also crucial to note that learning is a dynamic process providing room for diverse teaching strategies (Gengle et al., 2017).

Practical work conducted in the laboratory can expose the learners to dangerous equipment, which can be fatal if the safety precautions are not adhered to. In addition, rare specimens can be damaged due to overuse when hands-on practical work is conducted, and these can be preserved and used only to develop the SPS that YouTube videos cannot develop.

The choice of YouTube videos has an impact on the development of SPS.

The choice of videos influenced the development of SPS. The improved performance in the post-test could have been due to the excellent selection of videos, as they might have provided visual representation that appealed to the learners, making the experience memorable and effective (Chooprayoon & Sa-Ngiamwibool, 2020).

One of the notable findings to appear from this study is that the video audio had an impact on the audibility of the videos. Everhart (2009) emphasises the importance of audio standards and the implications of inaudible videos on the overall learning experience. It is, therefore, imperative that the videos selected are audible so that the learners can hear unobstructed what is being taught. In addition to the video choice factor, Brame (2016) stressed the importance of ensuring that the chosen video manages the cognitive load, promotes student engagement and endorses active learning.

5.6 Reference to the Theoretical Framework

In the previous section, the literature was used to discuss the findings about the significance of using YouTube videos to develop practical work, the learners' perceptions of YouTube videos and how effective YouTube videos are in learning SPS. In the current section, the model for evaluating the level of effectiveness by Abrahams and Reiss (2012) and the constructivism and active learning theories are used to comprehend the findings that emerged in the current study sensibly.

5.6.1 Significance of the YouTube videos on practical work.

As previously mentioned, there was a significant difference in the learner's performance on the practical tasks. The scores showed a vast improvement in the tests conducted. Therefore, learners could respond to the post-test using the knowledge they constructed. It is exhibited through the model by Abrahams and Reiss (2012) for evaluating effectiveness levels 1 and 2, for as the performances demonstrated an improvement, more learners were able to do and learn what was expected of them by the teacher in the post-test.

Constructive learning probably took effect, as learners could construct knowledge independently beyond the classroom setting and sift information they deemed relevant from the YouTube videos.

Active learning occurred in learners, as they could think of what they learnt about osmosis, and this was helpful in them being able to construct and apply the knowledge to the practical task they were given. In addition, learners tried to remember what was discussed in the classroom and what they observed on YouTube videos. Hence, there was a statistical significance in the learners' performances.

5.6.2 Learner's perceptions of YouTube videos on practical work.

As mentioned, the learners' perceptions revealed that YouTube videos are viable and can be used to develop SPS. Therefore, the learners are to incorporate videos into their learning of practical work. Lee and Sulaiman (2018) echoed that the effectiveness of practical work is vested in its ability to evoke motivation and understanding. The learners' perceptions were apparent that the videos possessed this ability. Riley (2017) reiterated that videos allow the teacher to unpack knowledge. Higgins and Moeed (2017) advocated the importance of active learning in their study, and the perceptions depicted in the current study reverberate that videos promote active learning. As a result, learners can independently construct knowledge.

Although the videos were compelling in terms of the evaluation model of effectiveness by Abrahams and Reiss (2017), it is imperative to note that the learners' perceptions voiced that there were contributing factors. Firstly, the multiple viewing of the videos, as Riley (2017) discovered, had an optimistic impact on the development of SPS. Secondly, the various examples of the videos provide prominence to conceptual knowledge, which aligns with the findings by Koto (2020). Thirdly, the length of the videos was another contributing factor to

their effectiveness, as shorter videos served a better purpose due to their visually stimulating capacity compared to long videos (Rosenthal, 2018). Fourthly, the entertainment ability had both a positive and negative influence. The positive being that some learners focused better on the video playback, whilst others were distracted as they watched for non-educational benefits. Fifthly, the choice of videos played a crucial role in ensuring that the learners learnt what they were supposed to learn according to the learning objectives the teacher had set.

Khamo and Johnson (2019) argue about the importance of multiple representation modes when constructing knowledge. As mentioned earlier, the findings show that learners prefer incorporating videos into their learning process, as it improves their understanding of the concept of osmosis. It also improves their grasping of the SPS.

Bada and Olusegun (2015) define the constructivism theory as a method of teaching and learning based on the principle that cognition is the consequence of intellectual construction and personal experiences. The learners' perceptions were evident in the current study, as they could construct knowledge outside of the classroom on their own.

The findings from this study were similar to those by Fleck, Beckman, Sternsa and Hussey (2014), that active learning is promoted by discussion among learners and encourages learner engagement and critical thinking. Learners hosted discussions in groups about what they observed in the videos. They were then able to formulate their understanding of the concept of osmosis, which probably assisted them in tackling the practical task, leading to better performance in the post-test.

5.6.3 The effectiveness of YouTube videos in developing process skills.

As mentioned earlier, effectiveness levels 1 and 2 were found to have improved, thus an indication that the teachers' objectives were met. These findings suggest that YouTube

videos are indeed effective in developing specific SPS. It follows the conclusion of a study by Yuniarti et al. (2018) that the improvement of SPS is due to implementation of a proper learning strategy. Therefore, this study's' objective was to establish the effectiveness of YouTube videos in developing process skills in the Grade 10 Life Sciences curriculum.

Abrahams and Reiss (2012) posit that the teacher must observe how the learners respond to questions posed to assess the effectiveness of the practical work from both levels. The findings demonstrate that the practical work on YouTube videos positively impacted the practical task's effectiveness. Although the effectiveness level averages were not grand, it must be noted that different learners have different learning abilities, which may have influenced their performances.

