Interactive learning through open education resources for physical science Grade 11 learners

By

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Abstract

We are currently living in the technological era where technology is developed at an unbelievable rate, resulting in easier communication and access to information. Even though the ease of access increases, few options of education through a technological medium are available. Technology is openly accepted and incorporated into most daily activities. To be specific, most people for a variety of activities, some work related, use smartphones and tablets. Yet, few learners use mobile devices for educational purposes in any subject, including Physical Science, due to various reasons. The Department of Basic Education designed a curriculum for each subject with prescribed content, one of which is Newton's Laws in Physical Science.

This research followed an interpretive philosophy within an intervention strategy. The research design, data collection and analysis was based on the Community of Inquiry framework of Garrison. An interactive virtual classroom was developed for Grade 11 physical science learners, based on the content of Newton's laws, to incorporate technology and mobile devices in education. Data was collected through surveys, and online observations. Although the responses of participants in the pre-survey and post-survey indicated that the majority of the participants made use of the virtual classroom, the activity recorded by the virtual classroom indicated that fewer participants made use of it. Participants who did not engage with the virtual classroom did not reveal any improvement, but the participants who continuously used the virtual classroom revealed an improvement in performance. The intervention was evaluated on a set of guidelines, based on the Community of Inquiry framework.

The researcher anticipates this research to be the starting point for more online teaching interventions. In future research, the virtual classroom can be incorporated as a teaching medium and platform for class tests or diagnostic tests in the classroom rather than an additional education source.

Language editor letter

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This is to confirm that the thesis titled ***"Interactive learning through open education resources for physical science grade 11 learners"*** *by Johannes Marius Joubert was proof read and edited by me in respect of language.*

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Anna M de Wet

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List of abbreviations

ADDIE - Analyse, Design, Develop, Implement, and Evaluate

CAPS – Curriculum Assessment Policy Statements

COI – Community of Inquiry

EULER – Environment of Ubiquitous Learning with Educational Resources

FET – Further Education and training

ICT – Information communication technology

MOOC – Massive Open Online Course

OER – Open Education Resources

PDA – Personal Digital Assistance

PIRLS – Progress in International Reading Literacy Study

SEG – Serious Educational Game

TIMSS – Trends in Mathematics and Science Study

TPACK – Technological, Pedagogical and Content Knowledge

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1. Chapter 1: Introduction and Problem Statement

1.1. Introduction

Technology is a developing part of our lives, as it increases the ease of communication, different and economical methods of transport and in the medical field. Many children, as well as adults, have the most recent or latest release of a smartphone or tablet. Everywhere and anytime people are busy with their mobile phone searching for content on the internet, connecting with people by making use of social media networks such as Facebook, Instagram, WhatsApp and Twitter or completing work for a deadline in the near future (Chaffey, 2017; Pew Research Center, 2017; KPMG, 2013; Sukhraj, 2016).

Learners have challenges to overcome and skills to acquire during the early stages of their lives. Taylor (2008) provides a list of challenges for learners: time management of learners, difficulty to find beneficial resources and additional support are some of the challenges of learners.

Additional resources are not widely available for learners. Although resources can be found online, most of the content was not developed for the South African curriculum, nor for the different languages. In other cases, beneficial resources are available, but subscription fees are required. Textbook or workbook are possibilities for additional resources, just as extra classes are, but in both options payment is required.

Trends in International Mathematics and Science Study (TIMSS) is a research programme where standardised tests in mathematics and science are given to multiple countries and different age groups. The results for each individual country were compared to previous years and compared to other countries in the same year. According to Martin, Mullis, Foy and Stanco (2012) who published the TIMMS reports, South Africa was near the bottom in terms of science scores between countries and for different age groups.

Since social media usage is increasing and science education is below average, the aim of this research was to investigate the use of social media to assist learners in the challenges they encounter during education.

The purpose of the study was to determine the effectiveness of using an interactive virtual classroom. The virtual classroom was designed for a preselected physical science topic containing content, videos, simulations, questions, tests and discussions. Each individual participant could access and progress through the modules and interact with peers, or if needed with the teacher.

1.2. Problem statement

Internet access and access to information is easily achieved thanks to internet and smartphones (Chaffey, 2017; Pew Research Center, 2017; KPMG, 2013; Sukhraj, 2016). Education is seen as a vital part of any learner's life. Not only is it vital but the education should be adequate and on standard. According to the TIMSS research, when South African education was compared to other African countries, South Africa was placed in the bottom half (Martin et al., 2012). Not only did the TIMSS research indicate an inadequate performance, but Cupido (2016), Coetzee (2015), Govender (2016) and Sadou (2017) confirmed this. Research indicated a number of factors influencing the educational system of South Africa. *The following were some of the factors:* time management of learners and teachers, possessing the suitable study material, promoting home educational practices, teachers and their teaching ability, teacher knowledge and motivation and interest (Department of Science and Technology, 2007; Mji & Makgato, 2006; Taylor, 2008).

Time management

Learners lack time management skills and as a result their school performance bears' the consequences. Time management, not only amongst learners, is a key element to reach pre-set goals therefore, requiring proper teacher planning and the execution of the prescribed curriculum, setting up timetables and organising learners to receive adequate and effective education. The lack of time management amongst learners can be indicated by the lack of planning prior to tests or exams, or planning and

completing homework in the time available (Considine & Zappalà, 2002; Mji & Makgato, 2006; Taylor, 2008).

Suitable study material

According to Taylor (2008); having study material is one of the main requirements for proper education. That being said, it is not always the case and learners are often without study material. For many learners having a textbook is crucial, because of the necessity of content knowledge, and for others the textbook alone is not enough. Learners who strive to achieve high grades do want more study material than only the prescribed textbook. Even with diverse study material, learners need proper guidance. The absence of study material causes the lack of learner motivation and interest in subjects (Considine & Zappalà, 2002; Mji & Makgato, 2006; Mushtaq & Khan, 2012; Taylor, 2008).

Promoting home educational practices

In connection with possessing and selecting suitable study material, high achieving learners do spend additional education time at home. It is advisable to spend educational time at home to perform better at school. Two factors associated with learning are reading and homework. The effectiveness of homework increases if parents inspect the completion of homework. Although homework contributes to educational time at home, it is not the only method. In preparation for tests and exams, learners are advised to study the content, yet not to memorise but comprehend the content (Considine & Zappalà, 2002; Mji & Makgato, 2006; Taylor, 2008; Wanyama, 2013).

Teaching ability

Learners are mainly dependent on the teacher's ability to transfer knowledge and provide education. Teachers are required to obtain the ability to simplify content, find easy methods to transfer the content knowledge, yet retain the essence. As poverty increases, the responsibility of the teacher increases due to the lack of support at home and the lack of alternative study material. Teachers should also be able to supply academically strong learners with additional work to enhance learning. Supplying learners with different needs with different teaching mediums and teaching materials

is of the essence (Mji & Makgato, 2006; Mushtaq & Khan, 2012; Taylor, 2008; Wanyama, 2013).

Teacher knowledge

Teacher ability is an obtainable skill, but teaching knowledge is just as important for proper teaching. Teaching knowledge is crucial as this is the knowledge possessed by teachers through experience or preparation. This knowledge will be portrayed to learners in a way they can comprehend. Learners should be provided with the correct content and explanations to improve learning (Mji & Makgato, 2006; Taylor, 2008).

Motivation and Interest

People have different skills, abilities and interests and learners are no different. Learners are not equally interested or do not have the skills in the same subjects. This creates a challenge for teachers to promote their subject in such a way that learners might find it interesting. Teachers need to spark the interest of learners who are not interested, and motivate those learners in need of it (Mji & Makgato, 2006; Mushtaq & Khan, 2012; Taylor, 2008; Wanyama, 2013).

The education in South Africa is not as effective when compared to different countries. Various reasons or a combination of reasons, as mentioned above, can be the cause of this problem. Learners do not perform as expected and when considering individual subjects, the results are similar.

1.3. Research question

Primary research question

How can interactive learning through Open Education Resources (OER) support Grade 11 learners in science education?

Secondary research questions

1. How do learners interact with each other and their study material through technology?
2. How can these interactions be incorporated in learning?
3. Which role can OER play as a vehicle for interactive learning?

1.4. Rationale

The rationale for this research is to investigate the incorporation of an interactive Open Educational Resource for learners to address various challenges in their environment as mentioned in the problem statement.

Mobility of devices, social media communication and cloud computing are all technologically developed systems and devices. Technology is no longer for only a few people, but rather the centre and critical part of our lives (Chaffey, 2017; KPMG, 2013; Pew Research Center, 2017; Sukhraj, 2016). The impact of technology on our lives is evident in our day-to-day living. One only has to look at the number of grownups and children spending time on their smartphones to call or text messages to get some indication of its impact on our social lives. Technological devices such as smartphones, tablets, notebooks and music devices are extremely common in public places so that most venues nowadays are designed to cater for users' specific needs (Chaffey, 2017; KPMG, 2013; Pew Research Center, 2017; Sukhraj, 2016).

Another noteworthy finding by KPMG (2013) was how big an impact social media already have on how society retrieves and shares information. High school learners and students were initially targeted as the main users of social media. Although the number of global users exploded, these groups still continue to form the single biggest user group of this development. In their report, KPMG (2013) found that 3 132 million social media accounts were already created by the end of 2012. It was estimated that this number would grow to about 4 870 million accounts by the end of 2016. Not only is this phenomenon a global occurrence, but individual continents and countries have found similar results. The use of mobile phones and social media by teenagers and young adults are increasing (Beger, Sinha, & Pawelczyk, 2012; Redecker, Ala-Mutka & Punie, 2010; Shabir, Hameed, Safdar & Gilani, 2014).

The attractiveness of using and interacting via social media is a well-known fact amongst users (KPMG, 2013). Most users report a willingness to interact using this impersonal, 'faceless' system rather than running the risk of openly exposing oneself to public scrutiny and being made fun of in meetings, social groups and other gatherings.

Even though the use of mobile devices are increasing, these devices are not optimised and utilised to enhance effective education. Challenges in the education need a solution and technology can bridge the gap between challenge and solution. Learners have fully planned days and weeks just to get by with homework, studying, extramural activities, or additional classes. In some cases extramural activities such as sport require learners to be absent from school due to match fixture. The absence can be due to transport, or illness, but the result remains absence from class. Tertiary institutions' requirements for entrance are increasing, eventually requiring learners to perform better and better to be accepted in such institutions. In rural areas teachers do not always turn up for work, leaving learners without education. The absence of the teacher can be influenced by many factors, as a result the learners do not receive education. These are all challenges identified in education (Considine & Zappalà, 2002; Mji & Makgato, 2006; Mushtaq & Khan, 2012; Taylor, 2008; Wanyama, 2013).

The advantage of incorporating mobile devices into classrooms is endless. According to Aubusson, Schuck and Burden (2009), Naismith, Lonsdale, Vavoula & Sharples (2004) and Sharples, Taylor & Vavoula, (2005), using technology as an educational medium, learners are more mobile and ubiquitous learning can occur. Due to the increase in interaction, collaboration amongst learners is easier, therefore content is constructed and technology enhances the controlling and distributing of content. Information and support can be easily acquired through mobile devices, leading to an increase in learning and teaching support.

Since social media usage is increasing across the world, including South Africa, it leads to the possibility of using social media for educational purposes. As Mji and Makgato (2006) and Taylor (2008) stated, time management is one of the factors resulting in poor educational results for South Africa. Learners have the right to education and should be provided with the necessary content. This applies to all subjects, including physical science. The effectiveness of incorporated technology in the classroom can be established by developing and creating a database containing subject specific content such as, videos, examples, explanations, worksheets, tests, discussion and support. Factors such as time management can be addressed by making use of the content. Learners can access this content and receive the necessary education. Absentees from school, no matter the reason, can view the

video of the content missed and not fall behind. When the learner returns to class, he/she can be up to date and continue. Learners in need of extra activities, explanations, or a recall in preparation can access the content ubiquitously. Not only does the content determine the effectiveness of such databases, but also how teachers implement and incorporate it as an educational medium.

1.5. Purpose of the research

The purpose is to provide guidelines to incorporate mobile interactive learning through Open Educational Resources (OER) to support Grade 11 learners in science education.

South Africa is not seen as one of the reckoned countries in the field of physical science for learners Martin et al. (2012). The education of physical science is a concern, resulting in end of the year results to be awaited with trepidation. Since the tendencies of mobile device usage across the world apply to South Africa, the opportunity to incorporate mobile devices as an educational tool arises (Beger et al., 2012; Redecker et al., 2010; Shabir et al., 2014)

Open education was used as an educational tool to provide Grade 11 physical science learners with content knowledge that could be accessed ubiquitously via their mobile devices. Learners who felt they would benefit from additional education, as well as learners who strived for excellence and were willing to do more than what was expected, were encouraged to make use of the pre-developed social media learning. Ideally, the use of social media and mobile devices as an educational medium would increase the level and quality of education for those in need, as well as top performers who are keen for extra activities, resulting in an improvement in physical science performance.

Learners who cannot attend class due to personal reasons, extra mural activities or illnesses, tend to fall behind academically. The design of the ubiquitous intervention was solely to bridge that gap, to prevent learners from missing class and falling behind, to refrain from misunderstanding concepts and additional education.

Interaction amongst learners and communication were aspects. The objective was for learners to communicate with each other about content they encountered, helping each other through discussions and asking questions about uncertainties or misunderstood content.

Participants were required to complete the research process and complete all surveys and tests, as well as to engage in the intervention. A pre-survey was completed to start the research process, this was followed by a pre-test, an intervention one and intervention two. The intervention phase required participants to engage in interactive learning. After the intervention, a post-test and a post-survey were completed. The data was collected from the surveys, tests and the data recorded by the platform used for the virtual classroom.