The implications of these findings may be that some learners are not visual. Therefore, YouTube videos did not affect their understanding of osmosis. The presence of stimuli does not propel such learners to evoke an interest in learning (Higgins & Moeed, 2017). Other learners may have personality disorder challenges, which may have been triggered by the video's background music, resulting in them being distracted. Some learners stated that they had internet connection challenges, which hindered them from viewing the videos multiple times, thus putting them at a disadvantage.

5.7 Conclusion

In this chapter, a discussion of the findings was presented. The generation of data was done through the use of pre-test, post-test and semi-structured questionnaires. The *t*-tests produced a statistically significant difference in the pre-test and post-test mean scores. The YouTube videos made an educational difference in the learners' performance. The findings from questionnaires revealed that what caused the differences in performance was the excellent

selection of videos that evoked an interest. The learners viewed the videos multiple times, and the subtitles assisted learners in following and understanding the narrations.

The YouTube videos enhanced active learning to occur and developed some SPS. In addition, the learners preferred incorporating technology and were convinced that technology brought that practice into the classrooms.

The following chapter provides a summary of the findings from the study, conclusion drawn from the findings and recommendations for future studies.

Chapter 6

Summary, Conclusion, and Recommendations

6.1 Introduction

This chapter reviews the results, conclusions, and recommendations of this mixed method study. The purpose of this study was to investigate the effectiveness of YouTube videos in developing SPS in the 10th-grade Life Sciences curriculum. Three research questions governed the study. The first question was: Is there a significant difference between the learner's performance before and after using YouTube videos in practical work in Grade 10 Life Sciences? The second one was: What are the Grade 10 Life sciences learners' perceptions of using YouTube videos in practical work? The third one was: How effective are YouTube videos in developing process skills in Grade 10 Life Sciences learners? This study used quantitative and qualitative data analysis to generate responses and answer research questions.

6.2 Summary of Findings

Responses from a pre-test (Appendix F), a post-test (Appendix G), and a semi-structured questionnaire (Appendix H) were used to generate data for the research questions. The findings are provided after the three research questions that came from the investigation. This section summarises the results of the literature review, the theoretical frameworks, and the data collection.

Research Question One: Is there a significant difference between the learner's performance before and after using YouTube videos on practical work in Grade 10 Life Sciences?

The findings from this study revealed that there was a statistically significant difference in the learner's performance. The learners performed better in the post-test after using science YouTube videos selected by the teacher. There was an increase in the percentage of learners who passed the post-test compared to those who passed the pre-test. Although the performance improved, five per cent (5%) of the learners did not show any improvement, and 10% showed a decline in their post-test performance.

Research Question Two: What are the Grade 10 Life sciences learners' perceptions of using YouTube videos on practical work?

The second research question focused on why there was a difference in the learners' performances after the science YouTube videos' intervention. From the learners' responses to the questionnaires, it was established that there were several reasons justifying the improvement in the learners' performances. One of them could be that multiple viewing of the YouTube videos gave learners a better understanding of the concept of osmosis. The videos evoked an interest due to their visual and audio effects, which kept the learners engrossed, and the option of subtitles assisted learners in following and comprehending the narration. YouTube videos enhance active learning. It also emerged that YouTube videos are an excellent supporting resource for teaching and learning Life Sciences.

The learners could view the videos multiple times due to their stunning effects. The lengths of the videos may have been extended and resulted in the learners' boredom. However,

the length of the videos did not affect the multiple viewing of the videos. Learners oversaw constructing their knowledge, as they had the autonomy to view the videos independently. They could control the learning process from the videos, as they could pause, rewind, replay and restart when it suited them. However, the findings of this study established that internet connectivity hindered some learners, as they could not have the privileges of multiple viewing but benefitted from the classroom viewings.

The learners could link the visuals to the words and follow the 'unclarity' of the narration of some videos—the ability for the videos to expose the learners to visuals catered for auditory and visual learners. Even though most of the learners could have benefitted from the narrations, some learners found difficulties understanding the accent in videos. Some videos demonstrated apparatus found in households that learners were familiar with, which made the videos relatable and fascinating. The step-by-step demonstrations kept learners captivated and intrigued as well.

YouTube videos enabled active learning in the classroom, as they created a channel for discussion amongst the learners based on what they viewed from the videos. Learners could reflect and construct knowledge based on the visuals and video narrations. It led to an in-depth understanding of osmosis, which led to SPS's development. Learners alluded that they liked the videos and would prefer if the Life sciences practical work videos were incorporated by the teacher into the Life Sciences subject. It would optimise the learners' understanding of the concepts.

Research Question Three: How effective are YouTube videos in developing process skills in Grade 10 Life Sciences learners?

The third research question addressed how effective YouTube videos were in developing SPS. The YouTube videos contributed to the development of SPS. The research

findings indicate that learners could cognitively respond to the questions by efficiently addressing specific process skills. They were able to show an understanding of the questions through their responses. It was also echoed in the learners' performances after watching YouTube videos. Although the learners indicated that the YouTube videos helped them prepare for the post-test, not all of the learners showed an improvement. The SPS that showed a significant improvement was inferring, interpreting data, constructing a hypothesis, communicating and predicting. It indicated that YouTube videos only developed some of the tested SPS. There were factors which were found to have affected the levels of effectiveness that YouTube videos had in developing SPS, these are outlined in Table 6.1 below.

Table 6.1

Factors Affecting the Effectiveness of YouTube Videos in Developing SPS

Level of effectiveness	**Factors affecting effectiveness**
Level 1: What the learners were expected to do versus what they did.	Quality sound/audio of the YouTube Videos Internet connectivity
Level 2: What the learners were expected to learn versus what they learned.	Length of the YouTube videos Ability to interpret accent

6.3 Significance of the Study

This study benefits curriculum designers, subject advisers, teachers, and learners who need help to develop and internalise science process abilities. The DoE's curriculum developers may find this study essential and reconsider the resources stated in curriculum documents by

including YouTube videos as viable tools. This study also highlights the importance of teaching SPS in schools since they contribute to the cognitive development of every student.