1.6. Chapter Overview

1.6.1. Chapter One: Introduction.

Technology is incorporated into our everyday life and the age of the user is no limitation. Learners are increasingly making use of mobile devices in classrooms. Even though the use of mobile devices is increasing, leaner performance is not improving. The results of scholars in South Africa are not what is expected and many factors have an influence. Time management skills, learner or teacher absence, insufficient study material, or different interests are some of the factors. Learners are also encouraged to perform better due to the rife competition amongst learners. The research question is: How can interactive learning through Open Education Resources (OER) support Grade 11 learners in science education? The purpose of the research is to provide guidelines to incorporate an Open Educational Resource into a Grade 11 physical science classroom to improve learner performance.

1.6.2. Chapter Two: Literature review.

The theoretical framework selected for this study, is the Community of Inquiry framework (Garrison, Anderson & Archer, 1999). This is presented in Chapter 2. The theoretical framework is discussed and all features are unpacked. Based on the problem statement, the literature layout starts with teaching methods and approaches in South Africa, after which the theoretical framework is discussed. The literature is

categorised and discussed based on the various aspects of the theoretical framework. Science education is unpacked in a similar method. Lastly, the Analyse, Design, Develop, Implement, and Evaluate (ADDIE) model is explained, as it was used to develop the interactive Open Education Resource.

1.6.3. Chapter Three: Research methodology.

During the methodology chapter all aspects of the data collection are addressed and discussed. The conceptual framework used was Community of Inquiry as developed by Garrison et al. (1999). Interpretivism was the selected research philosophy and qualitative research was the approach used. The intervention strategy was used to gather data for analysis and comparison.

1.6.4. Chapter Four: Results and findings.

Results for the research were obtained from three different tools: tests, surveys and participant activity. The tests were used to compare the results before and after the intervention. Qualtrics was used to analyse the results. The pre-survey responses were used to design and develop the intervention, whereas the post-survey's responses were used to determine the effectiveness of the virtual classroom based on the opinions of participants. Haiku Learning, the virtual classroom platform, recorded all the activities and participants accessing the virtual classroom. These results were compared with the post-survey responses of the participants.

1.6.5. Chapter Five: Summary, conclusions and recommendations.

The last chapter revisits the research questions as well as the findings from the conceptual framework. These are combined in a set of guidelines for future developments of interactive open education resources.

1.7. Conclusion

Education is a key aspect in learners' development, yet it is not always available or of adequate quality. Time management, suitable study material, promoting home educational practices, teaching ability, teacher knowledge, motivation and interest are reasons for inadequate education and poor learner performance.

How can interactive learning promote education for Grade 11 physical science learners to perform better?

Technology allows easier and more convenient access to information and data on the internet. The ease and convenience can be combined with education for learners to access ubiquitously. The purpose of the research was to provide guidelines to incorporate mobile interactive learning for Grade 11 physical science learners to communicate and assist peers to improve understanding and learners' performance.

2. Chapter 2: Literature Review

2.1. Introduction

This chapter focuses on the underlying literature for this study. Figure 1 provides an overview of the topics included. It commences with an overview of teaching in South Africa, after which the theoretical framework for the study is presented. This is followed by a discussion on teaching with technology, unpacked in the three main concepts of the theoretical framework. A discussion on science teaching follows. Instructional design, and specifically a focus on the model used for this study, concludes the topics of this chapter. Figure 1 is a visual representation of the arrangement of the literature review.

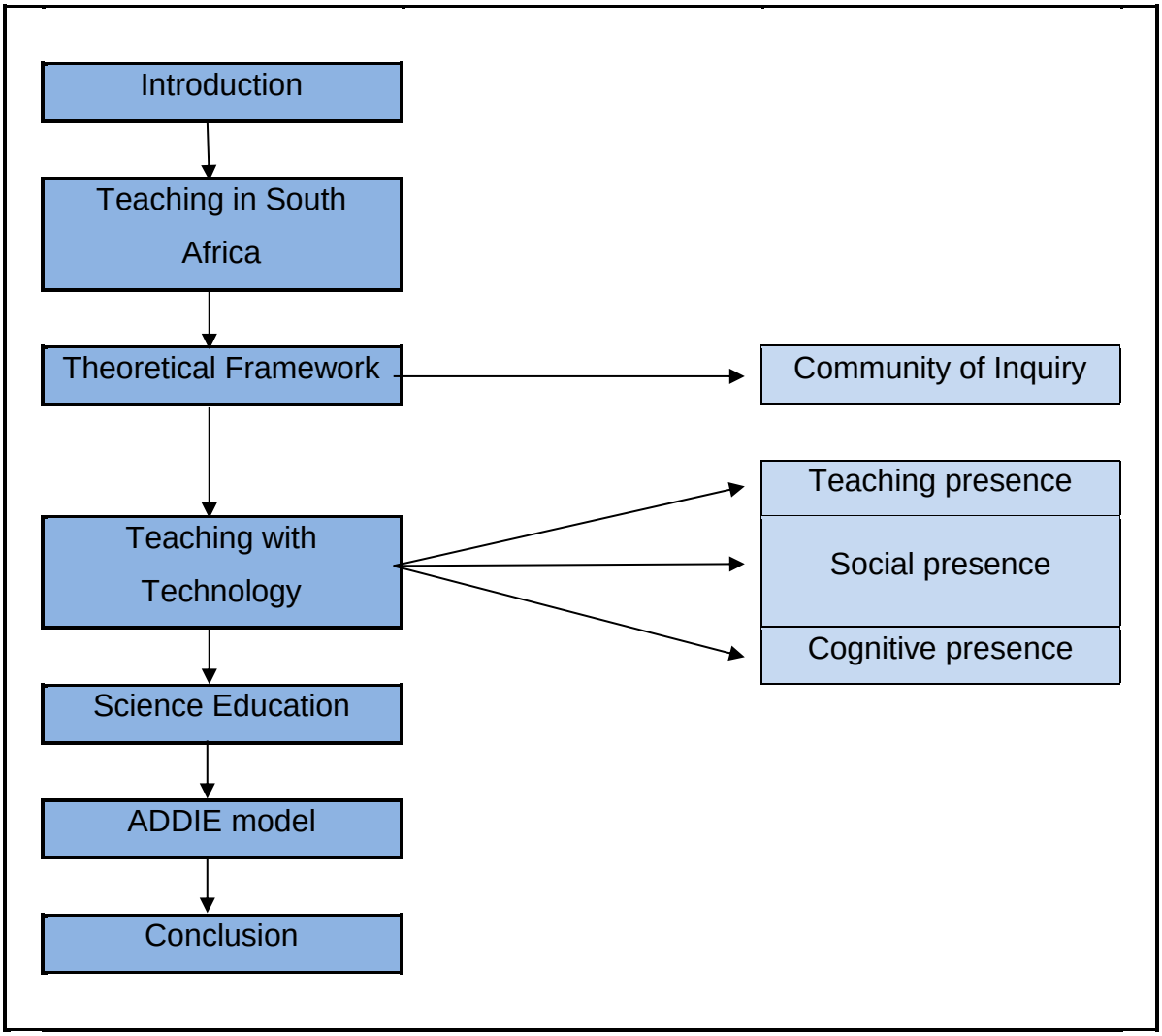


Figure 1: Literature review outline

2.2. Teaching in South Africa

Teaching in South Africa is a combination of prescribed content and methods containing: compulsory content and experiments, required tests and exams for marks, practical components for certain subjects, required goals and skills to be achieved, and each teacher's influence on the subject such as the method for education, classroom setup, management of classroom discipline, and additional information included.

The Department of Basic Education in South Africa prescribes the curriculum and syllabus for each subject and every year. Currently the CAPS curriculum is followed containing every syllabus. A syllabus is the prescribed content, demonstrations, practical components, assessments, projects and exams needed to be completed in an academic year. The curriculum document does not prescribe the methods of teaching or the tools used for teaching. Teachers can use their own initiative as long as the prescribed goals for each topic is met and learners acquire the skills as prescribed (Department of Basic Education, 2012).

Teaching in South Africa, like most countries, have contributing aspects, as well as aspects withholding progress. According to research the prevalent teaching method required teachers to assume the position of an authority figure, who is doing most of the taking and learning (Hoadley, 2010). Many teachers make use of this teaching method, not by choice but due to lack of resources. Subjects cannot be taught efficiently due to the lack of resources. Resources are requested from the Educational Department to develop a more interactive classroom (Makgato, 2014).

South Africa's has an education crisis, as indicated by the research of the Human Sciences Research Council (HSRC, 2016; Martin et al., 2012). The research conducted by Martin et al. (2012), called Trends in International Mathematics and Science Study (TIMSS), is a research conducted every few years in multiple countries, where learners from specific ages complete a standardised test in mathematics and science. The results of the tests are compared to all countries to determine the level of the country's education in mathematics and science as subjects. Similar to the TIMSS research is the Progress in International Reading Literacy Study (PIRLS)

research. Related to TIMSS, PIRLS focuses on the reading literacy of a specific grade of learners in the country (O'Hagan, 2017). The results of both TIMSS and PIRLS revealed the near bottom performance of learners in South Africa in mathematics, science, and reading literacy. Learner performance is inadequate and factors were identified as influential aspects. Firstly, the shortage of teachers results in children not receiving education, or in such multitudinous classes or groups that effective teaching cannot take place. Secondly, schools claim they do not have the correct textbooks, or in some cases no textbooks, for the academic year and do not have stocked libraries to make use of (Considine & Zappalà, 2002; Mji & Makgato, 2006; Mushtaq & Khan, 2012; Taylor, 2008).

The above mentioned factors influencing learner performance are seen as challenges to address and requiring possible solutions.

Challenge one for South African education is the shortage of teachers (de Villiers, 2017; Gumede, 2017; Hofmeyr & Draper, 2015). Without teachers in classrooms, learners cannot receive proper, compulsory education. Teachers are required to increase learners' skills and abilities and in order to succeed, teachers ought to have proper training and adequate teaching materials.

Challenge two for South African education is the lack of resources. Teaching material and resources are essential for adequate and effective teaching. Resources and materials are one form of support for teachers (Considine & Zappalà, 2002; Mji & Makgato, 2006; Mushtaq & Khan, 2012; Taylor, 2008; Makgato, 2014).

Challenge three for South African education is the quality of teacher in the profession. Ideally, highly qualified and educated teachers with a passion for education should be employed. These highly qualified teachers are the key to increase South African education. In order to deliver highly qualified teachers, students require high quality training (Armstrong, 2015; Ndlovu & Lawrence, 2012).

The Department of Basic education released a policy containing an outlined plan to increase quality of teaching, to address one of the challenges, and van der Berg, Taylor, Gustafsson, Spaull and Armstrong (2011) agreed with the statement after their

research. Technology is gradually being used more often as a possibility to address the educational challenges. Research indicated the use of mobile phones to gain access to textbooks and resources, as well as students engaging in joint problem solving and communication as a possibility. The use of mobile phones has a positive effect on teaching and is encouraged (Pimmer et al., 2014). Not only are mobile phones utilised as textbooks, but since people have mobile phones and are using social media, it is incorporated into education and teaching. Social media was applied for academic support in distance education and participants revealed a positive attitude according to van Rooyen (2015).

2.3. Theoretical Framework

Technology is a dominant factor in many industries, including society. Rapid development and production of technology assist many fields of studies such as science in the development and discovery of new knowledge. Cell phones, or more accurately described as smartphones have made the way around the world. It is no longer only a selected few people to carry smartphones, but it starts from children at a young age to elderly people. Fortunately, smartphones have reached the classrooms and have been utilised as a teaching aid (Guzey & Roehrig, 2009; Hennessy et al., 2007; KPMG, 2013). Although the technology reached modern day classrooms, it still takes a place as an aid and not a replacement for a teacher. This section presents a framework that will be used to unpack the literature as well as the research strategy for this study.

2.3.1. Introduction.

The focus of the research was to determine the effectiveness of incorporating technology and a virtual social aspect of education into a physical science classroom. Technology was incorporated into the classroom as an educational medium for learners to access academic content. The teacher manages and guides learning by being involved, and the learners communicate and interact with one another to enhance effective learning. Therefore the selected theoretical framework is the community of inquiry framework (Garrison et al., 1999).

2.3.2. Community of Inquiry framework.

Garrison et al.'s (1999) theory refers to the social, cognitive and teaching presence of learners making use of online communication mediums. Social-, cognitive- and teaching presence are the three categories that in combination create the framework. Garrison (2007) defined each category and intersection between the different presences in the following illustration.

Figure 2 shows the Community of Inquiry model.

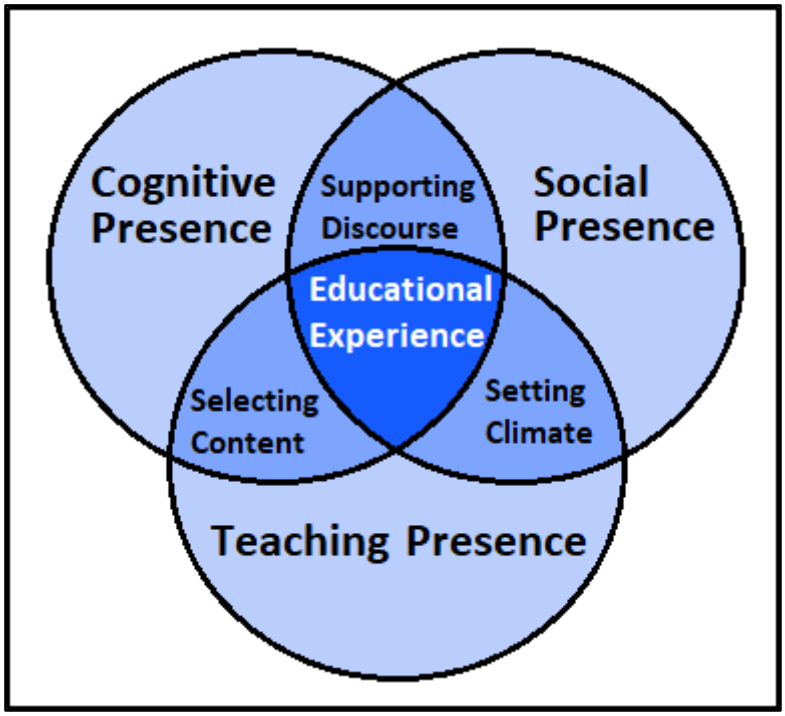


Figure 2: Community of Inquiry Framework

Source: (Garrison et al., 1999)

Figure 2 shows the three presences of the framework: social presence, cognitive presence, and teaching presence. Once all three presences are incorporated, the educational experience (centre of the figure) is achieved.

All three presences, cognitive- social- and teaching presence, require certain aspects to be incorporated and obtained, just as supporting discourse, selecting content and setting climate required. In the following discussions, the crucial aspects required to

be achieved in order for the community of inquiry framework to be successful are presented in Italics.

Social Presence

The ability to project the social and emotional aspect of oneself through the communication medium of choice during a learning and teaching environment defines social presence. Social presence is determined by skills, motivation, communication context created, activities, organisational commitment and the length of time using media. By developing these areas, the social presence of any individual increases. Considering social presence, three aspects are of the utmost importance to help define social presence (Garrison et al., 1999). *The three aspects are: effective communication (effective expression), group cohesion, and open communication.* Increasing the effectiveness of social presence should be in combination with group discussion as participants encounter perspectives of different people. One primary function of social presence is its ability to enhance cognitive presence, to be more specific, support and enhance critical thinking (Garrison, 2007).

Cognitive Presence

Cognitive presence is in the content that is required to be mastered, as portrayed in any lesson, activity or classroom. It is not a single step phase and therefore not easily achieved. Even though it is not easily achieved it is vital for education, since cognitive presence is crucial in critical thinking. *Critical thinking requires a person to explore content, construct ideas, solve problems and reflect.*

Teaching Presence

Teaching presence refers to the presence of a teacher to *conduct and focus learning on a pre-determined topic in an online environment*. Social presence and cognitive presence cannot be as efficient without teachers to facilitate learning.

Aiming to include three categories called design, facilitation and direct instruction is the main focus of teaching presence. Teachers need to design and plan a topic, facilitate learners during the learning process and be able to provide instructions once concerns arise (Garrison, 2007; Garrison et al., 1999).

Supporting Discourse

Social presence and cognitive presence intersects each other at an area called supporting discourse. Most of the leading concerns and problems appear in supporting discourse. These are the concerns and problems being discussed to *encounter different learners' perspectives and necessitate critical thinking* (Garrison, 2007; Garrison et al., 1999).

Selecting content

Selecting content is the area of intersection between cognitive presence and teaching presence. Teaching presence requires the teacher to *design, facilitate and provide instructions based on the content selected to promote critical thinking* (Garrison, 2007; Garrison et al., 1999).

Setting climate

Social presence refers to interaction, while teaching presence refers to structured process. Setting climate is the *responsibility of the teacher to guarantee learning takes place through interaction and not letting learners get distracted* by other topics of conversations. A learning environment is essential for learning (Garrison, 2007; Garrison et al., 1999).

Table 1 provides a summary of the guidelines to successfully incorporating community of inquiry framework.

Table 1: Guideline to incorporate COI framework

Framework presence	Crucial aspect to achieve
Social presence	Effective communication (effective expression), group cohesion, and open communication.
Cognitive presence	Critical thinking requires a person to explore content, construct ideas, solve problems and reflect.
Teaching presence	Teaching presence refers to the presence of a teacher to conduct and focus learning on a pre-determined topic in an online environment.
Supporting discourse	Encounter different learners' perspectives and necessitate critical thinking
Selecting content	Design, facilitate and provide instructions based on the content selected to promote critical thinking
Setting climate	Responsibility of the teacher to guarantee learning takes place through interaction and not letting learners get distracted
Practical inquiry model (process of cognitive presence)	Triggering events, explorations, integration and resolution

The following literature discussion will be unpacked in the main aspects of the theoretical framework, namely teaching presence, social presence and cognitive presence.

2.4. Teaching with technology

2.4.1. Teaching presence.

Over the years teaching methods for education have evolved, or have been altered to improve teaching. Teaching methods are techniques and tactics used to convey content in such a manner that the receiver, in this case learners, grasp and comprehend the concepts. Teachers have their own teaching methods and adapt teaching methods for the most efficient teaching. Therefore most teachers tailored their teaching methods to fit specific needs, even though differences might be

miniscule (Gill, 2013). Different teaching methods have been developed, implemented and used; later on they have been improved or discarded and replaced with a new teaching strategy. Different methods can be used for educational purposes even if the content is not school related. Button, Harrington and Belan (2014) and Carter, Creedy and Sidebotham (2016) researched the effectiveness and teaching methods. A variety of methods were used to enhance critical thinking. Methods such as: problem based learning, concept mapping, simulation, critical reading and writing courses, videotape vignettes, information communication technology (ICT) based modern approaches, web based animated pedagogical agents, reflective writing intervention, narrative pedagogy, evidence based course and interactive videodisc systems were applied and even though there were methodological concerns regarding some of the applied teaching strategies revealed and increase in critical thinking (Carter et al., 2016). In correlation, the results from research revealed students can certainly benefit from e-learning and ICT, if used and managed efficiently. Not only are the teaching methods relevant to specific subjects, but research suggested online learning can be developed and utilised to develop alternative learning methods (Chen & Huang, 2012; Iqbal, Lee, Pearson & Albon, 2016).

Videogames and online gaming are increasing amongst a variety of age groups (Williams, Yee, & Caplan, 2008). Educational videogames are an activity with potential for educational purposes. Videogames are used as an educational method for school related subjects, as well as every awareness and understanding (González et al., 2016). Another developed gaming system, Serious Educational Game (SEG) was developed for learners to engage in laboratory experiments they otherwise never would have had access to. The game presents users with problems that need solving in order for users to progress in the game (Annetta et al., 2014). An environment of Ubiquitous Learning with Educational Resources (EULER) is a platform for teachers to create lessons, activities or projects and learners to log in to the platform. As learners progress through activities or projects the platform records the progress for the following time the learner logs in. Teachers have the ability to track the progress of each individual learner (Tan, Lin, Chu & Liu, 2012).

Interactive videodisc systems (Carter et al., 2016) were developed for interaction, yet prior to developed systems, interactive teaching methods and exposing learners to

passive and active learning were used (Lukashevich, Shegelman, Sukhanov, Vasilev & Galaktionov, 2015). Active and passive learning were compared through learners attending a passive class and providing them with lectures and content, while active classes were also presented where interactive learning took place.

Smartphones and tablets enhance communication and interaction amongst users. Due to the nature of smartphones and tablets, ubiquitous learning becomes a reality and real world situations are easier to incorporate into classrooms (Chu, Hwang, Tsai & Tseng, 2010; Hwang, Wu & Ke, 2011). Smartphones, or in some cases PDA's (Personal Digital Assistants), are used for learners to gain access to content. Cameras of the mobile phones were used to take pictures of objects and during class the pictures were sent to the teacher. Each of the pictures was discussed and learners were given homework based on the pictures (Chu et al., 2010; Ekanayake & Wishart, 2014). Research indicates an increase in learner performance and effectiveness in teaching when making use of technology such as mobile phones, but application and devices should be updated as technology is developed (Zydney & Warner, 2016).

As Gill (2013) said, in the current era teaching methods are evolving and adapted for the best and most efficient results and, because of this trend, technology's contribution in teaching methods is escalating. Education methods are increasingly making use of technology, as Serafin (2016) indicated, in the inclusion of modern tools in inquiry based learning.

On the other hand, technology might be difficult to incorporate into the classroom, but one concern to keep in mind when using technology in classrooms is that teachers are not always well equipped and skilled in the field, therefore training is required to ensure that teachers possess the skills (Hennessy et al., 2007; Niess, 2005). According to Wallace (2002) teachers need to know three things, namely: technology is a useful tool to teach, what effective teaching looks like and a variety of technologies can be used for effective teaching.

Various teaching methods and strategies are being developed, implemented and used to increase effective teaching. Some teaching methods incorporate the use of technology or technological devices, such as smartphones and tablets, which raise

new challenges and concerns. Even though different methods are developed and used, teachers remain the key facet for developing and utilising different methods. Different methods need to be developed and incorporated into classrooms. It remains the responsibility of teachers to manage the use of different methods and tools effectively. The presence of the teacher is still crucial.

TPACK model

The TPACK, Technological, Pedagogical and Content Knowledge (Koehler & Mishra, 2006) is a framework designed to identify the knowledge a teacher requires to integrate technology into classrooms to focus on teaching content knowledge.

Figure 3 is a visual representation of the TPACK model. The model consists of three intersecting circles and the area where all three intersect is the focus.

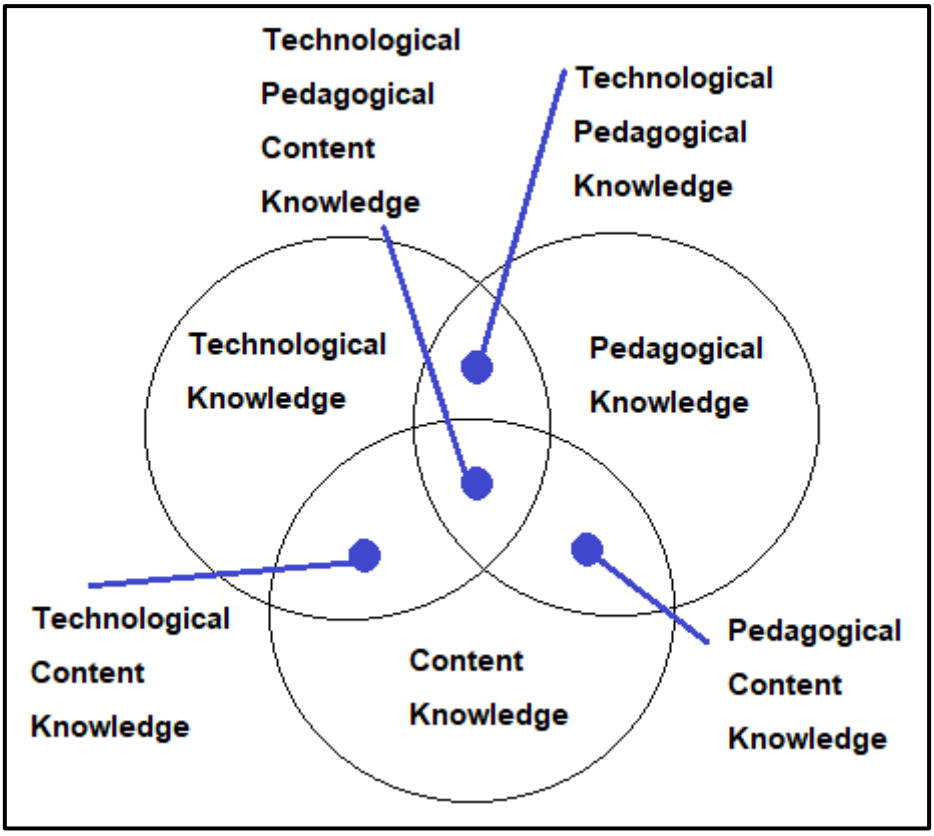


Figure 3: TPACK model

Source: Koehler and Mishra, 2006

Technological knowledge, content knowledge and pedagogical knowledge are the three intersecting circle. Technological pedagogical content knowledge is only obtained when all three areas intersect. Even though the focus is where all three prime aspects intersect, an intersection exists between two prime aspects.

Content knowledge – teachers are required to be experts and specialists in their respective fields in order to determine relevant content to teach learners. Content needs to be analysed to determine the accuracy and validity of the content before it is adopted and integrated into classrooms.

Pedagogical knowledge – This refers to the teacher's deep understanding of the process of teaching and various methods and aids. Teaching methods are selected and additional information is included in classrooms, because teachers have the pedagogical knowledge to compare methods and select the best option after considering all aspects.

Technological knowledge – It is knowledge about selecting, incorporating and working with technology as a resource. For effective use, teachers ought to understand the basics of technology and the information of technology to apply and use it effectively (Koehler, 2012).

Integrating technology into classrooms requires teachers to consider all three aspects of the TPACK model. Age and subject appropriate content are required to be identified, as well as the validity of content that needs to be determined. The method planned to be used as the educational method to teach the content should be carefully considered. Technology used or incorporated can be additional information of a part of the teaching method. Understanding the information and technology before applying it to teaching methods is crucial. Only when the teacher has considered the content, carefully selected the teaching method, and included technology, is the TPACK model implemented.

Incorporating the TPACK model into a classroom is not as easy, therefore it is the responsibility of a teacher (teacher presence) to confirm the age and ensure that subject appropriate content is selected, that the teaching methods used will suffice to

educate learners, and that the technology included is well managed to guide learners to effective teaching.

2.4.2. Social presence.

Examining school teachers and the teaching methods used, it becomes clear methods of lecturing while learners are writing and taking notes are fading swiftly. It is to be expected with smartphones, tablets and other technological devices being owned by most of the learners in the classroom. These devices are used to record or take pictures of what is important in the classroom, instead of taking notes. Because smartphones and tablets increase the ease of communication, these notes, pictures or recordings are easily distributed amongst peers. A positive correlation is visible between the development of technological devices and the number, as well as the usage, of social media accounts. The use of social media is escalating due to the simplicity of access thanks to technological devices (Anderson, 2012; KPMG, 2013).