6.4 Recommendations

This section presents recommendations to the various stakeholders to enhance the curriculum documents by expanding the educational tools to aid in the development of SPS.

6.4.1 Recommendations for the curricula developers

Following the current study's findings, it is recommended that curricula developers revise the existing curriculum document for Life Sciences. It would be beneficial to the learners to include YouTube videos as a suggested resource for the practical investigation of osmosis for developing SPS. The only listed resources are beakers, salt and potatoes or eggs. The literature has raised that teachers have numerous challenges conducting experiments, and learners are deprived of SPS. This study has discovered that YouTube videos can develop some of the SPS (inferring, interpreting data, constructing a hypothesis, communicating and predicting).

6.4.2 Recommendations for the subject advisors

After the findings of this study, it is recommended that Life Sciences subject advisors ensure the availability of data projectors or smartboards, uncapped internet access and computers to allow teachers to access YouTube videos that can be used during Life Sciences lessons. Life Sciences teachers can integrate suitable YouTube videos into their classes when there is limited time for curriculum coverage. The selected YouTube videos should be short yet effective in delivering the content to avoid monotony. Teachers can pose questions relevant to

the topic to evoke discussions and create a platform for learners to reflect, thus encouraging constructivism and active learning.

It is also recommended that more Life sciences workshops are held for teachers. These workshops would address the issue of teachers lacking competency in practical work and teachers who find the teaching of SPS insignificant (Gultepe, 2016; Artayasa et al., 2017). Subject advisors can also intervene in schools to check if Life Sciences teachers taught SPS, as outlined in the curriculum document for Life Sciences. This intervention would help mitigate the issue of learners being deprived of SPS in schools.

6.4.3 Recommendations for the Life Sciences teachers

It is recommended that Life Sciences teachers incorporate relevant YouTube videos and design effective practical tasks to enhance and elevate learners' development of SPS. Teachers can also take the initiative to further their knowledge of SPS and explore ways to teach practical work to ensure that learners are not deprived due to their incompetency (Gultepe, 2016).

When teachers use videos, they can ensure that all learners have access to multiple viewings of the videos to benefit from them and eliminate internet connectivity issues. It is also recommended that teachers consider the following factors when using YouTube videos in their Life Sciences lessons: choose short and direct videos, videos with good audio quality and videos that are in line with the curriculum and are visually stimulating. The accent must also be clear for learners to ensure optimum understanding of the concept. Furthermore, when teachers use videos they must activate the subtitles as they were found to assist with narration.

6.4.4 Recommendations for other studies

Other studies can be conducted using a larger sample size from different schools in varying quintiles to obtain an in-depth view of the phenomenon. Besides, the following can be undertaken:

- Do a longitudinal study across many grades
- Conduct a study focusing on different topics

6.5 Conclusion

This study's primary purpose was to investigate the effectiveness of YouTube videos in developing process skills. The researcher's concern was the lack of practical work being conducted in schools, thus depriving learners of obtaining the process skills that are fundamental tools in science. The researcher was looking for a viable alternative to ensure that the learners develop the necessary process skills in the absence of laboratory resources, large classes, teachers lacking skills and the exacerbation of these problems by the Covid-19 pandemic. It is the teacher's role to determine suitable strategies to deliver content in the classroom. It is in the teacher's interest to ensure that the learners benefit from the pedagogical tool the teacher utilises. The researcher's interest was to discover if there was a statistically significant difference in the learners' performances after using YouTube videos. It was executed by determining and comparing the mean scores from the pre-test before using YouTube videos and mean scores from post-tests after using YouTube videos. There was a statistically significant difference between the pre-test and post-test performance of the learners. The concept of osmosis was comprehended well after seeing videos on YouTube.

Good performance means a learner understands the content under study, while poor performance indicates knowledge gaps. The excellent performance was because YouTube

videos were visually enhanced, which encouraged the learners to view them multiple times. Subtitles assisted the learners in following the narrations, and YouTube videos were relatable, as they demonstrated familiar apparatus. The learners perceptions pointed out that there was an immense interest in the incorporation of YouTube videos to the teaching and learning of Life Sciences in Grade 10.

Classroom discussions emerged, which enabled active learning to occur, and these perpetuated an in-depth understanding of the concept. Learners could construct their knowledge outside of the classroom setting as they continued to view the videos from home. It resulted in learners preferring YouTube videos incorporated into the Life Sciences subject to understand the concepts better.

In this study, some learners could have performed better, which may have been due to their inability to view the videos multiple times because of unstable internet connectivity. Others needed help with understanding the narration due to accent differences. Nevertheless, YouTube videos were influential in developing SPS on osmosis. From the findings, YouTube videos can be used as a viable tool to teach practical work, but the teacher must ensure that they select brief videos to increase learner engagement.

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Appendices

Appendix A

Ethical Clearance, University of KwaZulu-Natal

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

18 June 2021

Miss Nobuhle Priscilla Mbanjwa (207512723)
School Of Education
Edgewood Campus

Dear Miss Mbanjwa,

Protocol reference number: HSSREC/00002810/2021
Project title: Exploring the Effectiveness of YouTube Videos in Learning Process Skills in the Grade 10 Life Sciences Curriculum.
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 12 May 2021 in connection with the above, was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC) and the protocol has been granted **FULL APPROVAL**.

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 18 June 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report to be submitted when study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

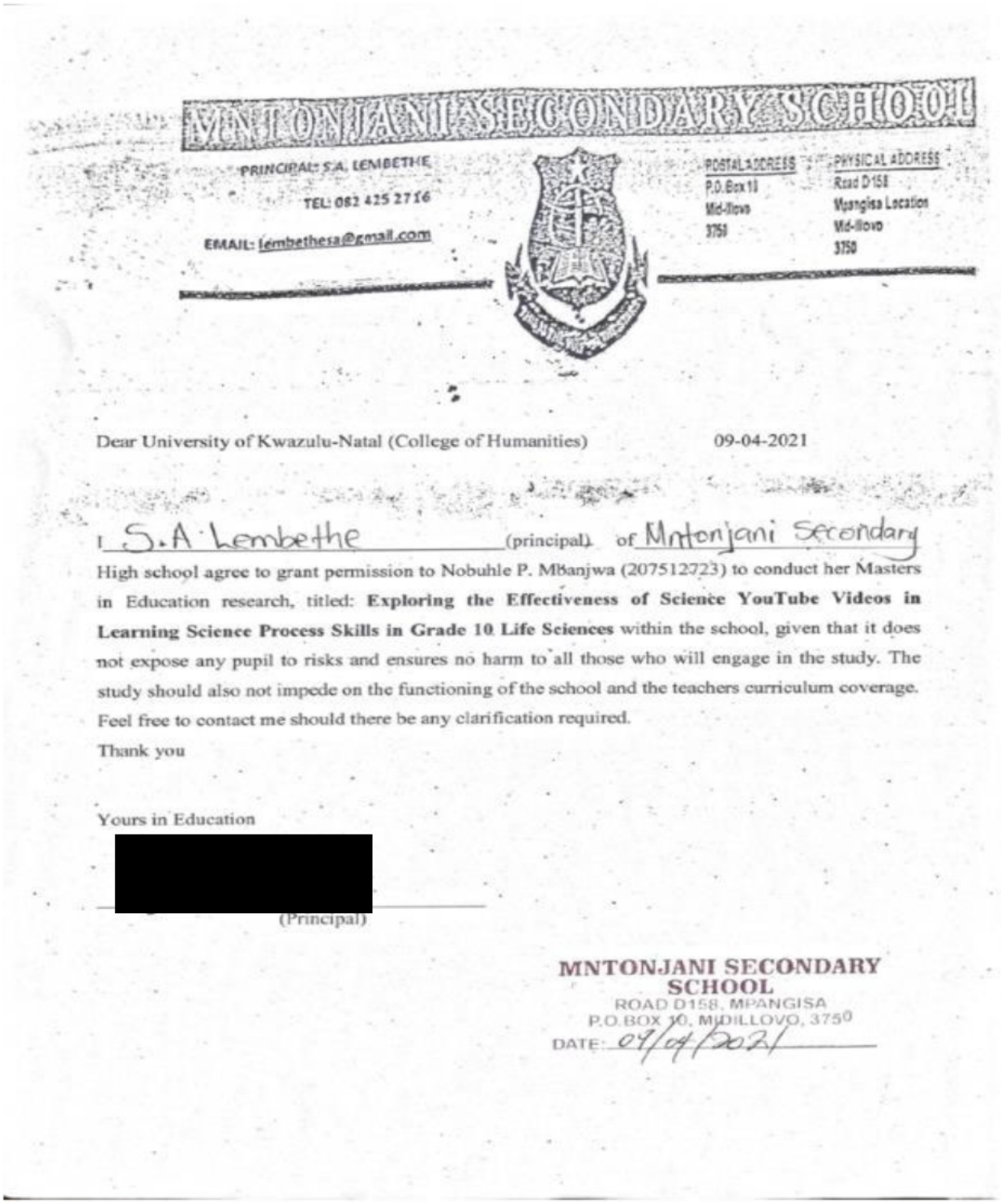
[redacted]

Professor Dipane Hlalele (Chair)

/dd

Appendix B

Letter of Permission from the School



MNTONJANI SECONDARY SCHOOL

PRINCIPAL: S.A. LEMBETHE
TEL: 082 425 2716
EMAIL: lembethesa@gmail.com

POSTAL ADDRESS
P.O.Box 10
Mid-Illovo
3750

PHYSICAL ADDRESS
Road D158
Mpangisa Location
Mid-Illovo
3750

Dear University of Kwazulu-Natal (College of Humanities) 09-04-2021

I S.A Lembethe (principal) of Mntonjani Secondary High school agree to grant permission to Nobuhle P. Mbanjwa (207512723) to conduct her Masters in Education research, titled: **Exploring the Effectiveness of Science YouTube Videos in Learning Science Process Skills in Grade 10 Life Sciences** within the school, given that it does not expose any pupil to risks and ensures no harm to all those who will engage in the study. The study should also not impede on the functioning of the school and the teachers curriculum coverage. Feel free to contact me should there be any clarification required.

Thank you

Yours in Education

[redacted]

(Principal)

MNTONJANI SECONDARY SCHOOL
ROAD D158, MPANGISA
P.O.BOX 10, MIDILLOVO, 3750
DATE: 09/04/2021

Appendix C

Consent Letter for Parents/Guardians

Road D158 Mpangisa
PO Box 10
Mid Illovo
3750
Date:____/ ____ /2021

Dear Parent

My name is Nobuhle P. Mbanjwa and I am a student at the University of KwaZulu Natal college of Humanities, and I am conducting a study exploring the effectiveness of Science YouTube videos in learning process skills in grade 10 Life Sciences curriculum. YouTube videos are commonly used as innovative methods to obtain information, and there is little research that has been obtained regarding their effectiveness in learning process skills. The results of this study will hopefully improve the available modes of acquiring process skills.

I would like your child _____ in grade 10____ to participate in the study. They will be required to complete a pre and post-test, as well as a questionnaire. The items in the questionnaire focus on his/her experience of the tests and the YouTube videos they will watch. Finally, the questionnaire includes questions evaluating how he/she experienced the YouTube videos.

I want to stress that your child's participation in this study is voluntary and all efforts to protect his/her identity and keep the information confidential will be taken.