Social media are more and more integrated into classrooms and utilised outside classrooms for educational purposes. Incorporating social media in a classroom does not restrict itself to one platform. Facebook, Twitter, Snapchat, Instagram and YouTube are all social platforms being used. Research indicates learners are desirous to use social media for learning, since social media is integrated into their daily lives. Facebook, for example, is used as the platform for learners to communicate with peers, share ideas, comment on post (text, pictures or videos) or request assistance. Also, in some cases it allows for easier and faster communication between teachers and learners or lectures and students. Results from research portray a positive view towards the use of social media for education (Balakrishnan & Gan, 2016; Milošević, Živković, Arsić & Manasijević, 2015). Boticki, Baksa, Seow and Looi (2015) made use of the SamEx mobile learning application during a research. Although it is not Facebook, yet similar, also allowing for comments, replies and posts to be made, the results point towards incorporating social media and software features.

The process of integrating social media in the classroom is more complex than choosing and using the social platform. According to Mayer and Moreno (1998), the aim of education is for learners to understand scientific content. When integrating

technology into classrooms there are five principles to consider ensuring learner comprehension. 1) Use pictures and words, 2) when explaining combine words and pictures, 3) spoken word is more effective than written words, 4) the aim is for lower knowledge learners, 5) and use fewer words.

The before mentioned principles should be incorporated in the social media platform to ensure proper learning. One major consideration when implementing social media is learners' familiarity with social media. When making use of social media, encouragement might be required as some learners are not as eager to engage with social media as others are. Therefore, establishing a team might be of value as different members can contribute in different areas. One crucial area is proper planning and drafting a plan. The teachers should be open minded and willing to adapt to enhance teaching experience (Anderson, 2012; Balakrishnan & Gan, 2016; Milošević et al., 2015).

A social aspect of teaching can be incorporated into classrooms by various methods and platforms. All platforms and methods have one focus, it is to increase communication, and interaction amongst learners, thus the social presence is fundamental. Even though challenges for integrating social media in classrooms arise, it is the obligation of the teacher to manage the platform to ensure a social presence persists.

2.4.3. Cognitive presence.

Cognitive presence focuses on higher order thinking processes such as critical thinking, as discussed in Section 2.3.2. Critical thinking can be described as an outcome, as well as a process. As an outcome, learners are required to identify the deep meaningful aspect of any situation. Once learners engage a vast amount of information or data, critical thinking assists learners to establish and identify the valuable information. Cognitive presence as a process refers to the progress of engaging with various information, assessing the information, establishing the value, and isolating what is of value. According to Garrison et al. (1999), the Practical Inquiry model enhances critical thinking. The authors developed the practical inquiry model as an idealised logical arrangement for critical thinking as a process to create cognitive

presence. The practical inquiry model was developed for online learning, therefore the selected platform or system is irrelevant as all of them focus on online learning.

The practical inquiry model is illustrated by Figure 4.

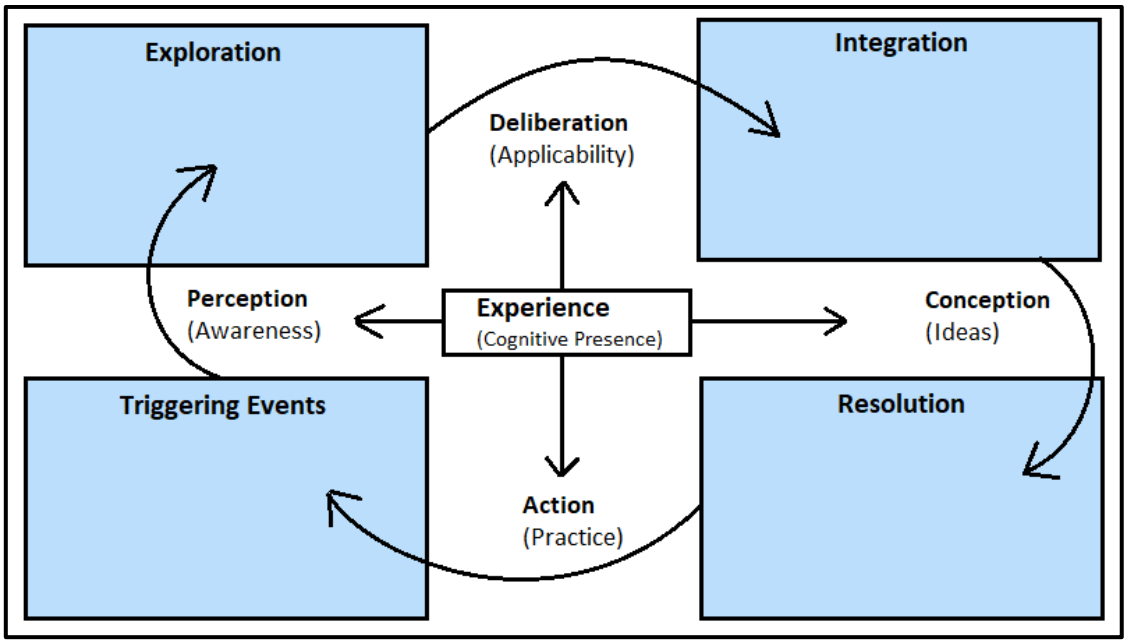


Figure 4: Practical Inquiry Model

Source: Garrison (2007).

The four phases necessary to inquire and understand are the four phases inside the circle. Garrison (2007) added four phases based on Dewey's research: shared world, private world, reflection and discourse; to the model. Dewey (1910) described these four phases as reflective thinking with the focal point of understanding.

This model consists of four phases.

The first phase is the **triggering events** and is seen as the initiation phase. A problem or issue arises that is the event to start the critically thinking process. The triggering event can be deliberately created like in the case of teachers, or it can be an unintended, incidental event. Teachers have a great responsibility to initiate, structure and guide the triggering events to focus on the process of critical thinking.

The second phase is **exploration**. Before the exploration phase commences, participants are required to comprehend the problem. The exploration phase focuses on the transition of a private, individual reflection to a social communication to exploration for ideas. Recurring interchange between the private world of the individual and the shared world are home to exploration. The shared world allows for exchange of ideas, brainstorming, or questioning to obtain information only relative to the topic and discarding irrelevant information.

The third phase is **integration**. Assembling concepts and assessing the applicability of the concepts based on the level of detail describing the event, depicted the integration phase. Once again the recurring switching between reflection and discourse is crucial. Students can prefer to remain in the exploration phase, therefore teacher presence is of utmost importance. Teacher presence is required to identify and correct misconception, provide additional information, support and guide, and ask investigative questions to steer learners into the process of critical thinking.

The fourth phase is **resolution**. Resolving the event or problem with the solution developed in the previous phase characterises the resolution phase. Resolving the problem or event can result in one of two possibilities. Firstly, the problem is resolved by the solution developed and then there is a move on to the next triggering event, usually the case in education. Secondly, the developed solution is implemented to solve the problem, yet it generates a new triggering event causing the process to start over.

Cognitive presence consists of four groups which are: triggering events, exploration, integration and resolution. As Garrison said, cognitive presence can be defined as the ability to understand a problem, examine the problem, and solve the problem (Garrison, 2007).

The responsibility of the teacher is to ensure learners engage in all four phases, as this is necessary to develop critical thinking skills. Critical thinking skills are key to enhance the cognitive level of learners. Therefore, teachers should guide and assist learners in their critical thinking abilities.

All platforms, systems and applications are designed and developed to increase the level of critical thinking. Critical thinking requires any person to be curious and to inspect an event of interest. The event is explored to gather as much information and data as possible in order to understand it. Following the exploration is the integration, where possible solutions are developed and lastly, resolving the problem with one or more of the pre-developed solutions. Applying this to a classroom, learners are given a problem that needs to be solved (triggering event). Learners are required to read and understand the problem before attempting any solution (exploration). Once learners comprehend the problem, possible solutions can be developed (integration). Lastly, the pre-developed solutions can be applied to determine the resolution of the problem.

Research found a variety of tools and applications that have been used by participants accessing their mobile phones. Mobile Learning Support Systems, Youubi and Mobile Collaborative Learning are some of the systems developed. Youubi is an open software solution for ubiquitous learning, thus allowing learners to access content at any given time or place. Massive Open Online Courses (MOOC's) can be developed in all systems for subject specific content. MOOC's are online courses open to users to ease the search for educational information and assistance. In all research cases, learners are encouraged to make use of the provided system, enabling them to access content. Participants are eager to make use of mobile phones that can be used to access the content. Furthermore, the results reveal an increase in performance, effectiveness, understanding or grades compared to the controlled groups (Brahimi & Sarirete, 2015; Chin & Chen, 2013; de Sousa Monteiro, Gomes & Neto, 2016; Ke & Hsu, 2015; Reychav & Wu, 2015; Sung, Chang & Yang 2015).

Educational platforms such as EdX, Edmodo, Haiku learning, and Schoology are all platforms available for classroom usage. Applications can also be used as an educational medium. Kahoot is an application developed for mobile devices to create questions learners need to answer in a competitive game scenario. Mobile devices (smartphones and tablets) can be used to access different platforms or download applications. This increases the efficiency of accessing educational information because the platforms can be accessed in- and outside of the classroom.

The following section focuses on science education specifically, as the subject content of this research is based in physical science.

2.5. Science Education

2.5.1. Introduction.

Science education in South Africa is a major concern (Areff, 2015; De Beer, 2016; Govender, 2016; Wilkinson, 2014). Education in South Africa faces many challenges and concerns withholding children from being educated. The quality of South African education is a major concern as South African education is encountering a shortage in skilled and qualified teachers. This leads to the next concern, learners are encouraged to pursue higher education and therefore they are required to have obtained the necessary skills and abilities. South African education cannot maintain a sustainable source of education, resulting in an increase in illiteracy. Today, education in classrooms bring more challenges due to multicultural classrooms. Teaching methods, content and approaches should include all cultures to involve every culture (Ramdass, 2009; Viljoen, 1998).

When analysing the South African education system and being subject specific, the results testify about the educational concerns. Physical science in South Africa is something to be concerned about (Kriek & Grayson, 2009). South Africa, like many other countries, have participated in TIMSS – Trends in International Mathematics and Science Study, where countries are given a benchmark test and countries are ranked according to performance. According to the results, South Africa was placed near the bottom in mathematics, science and in combination (Martin et al., 2012). This is clearly alarming and requires attention to improve mathematics and science teachers, requiring an increase in learners' performance. Although guidance is available to improve science teachers and their abilities of teaching, not many research focus on using technology as an aid but rather skill and cognitive development (Kriek & Grayson, 2009; Makgato, 2014). Science education requires a certain level and process of thinking and the process can be taught through various methods.

2.5.2. Active learning.

Active learning is considered a teaching method different to the traditional passive learning seen in classrooms and is not restricted to subjects. Teaching Science can make use of an active learning approach. Therefore, active learning allows for more interaction amongst teacher and learners. To incorporate active learning into classrooms, discussions, experiments, group activities, interactive problem solving and exercises can be implemented. Similar methods will not be sufficient for all teachers, therefore it is important to use an active teaching method, or a combination of methods until the best-suited methods are adopted. Active learning is more effective than the traditional passive teaching methods, as it allows learners to interact and discuss situations or problems. These problems or situations can be related to real-life problems (Mathias, 2014; Freeman, et al., 2014).

2.5.3. Inquiry learning.

Inquiry learning is a teaching approach that encourages learners to question, investigate and answer questions. Investigating problems and seeking answers requires learners to think critically. Science education promotes critical thinking. This approach places the learner's question at the centre of the curriculum. Problem-based teaching is another term used for inquiry learning. Even though the learner's question is the most important, teachers need to guide and instruct education to ensure goals and outcomes are reached. Because the learner's question is the most important, teachers use an alternative method (Guido, 2017; Towns & Sweetland, 2008).

In most cases teachers assumed an authoritative position, enabling them to communicate with learners, but response is not seen as valuable. Teachers tend to explain content to the best of their ability and proceed to examples or calculations, leaving learners with very little input. Learners are required to retain the content, even though they might not understand it. Therefore, teachers can place themselves alongside learners to guide them during the inquiry rather than prescribing (Botha & Onwu, 2013; Msimanga, 2013).

2.5.4. Authentic learning.

Authentic learning can be described as a designed teaching method connecting content learners were taught in classrooms to the real life issues, problems and situations. Four themes should be kept in mind when applying authentic learning: 1) involve real-life problems in classrooms, 2) enhance thinking skills, 3) allow learners to engage socially, 4) the outcome should focus on project work (Rule, 2014; Shaffer & Resnick, 1999; Towns & Sweetland, 2008; Botha & Onwu, 2013).

Whatever the method, according to the Department of Basic Education (2012) the curriculum aims to ease the transition between education institutions to workplace, provide employers with learner profiles, and to provide a possible opportunity to tertiary institutions. The curriculum is based on certain principals and it is the responsibility of teachers to evolve these in learners. Some of the principals contain: being a critical reader, developing skills, progression between grades, appreciation of indigenous knowledge, religion appreciation, and human, social and environmental responsibility. Skills learners are required to obtain are: identifying and solving problems, working efficiently as a group member, organising and managing oneself, collecting and evaluating data, and to use science and technology with responsibility towards the environment and health of others. (Department of Basic Education, 2012).

The curriculum has prescribed skills and abilities learners are required to obtain, time allocation for different subjects, time allocation for different topics within a subject, minimum assessment, types of assessments, and processing marks for term and end of the year results. All the requirements can be met by making use of different teaching strategies. The curriculum does not prescribe the teaching strategy, only the skills and abilities. (Department of Basic Education, 2012).