Please read the form and feel free to contact me if you have any questions about the study. Thank you for taking your time to read this letter.

Sincerely,

_____

Nobuhle Priscilla Mbanjwa (207512723)
Contact: 0793927725

✂----------

PARENT/GUARDIAN CONSENT INDEMNITY FORM

I_____ parent/guardian of _____ have read the above explanation of the research study entitled Exploring the Effectiveness of YouTube Videos in Learning Process Skills in the Grade 10 Life Sciences Curriculum. Everything about the research has been clearly explained and I understand all the details of this research. I understand that my child may withdraw without prejudice at any time and that his/her identification will remain anonymous throughout the study.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at (provide details).

If I have any questions or concerns about my child's rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

SCHOOL OF EDUCATION
College Of Humanities
Edgewood Campus
121 Marianhill Rd, Pinetown,
Durban
3605

Dr Tamirirofa Chirikure
Tel: 0312603470
Email: chirikure@ukzn.ac.za

OR

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION
Research Office, Edgewood Campus
121 Marianhill Rd, Pinetown,
Durban
3605

KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2603895 - Fax: 27 31 2603895
Email: HssrecHumanities@ukzn.ac.za

_____ _____

Parent/Guardian of participants' Signature Date

✂----------

Appendix D

Assent Letter for the Participant

Road D158 Mpangisa

PO Box 10

Mid Illovo

3750

Date:____/ ____ /2021

Greetings

I am inviting you to participate in my research study titled: **Exploring the Effectiveness of YouTube Videos in Learning Process Skills in the Grade 10 Life Sciences Curriculum.**

My name is Nobuhle P. Mbanjwa and I am a student at the University of KwaZulu Natal college of Humanities, and I am conducting a study exploring the effectiveness of Science YouTube videos in the learning of science process skills in grade 10 Life Sciences. YouTube videos are commonly used as innovative methods to obtain information, and there is little research that has been obtained regarding their effectiveness in learning science process skills. The results of this study will hopefully improve the available modes of acquiring science process skills.

I am interested in your responses to the pre and post-test as well as the semi-structured questionnaire which asks you to respond to a series of questions. The items in the questionnaire focus on your experience of the tests and the YouTube videos you will watch. Finally, the questionnaire includes questions evaluating how you experienced the YouTube videos.

I want to stress that your participation in this study is voluntary and all efforts to protect your identity and keep the information confidential will be taken.

Please read the form and feel free to contact me if you have any questions about the study. If you choose to participate, please sign, initial and date the consent information form and return it. I look forward to working with you. Your participation will be greatly appreciated.

Sincerely,

Nobuhle Priscilla Mbanjwa 207512723

Contact: 0793927725

This study was reviewed and approved by Mntonjani Secondary School. Questions concerning your rights as a participant in this research may be addressed to SA Lembethe. Road D158 Mpangisa, PO Box 10 MidIllovo, 3750. Contact: 0824252716

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the proposed procedures. It describes the procedures, benefits and discomforts of the study. It also describes your right to withdraw from the study at any time.

Purpose of study:

- The aim of this study is to explore the effectiveness of YouTube videos to learn science process skills.

Procedures involved in the study:

- The researcher will give the participants a pre and post-test and mark it. Then give the participants their results, thereafter a semi-structured questionnaire with open ended questions which the participants have to respond to.

Confidentiality of Research Records:

- Your names will remain anonymous throughout the study.
- Only the researcher has access to responses.
- Your responses will be recorded.

Potential Risks and Discomforts:

- No physical, social or economic risks are posed to participants.

Participating in the study will not affect your current curriculum coverage.

Potential Benefits: By participating in this study, you will get an opportunity to provide information about how YouTube videos were beneficial in the understanding of science process skills. You will also gain in-depth information about Osmosis which will be advantageous in the understanding of the concept in the Life Sciences curriculum.

***Voluntariness & Withdrawal from Study*:**

Your participation in this study is strictly voluntary and will not affect your current Life Sciences results.

✂- -

PARTICIPANT CONSENT INDEMNITY FORM

I ____ have read the above explanation of the research study entitled Exploring the Effectiveness of YouTube Videos in Learning Process Skills in the Grade 10 Life Sciences Curriculum. Everything about the research has been clearly explained and I understand all the details of this research. I understand that I may withdraw without prejudice at any time and that my identification will remain anonymous throughout the study.

If I have any further questions/concerns or queries related to the study I understand that I may contact the researcher at (Tel: 0793927725, Email: 207512723@ukzn.stu.ac.za).

If I have any questions or concerns about my rights as a study participant, or if I am concerned about an aspect of the study or the researchers then I may contact:

Dr Tamirirofa Chirikure
Tel: 0312603470
Email: chirikure@ukzn.ac.za

OR

HSSREC Research Office
Tel: 031 260 8350/4557/3587
Email: hssrec@ukzn.ac.za

________________________________ ________________________

Participants' Signature Date

✂- -

Appendix E

Learners' Pre-test and Post-test Scores and the Differences in Scores

Learner ID	Pre-Test	Post-Test	Difference
Total	**25**	**25**	
L1	9	12	3
L2	10	12	2
L3	5	14	9
L4	9	8	-1
L5	5	11	6
L6	6	6	0
L7	9	14	5
L8	15	15	0
L9	22	11	-11
L10	10	12	2
L11	2	2	0
L12	11	18	7
L13	0	20	20
L14	4	16	12
L15	15	20	5
L16	19	22	3
L17	9	18	9

L18	14	18	4
L19	12	17	5
L20	9	12	3
L21	11	16	5
L22	10	18	8
L23	6	19	13
L24	8	20	12
L25	11	15	4
L26	7	17	10
L27	7	13	6
L28	9	16	7
L29	7	13	6
L30	6	21	15
L31	11	23	12
L32	8	19	11
L33	9	11	2
L34	4	9	5
L35	3	20	17
L36	8	17	9
L37	8	15	7
L38	2	16	14

L39	11	19	8
L40	16	18	2
L41	3	17	14
L42	11	20	9
L43	12	14	2
L44	16	18	2
L45	4	19	15
L46	13	10	-3
L47	14	14	0
L48	17	20	3
L49	9	17	8
L50	7	16	9
L51	11	20	9
L52	15	18	3
L53	9	14	5
L54	4	9	5
L55	10	19	9
L56	17	16	-1
L57	6	19	13
L58	14	20	6
L59	9	19	10

L60	12	18	6
L61	7	11	4
L62	9	22	13
L63	5	14	9
L64	4	23	19
L65	9	18	9
L66	2	18	16
L67	13	9	-4
L68	17	16	-1
L69	13	11	-2
L70	11	18	7
L71	7	11	4
L72	14	18	4
L73	17	15	-2
L74	4	20	16
L75	0	18	18
L76	9	20	11
L77	2	18	16
L78	9	14	5
L79	12	13	1
L80	2	16	14

L81	6	7	1
L82	9	18	9
L83	4	19	15
L84	9	10	1
L85	2	15	13
L86	3	18	15
L87	6	15	9
L88	13	6	-7
L89	6	9	3
L90	8	8	0
L91	5	13	8
L92	4	16	12
L93	4	13	9
L94	6	10	4
L95	11	1	-10
L96	9	12	3
L97	6	15	9
L98	5	10	5
L99	8	13	5
L100	10	17	7

Appendix F

Pre-Test

LIFE SCIENCES

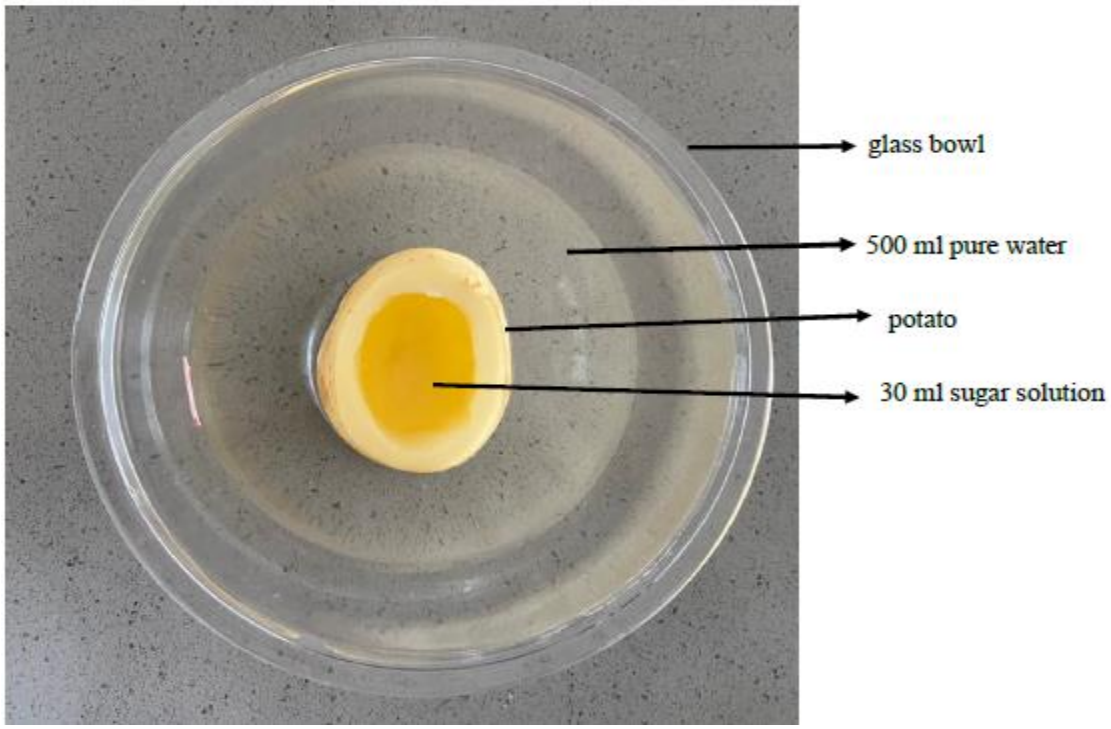
MARKS: 25

Thank you for agreeing to participate in this study aiming to Explore the Effectiveness of YouTube Videos in Developing Process Skills in the Grade 10 Life Sciences Curriculum.

Your input is very valuable to the researcher. Please take a moment to respond to the questions to help me conduct my study. This test aims to assess the Process Skills based on a Practical for Osmosis.

Some grade 10 learners set up the equipment below to investigate osmosis.

QUESTION 1



(a) What influence does osmosis have on the water level in the potato during the investigation? (3)

_____

_____

_____ *(inferring)*

(b) In your understanding, explain why this happens. (2)

_____

_____

(Constructing hypothesis)

QUESTION 2

In a fish and chips shop, potatoes are cut into chips several hours before the chips are cooked. The amount of water in the chips must be kept constant during this time. To keep the water in the chips constant, the chips are kept in a salt solution.

A student investigated the effect of different concentrations of salt solution on the mass of five chips.

- She measured each one of the five chips.
- She placed each chip into a different concentration of a salt solution.
- After one hour she removed the chips from the salt solutions and then remeasured the chips.