Even though guidance is given to improve science teaching and making use of technology in classrooms, some teachers have already incorporated technology. The teachers prepared projects for learners using technology and required completion by making use of the technological process (Kok & van Schoor, 2014).

According to Telkom (2015), technology should be incorporated into South African education, due to its benefits. Technology can incorporate many different teaching methods such as communication and collaboration, allowing learners to communicate

and interact amongst teachers and learners to enhance effective learning. Open Education Resources can be used for ubiquitous learning by developing virtual classrooms which learners can access anytime. Learners who are not educated by teachers can make use of Open Educational Resources to obtain the necessary knowledge from the comfort of their own home. Because the information remains on the Open Educational Resource until removed by the teacher, it is a sustainable source of education. Problems with textbooks not being delivered to schools can be solved by having textbooks electronically for anytime access.

A gap in the literature is identified when searching for science education. In most cases, science education refers to natural science for Grade 8 and Grade 9 learners, or life science for Grade 8 to Grade 12. When searching the literature for physical science as subject, Grade 11 learners, technology incorporated, in South Africa; not much literature is available.

The following section describes the model used to design an interactive Open Education Resource for a Grade 11 Physical Science intervention.

2.6. ADDIE Model

An intervention was planned for this research, to investigate the incorporation of technology in an online learning environment for physical science learners in the FET phase (Grade 11). This process was executed by making use of the ADDIE (Analysis, Design, Develop, Implement, Evaluate) model.

2.6.1. Introduction.

Instructional design can be described as a systematic process to design and develop educational and training courses or programs. These designs make use of specific methods, and if used, result in acquiring knowledge, skills and attitude (Instructional Design Central, 2018). The ADDIE model is an instructional design model and was selected for this research due to the phases and the cyclic process. These phases and cyclic processes allowed for the intervention to be designed, developed and implemented before being analysed. After analysis, the intervention was re-designed, developed and implemented.

Branson, Rayner, Cox, Furman and King (1975) developed the ADDIE model as a cyclic process and it has since then been used in multiple studies by different researchers. Most of the researchers or users have made small alterations to fit them best. ADDIE is a five stage model with the following stages: Analyse, Design, Develop, Implement and Evaluate.

The ADDIE model is illustrated by Figure 5.

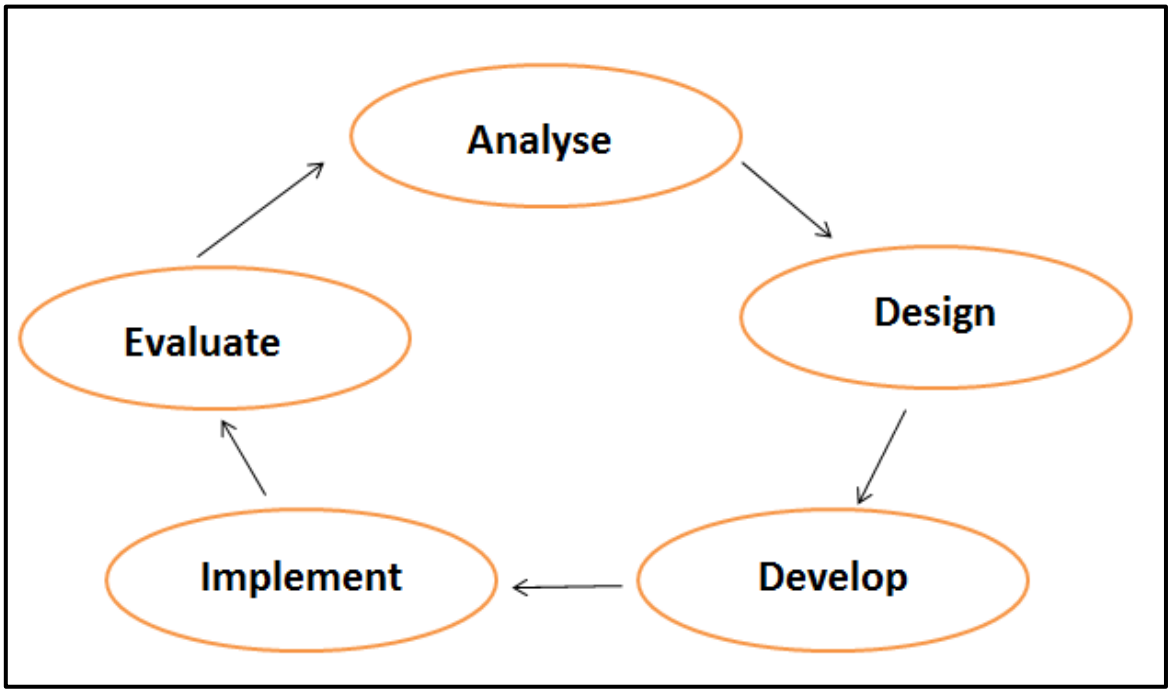


Figure 5: ADDIE model

Source: Welty (2009).

Figure 5 illustrates the cyclic process of the ADDIE model starting with analysing a problem and ending in evaluation, before the process repeats itself.

2.6.2. Analyse.

The analysis stage identifies problems, performance gaps or possible areas for improvement. These problems can be a self-observed phenomenon, or an indicated problem. The focus is to improve the problem situation through the process.

2.6.3. Design.

In order to solve the problems identified in the analysis stage, designing a possible solution is necessary. The design is a planned approach to bridge the performance gap, or to solve a problem that occurred.

2.6.4. Develop.

The planned approach is being developed from the start of the possible solution to the evaluation of the design. All methods, possible equipment, processes and executions are described.

2.6.5. Implementation.

During this stage, the approach is put into action. All planned steps are performed in the exact planned order.

2.6.6. Evaluate.

Lastly, the approach is evaluated. During this stage the approach is evaluated for any improvements that can be made, as well as strong points of the approach.(Branson et al., 1975; Welty, 2009).

Due to the cyclic nature of the ADDIE model, once all the phases have been completed the evaluation phase is followed by the analysis phase. During the first cycle a problem is indicated and for that problem a possible solution is selected. The planning of the solution commences and is followed by the implementation. Evaluating the entire process to determine possible alteration or improvements to be made is the final phase. The cyclic process continues and the next problem or difficulty is identified resulting in implementing the ADDIE model a second time (Branson et al., 1975; Molenda, 2003; Welty, 2009).

2.7. Conclusion

For many years information has been transferred from person to person as in education. Differences in teaching methods and strategies occurred due to available resources, the preference of each individual teacher, and the prescribed methods from the curriculum. Teachers altered methods and strategies to match their needs.

Incorporating technology into classrooms can be beneficial, if it is managed and the teaching method accommodates the use of technology. A variety of methods can be used for incorporations. Community of inquiry framework accommodates the use of mobile devices. The social aspect of the framework allows for the use of mobile devices, because learners can communicate and interact socially through mobile devices.

The next chapter presents the research methodology followed during this study.

3. Chapter 3: Methodology

3.1. Introduction

In this chapter the research design, research philosophy, research approach, conceptual framework, research strategy, population and sample, ethical considerations, data collection method and data analysis will be discussed. This chapter describes the process of the research from the developing stages to the execution of the research and the data analysis.

Figure 6 presents the layout for the methodology.

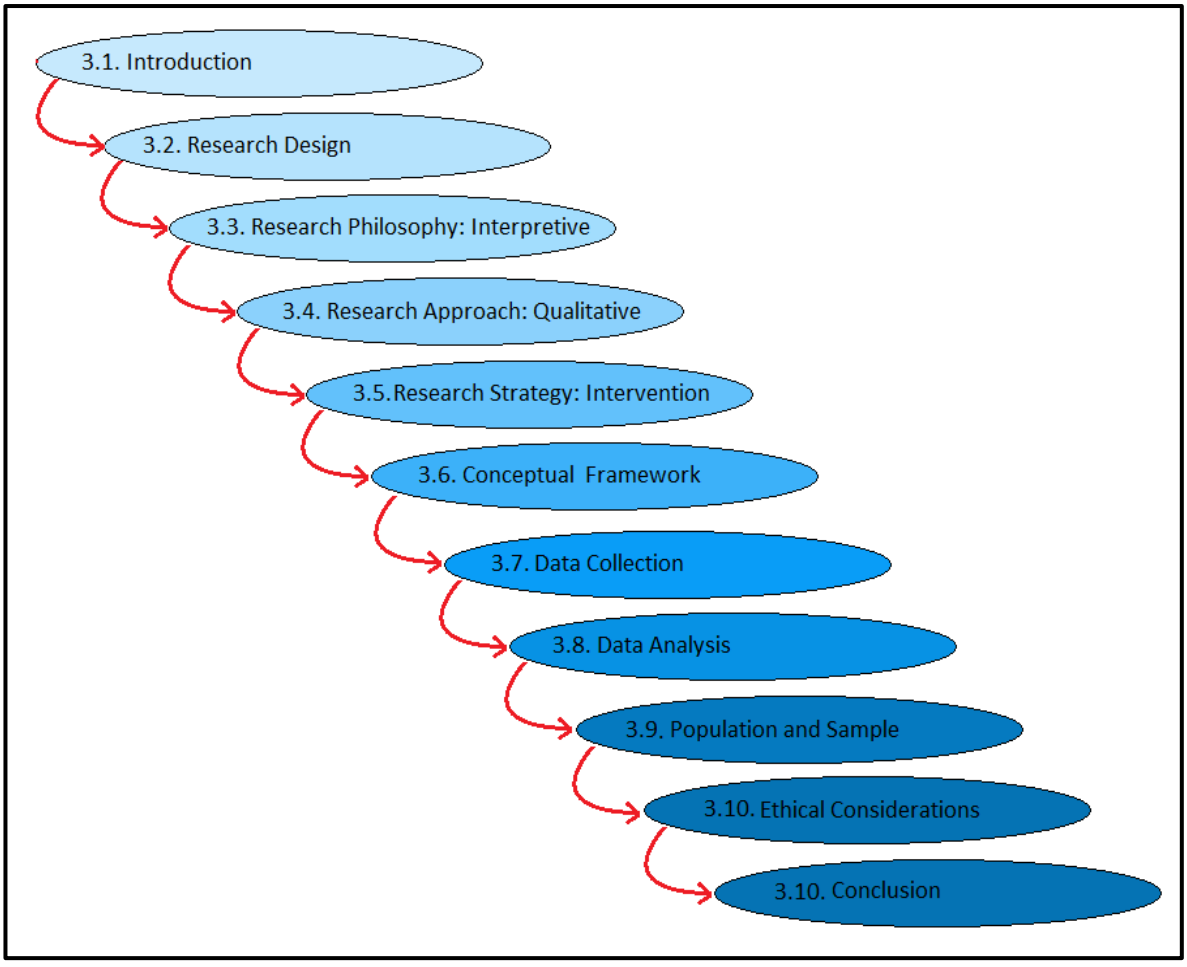


Figure 6: Methodology diagram

As indicated in Figure 6, the methodoloy chapter commences with the research philosophy followed by the approach and strategy. As each step progresses to the following the decisions made also progress from abstract and high level to the more practical.

3.2. Research Design

Saunders, Lewis and Thornhill (2009) developed an “onion” to support business students in the design of their research. Starting from the outer circle, each layer describes another section of the research process. The effectiveness of the research onion is that each subsequent layer supports decision-making towards more detailed aspects of the research. Due to the adaptability of the research onion, it can be incorporated and adapted for a variety of fields. The following diagram was adapted from the research onion and applied to this study.

Figure 7 depicts Saunders et al.’s (2009) research onion.

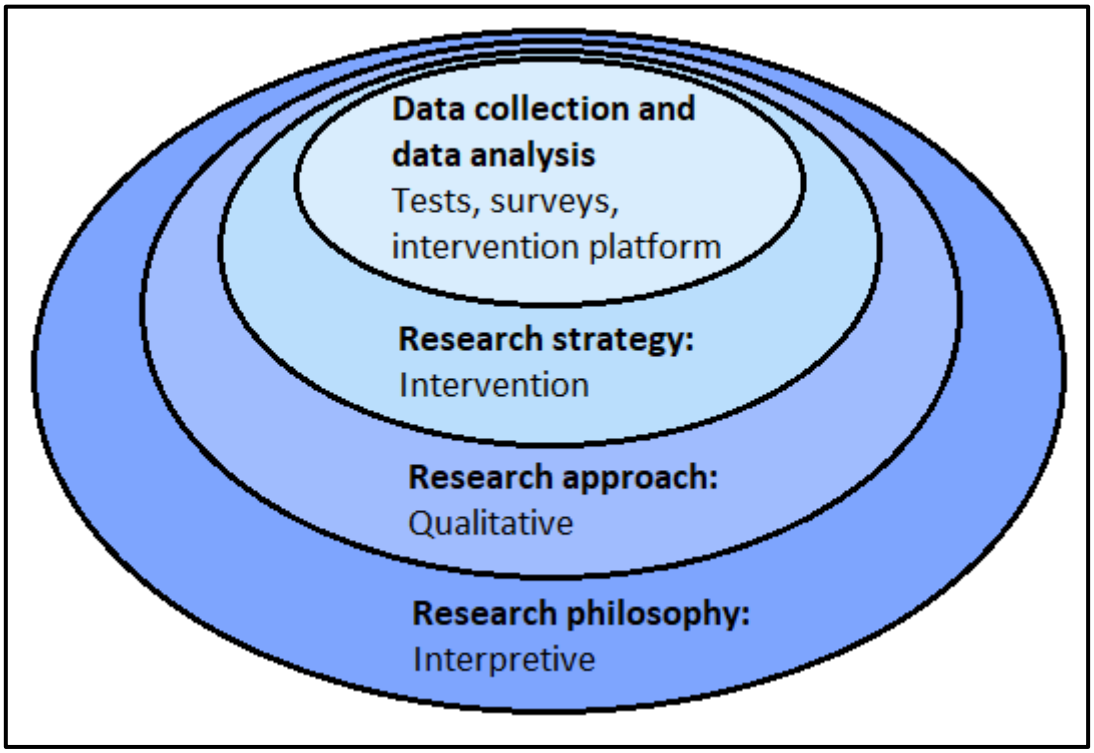


Figure 7: Research Onion

Source: Saunders et al., 2009

Figure 7 starts with the outer circle which is a broad perspective and as one progresses towards the centre of the circle the topic becomes more focused and specific.

3.3. Research Philosophy: Interpretive

Any research is based on philosophical assumptions, as these assumptions are what is believed to be true. Depending on the aim of the research, different philosophies will be used. Each philosophy has advantages and disadvantages due to how it is implemented and the methods followed. This research made use of an interpretive philosophy. Interpretivism focus on the understanding, rather than explaining, of a specific phenomenon. Understanding a specific phenomenon requires involvement of the researcher and his or her views and beliefs. In order to understand the phenomenon an in depth research is required, as it generates information rich data, therefore qualitative data is accentuated. Interviews and observations are two data collection approaches noteworthy of qualitative data (Dean, 2018; Packard, 2017; Thanh & Thanh, 2015).

According to Klein and Myers (1999) seven principles are crucial to evaluate interpretive studies. These principles are the fundamental principles of the hermeneutic circles, contextualisation, interaction between the researchers and the subjects, abstractions and generalisation, dialogical reasoning, multiple interpretations and suspicion.

Fundamental principles of the hermeneutic circle

In order to comprehend and understand a situation or content we need to iterate between the meaning of individual parts and the situation as a whole (Klein & Myers, 1999).

Contextualisation

The social and historical background of the research should be critically analysed, in order for participants to understand the current research.

Interaction between the researchers and the subjects

Due to the interaction, the research data requires critical reflection of the interaction between the researchers and the subjects.

Abstractions and generalisation

Before data can be revealed, the interpretation of the data due to various principles and the generalisation of concepts needs to be described.

Dialogical reasoning

Refers to the management of possible contradictions between theory and actual findings.

Multiple interpretations

Although the data might remain the same, the researcher should be open to different interpretations of the same data.

Suspicion

This requires sensitivity of the researcher to possible biases. (Klein & Myers, 1999).

A discussion on the application of these principles is presented in Section 5.4.2

As mentioned, the selected philosophy is interpretive research. The reason being, the problem learners are having with education are effecting their results and by understanding the problems, possible solutions can be developed. By using surveys, insight can be gained towards the problems and according to the responses of the surveys, the virtual classroom is developed.

3.3.1. Advantages.

An advantage of interpretive research philosophy is comprehensive research, since it produces rich data for analysis. Reactions and experiences of people are crucial as this is the data the research is based on. The truth of any research will never be revealed, since each person will focus on different aspects to gain information, and validity of the research can be increased by several methods.

Interpretive paradigm is merely the perception of the researcher of a certain event based on observations. However, the findings could be similar to previous research on the same topic, even though researchers differ (repetitiveness of the researcher).

The other limitation is subjectivity of the research because observations are made through the perspective of the researcher, each individual having different views and beliefs. Analysis of the data tends to be more objective than the process of data collection (Creswell, 2011; Di Fabio & Maree, 2012; Jansen, 2007; Mack, 2010).

3.3.2. Disadvantages.

Key disadvantages of interpretivism are associated with the subjectivity of the approach mainly due to the partiality of the researcher. Data generated through various data collection approaches cannot be generalised as values and personal views are integrated into the data. Similar to the biased data, hypotheses seldom feature since subjectivity might alter views and understandings or cause misinterpretations. Therefore, the experiences of the participants should be observed. The subjectivity of people differs and the focus of each researcher is different, consequently different researchers will not value the same data as important, or make exactly the same conclusions from the exact same data. Observations and interpretations cannot be done objectively, hence the researcher is obliged to observe and interact through the perspective and experience of the participants, but elucidate his/her views and beliefs through which observations are made. Even though data collection tends to be subjective, data analysis, interpretations and conclusions can be more objective (Jansen, 2007; Mack, 2010; Maree & Van der Westhuizen, 2007; Morgan & Sklar, 2012).

One of the disadvantages of interpretive research is subjectivity. During the research the researcher did not socially interact with participants, unless participants needed guidance or assistance was being requested. This reduced the subjectivity of the researcher when observing and interpreting the data. Another disadvantage is the subjectivity when collecting data, therefore quantitative data is included in the research. By including quantitative data the results of the quantitative and qualitative data can be compared for correlations of differences.

3.4. Research approach: Qualitative

The proposed research approach that was used to conduct the research was a qualitative approach. Qualitative research can be described as: the inquisitiveness of a person to understand certain phenomena and experiences of people. It is known for its in-depth research and the findings because of the research instruments used. Because of the in-depth research, qualitative research offers rich data on a certain topic, which can only be done through interviews, focus groups, observations and surveys as the data collection methods (Nieuwenhuis, 2007; Theron & Malindi, 2012).

Each research topic leans itself towards either qualitative, quantitative or a combination research approach. A qualitative research approach determines the appropriate research strategy, data collection methods, sample size, ethics to consider and limitations of the research (Nieuwenhuis, 2007).

The results of the qualitative approach should be credible and trustworthy, if every step was followed. To increase trustworthiness, different research methods should be incorporated with each other to broaden the number of research instruments that can be used. In addition, crystallisation refers to the idea of thinking about a concept not only as a three dimensional object, but as a crystal with multiple faces and angles. When applying crystallisation, a phenomenon is investigated from multiple angles by making use of different methods. Observing or studying a case from multiple perspectives provides a much deeper and richer data (Nieuwenhuis, 2007). Methods such as surveys, tests and data from the intervention were all used to enhance the trustworthiness of the research. Each individual method could be seen as a different approach to the data collection step, and serves as the different faces of a crystal. The data was compared to determine the correct answer and result in the findings of the research.

A major concern of qualitative research is subjectivity, because the researcher can get too involved, resulting in erroneous data. The results of the research sanction an insightful understanding of a specific phenomenon and therefore cannot be generalised to the population. Validating the results was more complex since the data reveals how a phenomenon was observed and recorded though the perspective of the

researcher (different researchers would value different aspects more or less important than others), and skills were required for a more professional interaction, such as: questions were well constructed, showed appreciation of the participants, listened to what was said. (Theron & Malindi, 2012).

3.5. Research Strategy: Intervention

This research aimed to determine the effect of using technology as an alternative teaching method through social learning. Intervention strategy was used in this research. An intervention research is a deliberate change or alteration between data collection processes, and the data before the intervention is compared to the data collected after the intervention. Comparing the different sets of data provided insight on the effect of the intervention. The reason for the data comparison is to have data before the intervention and compare it to the results after participants encountered the intervention. By comparing the results the effect of the intervention could be determined (Fraser & Galinsky, 2010).

The intervention phase of the research was the virtual classroom learners used. Because the virtual classroom was not used in the classroom of the researcher, the intervention was an extra teaching instrument. By making use of the intervention outside of the classroom, the alternative teaching instrument was the deliberate change required for an intervention strategy.

Although the research strategy was an intervention strategy, the ADDIE model (Branson et al., 1975) was applied to develop the intervention. The ADDIE model is a cyclic process of analyse, design, develop, implement and evaluate. After evaluation the analysis phase commences and a new problem or concern is identified.

The ADDIE model is an instructional design, usually for online courses, as described in Section 2.6. Since the intervention was an instructional online course, the ADDIE model was used to design, develop and implement the online course. After implementing the course, it was evaluated to determine possible changes and alterations for improvement. Because the ADDIE model is a cyclic process the online course can be implemented for a second time, including improvements as identified in

the evaluation phase of the first cycle. The data obtained from the cycles included different tests, surveys, observations and data recorded by the learning platform, all of which could be compared.

Figure 8 is an illustration of the intervention phase as designed through the ADDIE model.

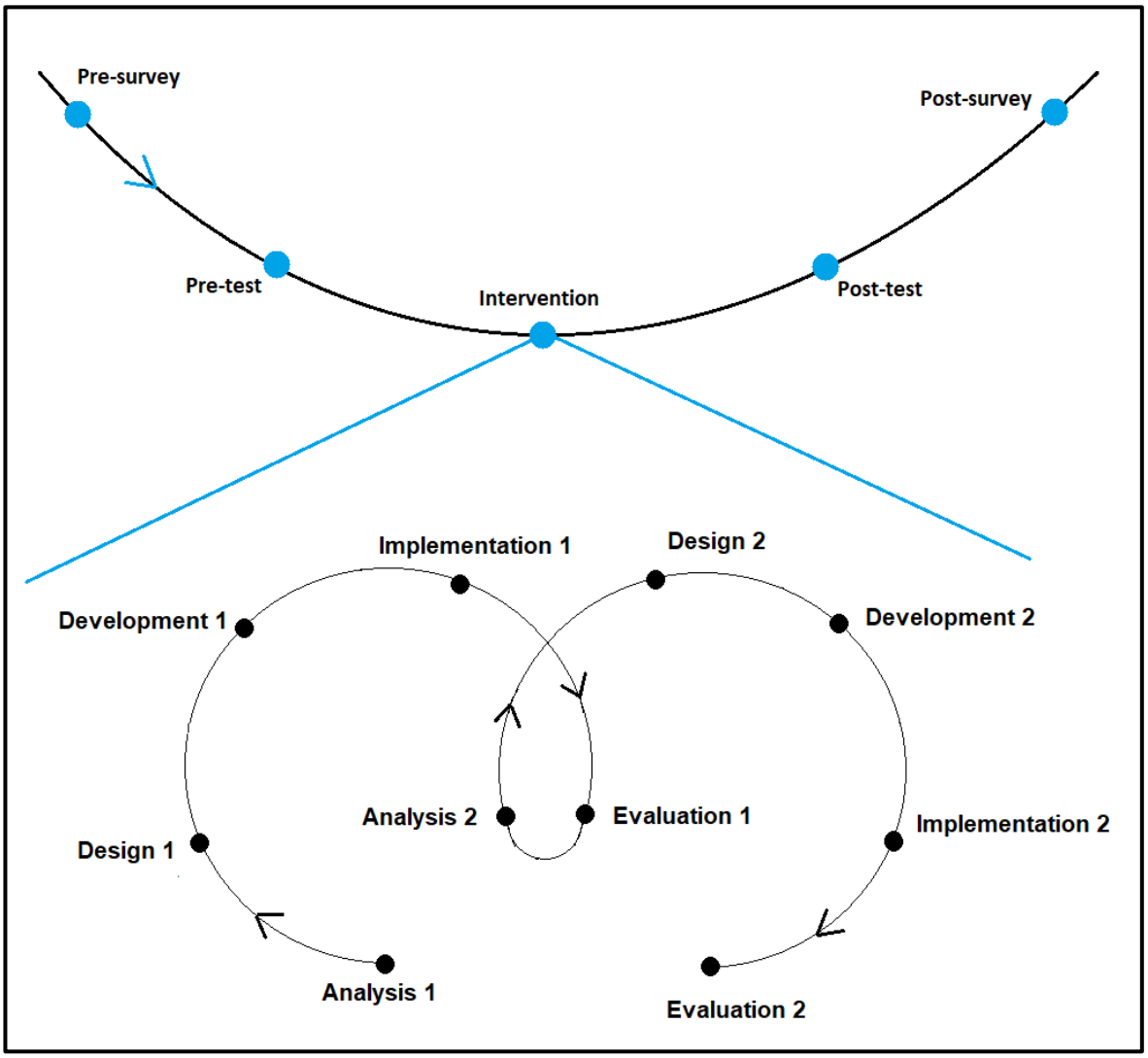


Figure 8: Intervention process

Figure 8 starts with a layout of the data collection steps starting with the pre-survey and ending with the post-survey. The focus is on the intervention phase, therefore the intervention phase is unraveled and displayed in the cyclic process. The first step of the ADDIE model is analysis. It is number “1” because the intervention was conducted a second time. The ADDIE model is a cyclic process and therefore the intervention

was illustrated in a similar fashion. After evaluation 1, the second intervention phase started and the ADDIE model repeated itself. **The results and findings of the first research cycle is discussed in Section 4.2 and the second research cycle in Section 4.3.**

Analysis 1

A concern or problem raised about learner performance that was linked to the **analyse** stage of the ADDIE model, was that learners did not perform academically in physical science as subject. Pass rates are decreasing and school standards are lacking (Coetzee, 2015; Cupido, 2016; SADOU, 2017; SAPA, 2015). This is due to learners not receiving education due to various reasons, or the education learners receive is inadequate (Considine & Zappalà, 2002; Mji & Makgato, 2006; Mushtaq & Khan, 2012; Taylor, 2008; Wanyama, 2013).

Design 1

The problem initiated the **design** stage where a possible solution was cautiously considered and designed. As designed, the possible solution was to incorporate mobile devices into education to provide learners with ubiquitous learning. Learners had the opportunity to access educational content using mobile devices and communicate with peers or the teacher for any questions or requesting assistance. Many factors were considered upon designing a possible solution such as availability of smartphones, usage, the social media profile of learners, and interest in a virtual classroom. An educational platform such as Edmodo, Kahoot, EdX or Haiku was considered for the development of the virtual classroom, all of which have advantages and disadvantages. After comparing platforms, Haiku learning was the selected platform for the virtual classroom, as the platform is free to use, provides access to content delivery, has interactive teaching elements and social learning elements, as well as participative data collection.