Concentration of salt solution			
	0M	**1M**	**2M**
Length of chip at the start in cm	9CM	9CM	9CM
Length of chip at the end in cm	9CM	8CM	7CM

(a) (i) In which concentration of the salt solution did the chip decrease in length? (2)

_____ *(interpreting data)*

(ii) Explain why the chip decreased in length in this solution (2)

_____

_____ *(inferring)*

(b) In which concentration of salt solution should the chips be kept in the shop? Give a reason for your answer. (3)

_____

_____

_____ *(identify variables, communicate)*

(c) In which concentration of salt solution did the length of the chip decrease the most? By how much did it decrease? (2)

_____*(measuring)*

(d) Which variable(s) had to be kept constant during the experiment? (2)

_____

_____ *(controlling variables)*

(e) Draw a diagram showing the chip in 2M solution at the start and after an hour. (3)

_____

(Formulating models)

QUESTION 3

The diagram shows the same potato chip after 1 hour in distilled water and after 1 hour in a salt solution.

1hr in distilled water

1hr in a salt solution

(a) Describe what you see in the diagrams above. (2)

_____

_____

_____ *(observe)*

(b) Describe **two** ways in which the cell of the potato found in the strong salt solution is different from the cell in distilled water. (2)

1 _____

_____

2_____

_____

(Communicate)

(c) If the potato chip in the strong salt solution was removed and placed in distilled water, predict what would happen to the cell. (2)

_____

_____ *(predicting)*

Appendix G

Post-Test

LIFE SCIENCES

GRADE:10

MARKS: 25

Thank you for agreeing to participate in this study aiming to Explore the Effectiveness of YouTube Videos in Developing Process Skills in the Grade 10 Life Sciences Curriculum.

Your input is very valuable to the researcher. Please take a moment to respond to the questions after watching the YouTube Videos to help me conduct my study. This test aims to assess Process Skills based on a Practical for Osmosis.

Videos: https://www.youtube.com/watch?v=Ao3dPwpWiBs

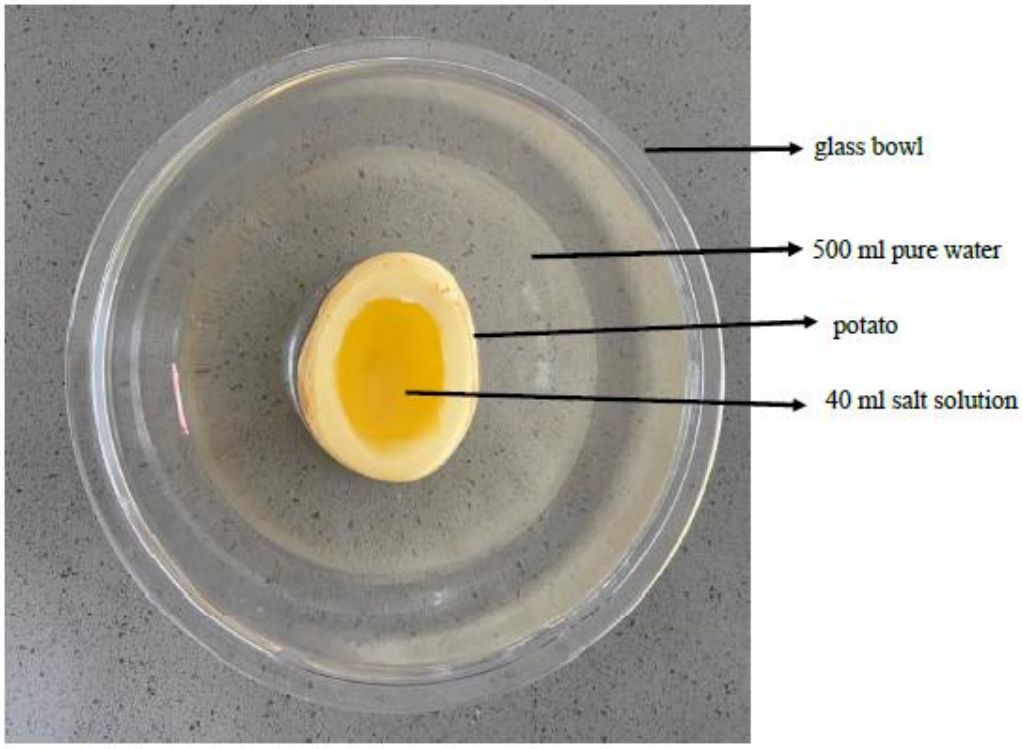
https://www.youtube.com/watch?v=uixn83fA5_Q&t=15s

https://www.youtube.com/watch?v=L-osEc07vMs&t=10s

https://www.youtube.com/watch?v=A9Z8eYDoDBw

QUESTION 1

Some grade 10 learners set up the equipment below to investigate osmosis.



(a) (i)What will happen to the water level in the bowl and the potato during the investigation because of osmosis? (3)

_____

_____

_____*(inferring)*

(ii) Use your knowledge of osmosis to explain why this happens (2)

_____

_____

_____ *(constructing hypothesis)*

QUESTION 2

In a fish and chips shop, potatoes are cut into chips several hours before the chips are cooked. The amount of water in the chips must be kept constant during this time. To keep the water in the chips constant, the chips are kept in a salt solution.

A student investigated the effect of different concentrations of salt solution on the mass of five chips.

- She weighed each one of the five chips.
- She placed each chip into a different concentration of a salt solution.
- After one hour she removed the chips from the salt solutions and then reweighed the chips.

Concentration of salt solution			
	0M	**1M**	**2M**
Mass of chip at the start in grams	15g	15g	15g
Mass of chip at the end in grams	15g	14g	11g

(a) (i) In which concentration of salt solution did the chip remain the same? (2)

_____ *(interpreting data)*

(ii) Explain why the chip remained the same in this solution. (2)

_____

_____

_____ *(inferring)*

(b) In which concentration of salt solution should the chips not be kept in the shop? Give a reason for your answer. (3)

_____

(identify variables, communicate)

(c) In which concentration of salt solution did the mass of the chip decrease the most? By how much did it decrease? (2)

_____*(measuring)*

(d) Which variable(s) would bring change to the experiment results? (2)

_____

_____ *(controlling variables)*

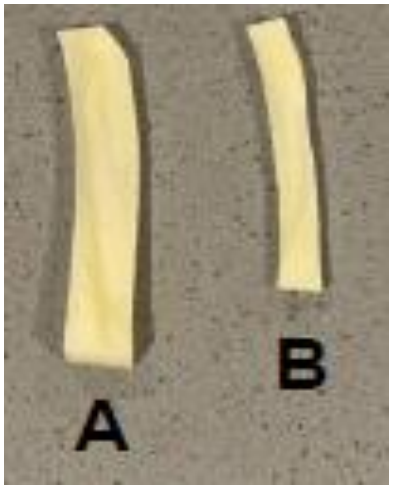
(e) Draw a diagram showing the chip in 0M solution at the start and after an hour. (3)

_____

(Formulating models)

QUESTION 3

The diagram shows the same potato chip: after 1 hour in distilled water and after 1 hour in a strong salt solution.



(a) Describe the water content in these potato strips. Explain your answer. (2)

_____

_____

_____*(observe)*

(b) Describe how the potato chips differ from each other. Justify your answer. (2)

_____

_____

(Communicate)

(c) If the potato in the distilled water was removed and placed in a strong salt solution, predict what would happen to the cell. (2)

_____

_____

(predicting)

Appendix H

Questionnaire Schedule

In the space provided below, kindly reflect on your experience of learning practical work using YouTube videos. Please respond by answering to the following questions:

1. How many times did you watch the YouTube videos?

_____

2. Why did you watch the YouTube videos so many times?

_____

_____

_____

_____

3. What did you like/dislike the most about the YouTube videos?

_____

_____

_____

_____

4. What did you learn from the YouTube videos?

_____

_____

_____

_____

5. How useful were the YouTube videos in preparing for the second test?

_____

_____

6. Why do you think you performed the way you did in:

(a) The first test?

_____

(b) The second test?

_____

7. Would you want to watch more videos on practical work in Life Sciences? Explain your answer.

_____

_____

_____

8. What did you see from the videos that captured your attention the most? Explain why.

_____

_____

_____

9. Were the videos audible enough? If not, what was the problem?

_____

_____

Appendix I

Editor's certificate

Registered with the South African Translators' Institute (SATI)

Reference number 1000686

SACE REGISTERED

22 November 2022

The Effectiveness of YouTube Videos in Developing Process Skills in Grade 10 Life Sciences Curriculum

This serves to confirm that I edited substantively the above document including a Reference list. The document was returned to the author with various tracked changes intended to correct errors and to clarify meaning. It was the author's responsibility to attend to these changes.

Yours faithfully

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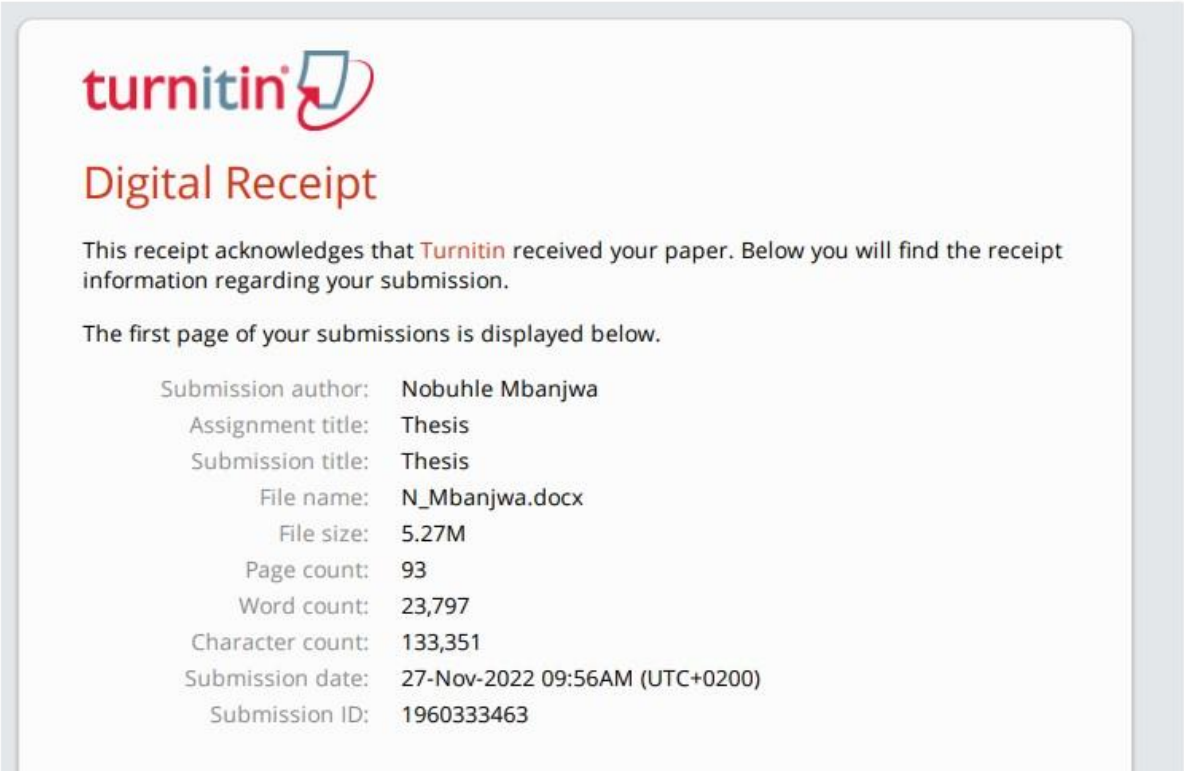
Appendix J

Turnitin Report



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