Development 1

After understanding the aspects of the problem, as well as having more detail about the design, the selected and designed solution was **developed**. Haiku learning was the selected platform and the researcher gained access through registering as a teacher. All facilities were available to the researcher for constructing the virtual classroom. Newton's first, second and third law were the selected topic to base the classroom upon. Each law was developed into its own online course starting with an introduction and ending in a discussion. Even though each course could be constructed individually and differently to previous courses; the layout of the courses remained the same for all the courses. Each course started with a downloadable PowerPoint document, followed by the introduction containing theory promoting the cognitive presence. Throughout the theory downloadable examples of questions were available, where possible. Links to simulations about the topic were placed for learners to gain a visual representation of the content. YouTube videos were linked to different scenarios and explanations were provided for learners to view. Lastly, each course contained a discussion for learners to interact and communicate with peers, promoting social presence, or the teacher, referring to teacher presence. Before implementing the virtual classroom, the classroom was piloted to establish any ineffective links.

Implementation 1

Following the development stage, was the **implementation** stage where the virtual classroom was activated for participants' usage. Participants were required to complete the pre-test before engaging the virtual classroom, to establish a benchmark. Afterwards the use of the virtual classroom was promoted and participants were encouraged to take part. Learners could access the virtual classroom at any time of day. The learners were encouraged to make use of the virtual classroom and to use the discussion for questions or problems. Even though the virtual classroom was promoted and the participants were encouraged, participation remained voluntary. The duration of the active classroom was two months, after which it was deactivated.

Evaluation 1

The effectiveness of the virtual classroom was **evaluated** during the last stage. Learner participation was not what was expected and participants did not engage in discussion or make full use of the virtual classroom.

Analysis 2

Since participants did not engage with the virtual classroom that much, modifications and changes were considered to improve the learner participation and social interaction of the learners. The concern initially identified still remained, but the lack of learner participation was raised after the first cycle of the intervention. Learners did not participate as regularly as what was initially expected, even though learners were reminded to make use of the virtual classroom. In order to determine the effectiveness of the intervention, learners had to participate.

The second cycle of the ADDIE model focused on the lack of participation.

Design 2

After the first cycle the virtual classroom was re-designed, therefore the same classroom would be used but with the necessary changes. An idea of a solution was to influence the learners to make use of the virtual classroom. The designed strategy was to develop preparation tests learners could use, providing them with an indication of their understanding of the content prior to formal school assessments. The test questions were cautiously considered to improve cognitive presence. Additionally, a question was included which learners were required to answer and discuss amongst peers to enhance the social interaction. By requesting learners to engage in communication and interaction, the social presence of the research was revealed. Each question was based on the specific Newton's law. Lastly, instructions were included before every heading to guide participants what to do. The teacher was involved in the design process and available for assisting learners, thus promoting teacher presence.

Development 2

In order to improve the virtual classroom, the different tests and questions needed to be developed and included into the classroom. Three different tests were developed and incorporated into the virtual classroom. Each participant's activity, progress and scores for the different tests were captured by the Haiku learning platform. A question was developed and included before the discussion for learners to answer and discuss any uncertainties or to assist peers. The instructions were incorporated before every heading to guide learners through the virtual classroom.

Implementation 2

The virtual classroom was implemented and made active for learners to use, after all the alterations and modifications were made. Learners were encouraged to make use of the virtual classroom and they were informed about the tests, questions, better layout and more user friendly design.

Evaluation 2

After the second intervention, the virtual classroom was deactivated and the results recorded by the platform were retrieved. The data recorded by the platform included: each learner's activity on the virtual classroom, amount of time spent, links followed, documents downloaded, tests entered, tests completed, test scores, activity and answers to the question and interaction amongst learners. This data was analysed to determine the effectiveness of the virtual classroom.

3.6. Conceptual framework

According the framework of Garrison (2007) the community of inquiry, as discussed in Section 2.3, is an online learning research tool. The online component of this research is the intervention phase, when participants logged onto and made use of the virtual classroom. Mobile devices such as smartphones and tablets were used to access the virtual classroom.

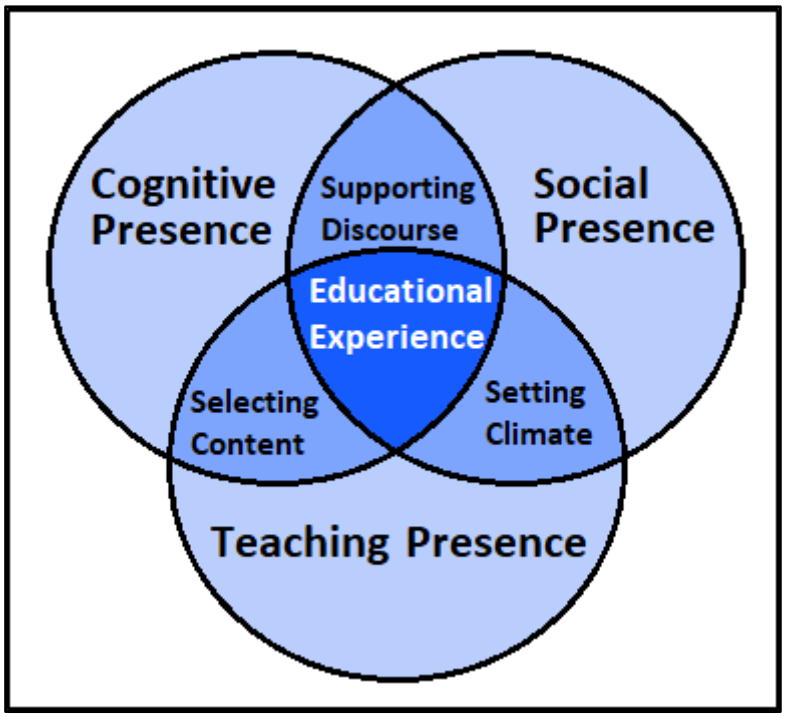


Figure 9 : Community of Inquiry

Source: Garrison et al. (1999).

Cognitive-, social- and teacher presence are the three main facets of the framework, as identified in Section 2.3.2. Cognitive presence refers to the ability of learners to think critically by assessing a problem or issue, exploring the problem, producing a possible solution and applying a solution, as well as exploring the content selected and prepared for teaching. Critical thinking is an aspect addressed in the research as learners are required to scrutinise any problem or question rather than memorising answers or methods. Participants encountered problems or issues they needed to solve as they progressed through the module. Questions from the pre- and post-test required participants to understand the problem and provide a possible solution by choosing the correct answer.

Secondly, social presence refers to interaction and communication where content is discussed and explained to learners, as well as being exposed to different opinions and views. Participants were encouraged to communicate with others by explaining their views, providing assistance to peers, and acquiring correct methods and answers from peers and if not, the researcher intervened. At the end of each module a

discussion was available for participants to communicate and converse, linking to the social presence of the community of inquiry framework.

Lastly, teacher presence is required for teachers to be present to select content, facilitate learning and create a learning environment. As for the research, the topic of Newton's Laws was used to design and develop the necessary modules, create assessments and was used during discussion to assist learners. The social presence required participants to socialise and for that reason a discussion was created. Even though the discussion was created for participants to converse, the researcher was present to ensure the advice and assistance was scientifically accurate. The researcher aided participants with hindrances they encountered.

Since the Community of Inquiry framework is not restricted to a specific age, grade, field or topic, the framework was applied only to physical science Grade 11 learners in a school in Pretoria.

Every two aspects intersecting creates an area of a combination of the two aspects. Ideally, the area to function at is the intersecting area of all three aspects, called the "Educational Experience". Each aspect requires certain attributes in order for the framework to be effective, as identified in Section 2.3.2.

Areas where conceptual framework is incorporated.

Table 2: Areas where conceptual framework is incorporated

Conceptual framework aspect	**Area where incorporated**
Teaching presence	• Design, development and implementation of virtual classroom. • Creating of tests, surveys and interventions. • Encouraging interaction. • Available for learner's assistance.
Cognitive presence	• Types of question in pre-, and post-test. • Questions in the preparation tests on the virtual classroom. • Question learners were required to answer and interact with one another. • Content and layout of the virtual classroom.
Social presence	• Interaction between participants. • Interaction between participants and teacher. • Motivation to communicate and interact. • Question included to enhance interaction.

3.7. Data collection

Qualitative research was used during this study. Although qualitative research was used, quantitative research was also incorporated to confirm or contradict the finding of the qualitative data. The quantitative data contributed a small part of the data. The results of the qualitative research produced deep and rich data gathered from participants. Data was acquired through pre- and post-surveys, pre- and post-tests and the data recorded on the virtual classroom.

To gain understanding of participants' experience about a certain phenomenon, qualitative data and results were required. This required questioning of participants,

as data is indispensable. These questions were not asked at random, but rather had a structured format to enhance progression and understanding. If well-constructed and planned, questions should encourage openness between the researcher and participants and allow participants to explain or expand on a topic. Researchers are required to avoid pre-judgments as it can result in selective recording of data. Researchers need to develop the skill to really listen to what has been said and the manner in which it has been said (Theron & Malindi, 2012).

Making use of qualitative research approach requires certain data collection methods. The following diagram illustrates the procedure followed, in order, to collect all data during the research.

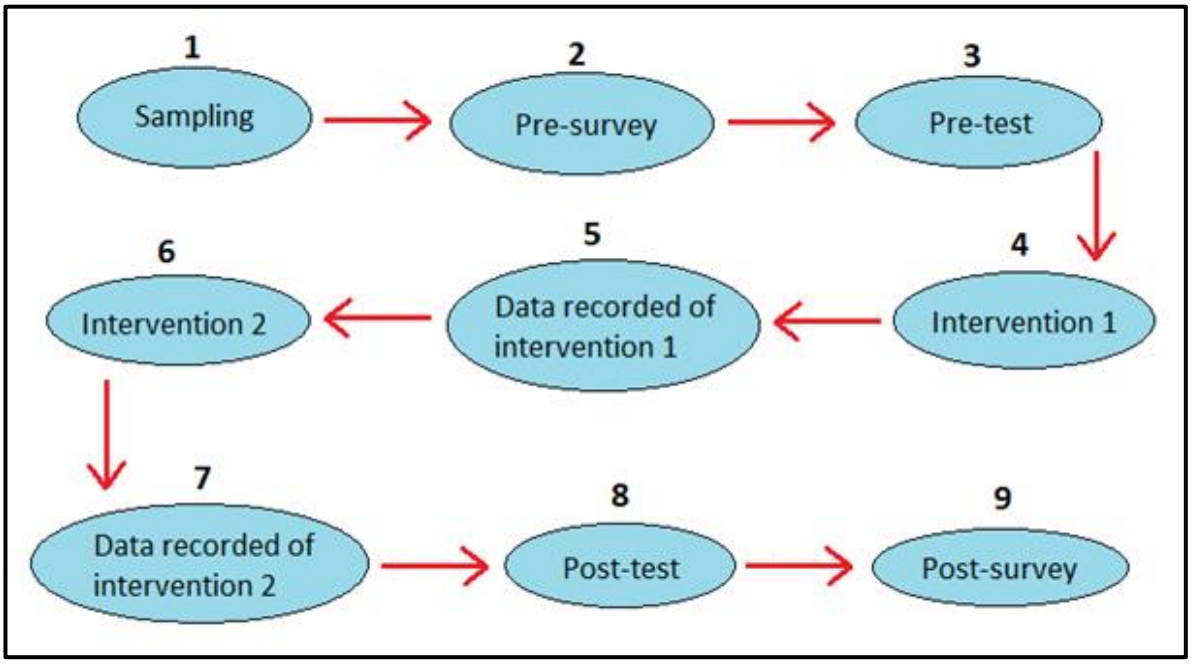


Figure 10: Data collection process

In Figure 10, the design for the data collection process is illustrated.

Phase 1 – All Grade 11 physical science learners were approached and those interested were the sample group. Consent forms from both parent and learners were a requirement.

Phase 2 - the participants completed a pre-survey (phase 2). This survey's purpose was to gather information about social media, mobile device usage, study preferences and the response towards possible online classrooms. This data was used to design

and develop the intervention of the Haiku learning platform. All participants complete a pre-test (phase 3) based on Newton's laws, as this test served as the benchmark for the post-test. The intervention phase commenced (phase 4) and the participants were given the opportunity to make use of the virtual classroom and all its features. After a period, the intervention phase ended and the data recorded by the platform was gathered (phase 5). This data contained all the activities of each individual participant. The intervention was modified, altered, improved, and implemented once more (phase 6). Participants were encouraged to make use of the virtual classroom and engage in communication and interaction amongst peers. Once again, the intervention phase ended and the data recorded by the platform was gathered (phase 7). All participants completed a post-test (phase 8), as this results were compared to the pre-test to determine the significance of the virtual classroom. Lastly, participants were requested to complete a post-survey. The post-survey (phase 9) focused on learner experiences and possible improvements to be made.

The pre- and post-test and the results recorded by Haiku learning were more objective because each question had only one correct answer and the platform recorded every activity in the virtual classroom. Only the pre- and post-surveys were more subjective. Even though some of the questions were only a choice between what was given, other questions required participants to explain and provide their opinion. In order to reduce the subjectivity of the researcher the post-survey was answered and completed on Qualtrics. Qualtrics is an online platform created to capture and analyse qualitative data and provided the researcher with sufficient data. The pre- and post-test were used for comparison purposes to determine the effectiveness of the virtual classroom, as well as to compare with the results gathered from Haiku learning and the surveys. Responses given in the surveys were compared to test results and numerical data gathered on Haiku learning to determine if the responses could be supported by qualitative data.

"Surveys are frequently used to describe attitudes, beliefs and opinions" (Seabi, 2012). Surveys were used to obtain information from a selected sample group. Conducting research using surveys can be done using a variety of methods such as questionnaires, telephone calls, postal mail, email, or face to face surveys. Each survey has its own advantages and disadvantages. Some advantages are: low costs

involved, participants are not bound to a certain time to complete the survey, answers may be more accurate if postal mail or email is used, the response time is immediate when using face to face and telephone surveys. In order for postal and email surveys to have their full effect people need to have postal or email addresses, they also have to be literate to read and answer the questions. Face to face surveys do have the drawback of being time consuming and not getting the number of responses, whereas telephone surveys are costly. Each survey does have the same goal to achieve and it is to gather information. (Maree & Pietersen, 2007).

3.7.1. Pre-survey.

Surveys, in this research, were used initially to provide information about each participant's use of technology, social media, study methods and materials and interest in a virtual classroom whereas the post-survey commenced after the post-tests for participants to provide the researcher with their opinion and feelings towards the Open Education Resource used in the intervention. The pre-survey was constructed to obtain information about how learners would like to learn, do they prefer a teaching method using a smartphone, ubiquitous learning, what they expect from such a virtual classroom, technological devices they possess and the usage of these devices. Different types of questions were asked, such as: dichotomous questions, multiple choice questions, ranking questions, closed-open questions, biographical questions, Likert scale questions and open questions. The pre-survey was compiled and then reviewed to ensure questions were asked to obtain rich data. Because the pre-survey was printed as a hard copy, participants were required to fill in and complete the pre-survey and return it to the researcher. These responses were used to design and develop the intervention.

Figure 11 is an illustration of the pre-survey analysis in terms of the conceptual framework.

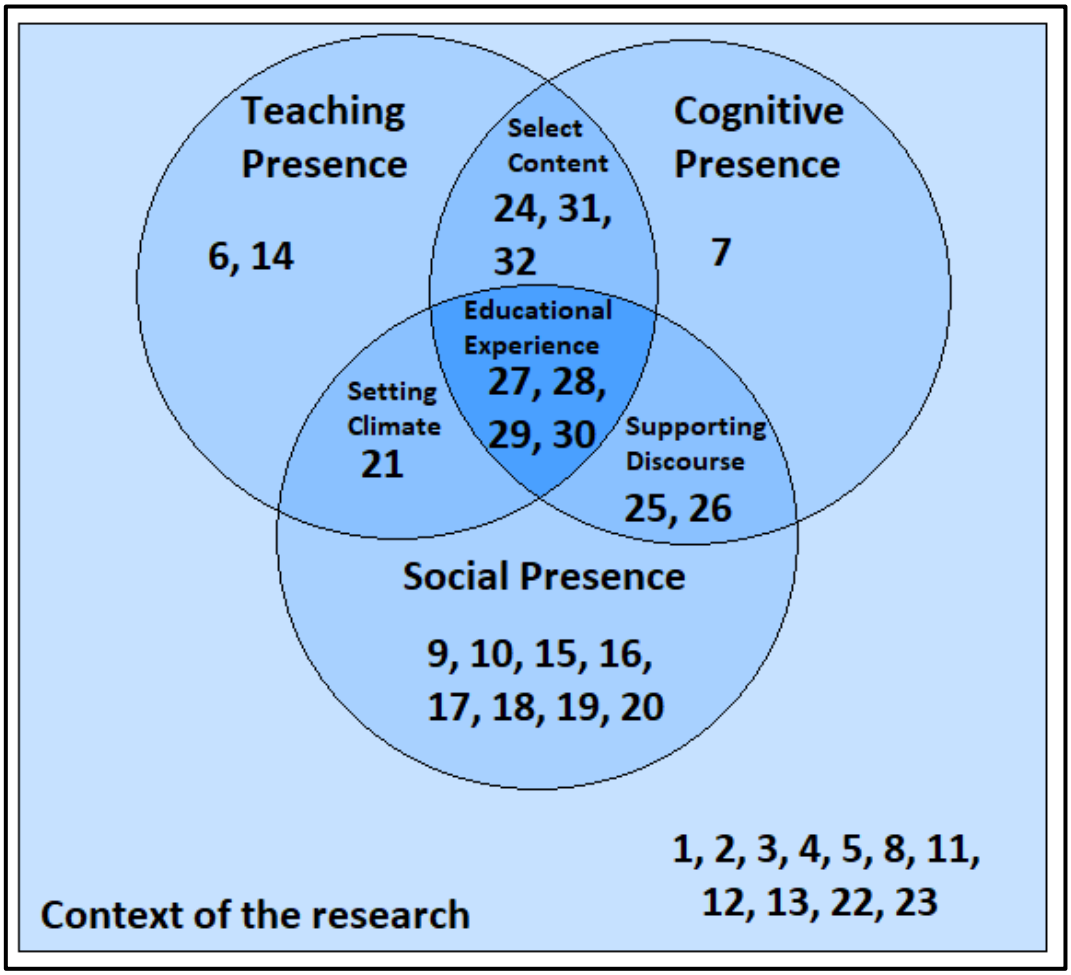


Figure 11: Pre-survey analysis according to the conceptual framework

The conceptual framework was used to analyse the question of the pre-survey and the numbers within the conceptual framework represent the question numbers.

3.7.2. Post-survey.

The post-survey was assembled to gain information about the participants' experience with the virtual classroom. Similar to the pre-survey, different types of questions were asked. Dichotomous questions, multiple choice questions, ranking questions, closed-open questions, biographical questions, Likert scale questions, semantic differential scale questions and open questions were all part of the post-survey. Reviewing the post-survey ensured the questions asked were appropriate and probable to deliver rich data. The main difference between the pre- and post-survey was the method of completing it. As mentioned, the pre-survey was a hardcopy that needed to be

completed, instead the post-survey was completed on a survey platform called Qualtrics. The responses of the pre-survey were later copied to Qualtrics. Qualtrics was selected because of the ability of the platform to analyse qualitative data. The data was available as sets of data or as graphs for each individual question.

Both pre- and post-survey were selected as data collection methods to gather data concerning learners' preferences when studying, the shortcomings they encountered, possible solutions they suggested, and what was expected of their performances and the extra teaching method.

Figure 12 is an illustration of the question analysis of the post-survey.

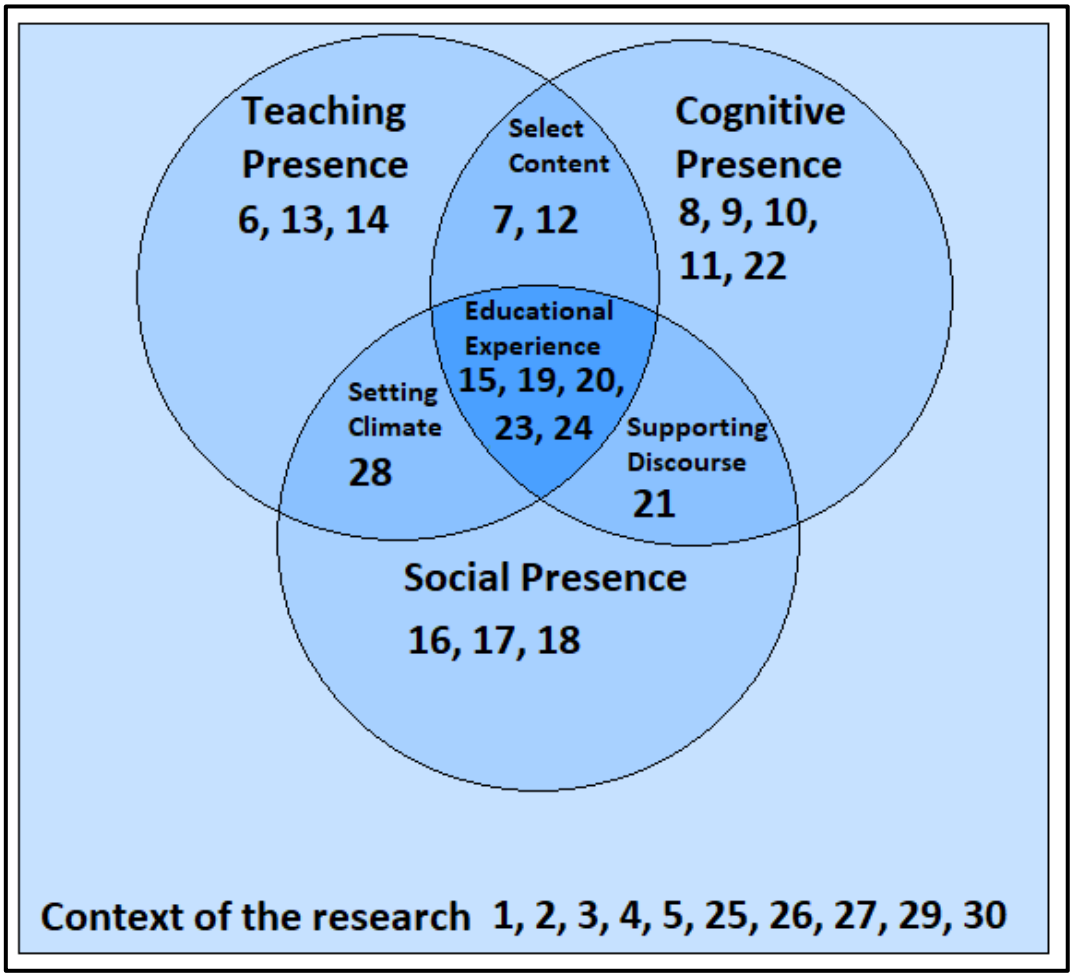


Figure 12: Post-survey analysis in terms of the conceptual framework

Each question of the post-survey was categorised within the conceptual framework, and the numbers represent the question numbers.

3.7.3. Pre- and post-test.

Quantitative data was described by Maree and Pietersen (2007) as the process to gather numerical data from a sample group to generalise the findings to the population. The qualitative data was incorporated in the research to determine the numerical value of the effect of the intervention by comparing averages, comparing individual participants' scores, and comparing scores of regular virtual classroom participants to once-off users. The pre- and post-tests were exactly the same test by design for comparison reasons. After designing the test, it was reviewed by a subject specialist to ensure content accuracy, memorandum correctness, and diversity of questions and level of questions. Neither the pre-test, nor the post-test or any of the questions were ever explained to the participants. Although the content was explained in the classroom and available on the virtual classroom, the misconceptions and incorrect answers needed to be corrected through the virtual classroom. Questions for the test originated from the researcher and were compiled into the test. All thirty questions were multiple choice questions. Because the test consisted of multiple choice questions, the distraction options should be well thought through to ensure the cognitive presence of the research and the critical thinking of the participants.

After completing the test, it was reviewed by a subject specialist to ensure the questions asked were testing misconceptions of learners. The test was returned and the necessary changes were made before being reviewed for a second time. After the third time the subject specialist was satisfied and the test was printed. Before the participants received the test, it was piloted by learners not participating in the research. The purpose of piloting the test was to ensure all distraction options were selected by some of the learners. Distraction being selected indicated the possible correctness of the question, but due to a misunderstood concept, or information skipped the answer was incorrect. The results of the pilot indicated the section of all the options on all thirty questions.

Participants received the pre-test in exam rules and conditions, and were required to compete the test and return to the researcher. After the intervention the post-tests, the same as the pre-test, were distributed amongst the participants and were completed and returned to the researcher. Both the pre- and post-tests were marked using a memorandum and the scores were recorded for later comparisons and conclusions.

3.7.4. Intervention.

The intervention was the third data collection method. An intervention is a deliberate change in a method and by comparing the results prior to the change and after the change, the effect of the intervention can be determined (Fraser & Galinsky, 2010).

The ADDIE model (Branson et al., 1975) was used to develop the intervention phase through the Community of Inquiry framework. Analyse, design, develop, implement and evaluate are the steps for the ADDIE model. Although containing steps, the ADDIE model is a cyclic process and therefore repeats itself. The value of the repetition is to determine and identify problem areas with the possible solution to increase its effectiveness.

The virtual classroom was designed, developed and implemented to address the pre-assessed problem. After the first intervention the effectiveness was evaluated and the necessary changes and modifications were made to increase the effectiveness, change the layout, make it more user friendly and questions were included to increase social interaction. Haiku learning was the platform selected to design and develop the virtual classroom. Although many other platforms exist, Haiku learning was selected for the variety of aspects such as videos, audio, downloading of files, tests, social aspects and user friendliness. The virtual classroom developed on Haiku learning could be altered at any time, whether it is a detail within a section or rearranging the sections, it is user friendly for both researcher and participants. Haiku learning provided all aspects required for the virtual classroom including tests and discussion. A specific topic was selected on which to base the virtual classroom (Newton's Laws). Each section's layout was the same: it started with a PowerPoint document for downloading, it was followed by an introduction of the module, explanation of the content, examples, files for downloading (exercises or examples), explanation videos, simulations and a discussion for participants to engage in conversation about the topic.

The intervention period commenced and only participants were allowed access. After a time period of four weeks the intervention ended. Changes were required and therefore short descriptions were added to each section to guide participants as to what was required and what to do. To encourage participants to engage in conversation a question was added which they needed to answer, discuss possible

solutions and help their peers. Lastly tests were added for participants to test their knowledge of each individual topic. The intervention commenced a second time and after the period expired the results were recorded and compared. Haiku learning recorded every activity in the virtual classroom starting from the development of the virtual classroom until the end of the second intervention period. Data recorded included: activity in the virtual classroom, files downloaded, videos viewed, simulations encountered, participation in the discussion as well as answers on the question stated, completed tests and the obtained scores, as well as tests started but not completed.

The focus of the intervention was the answers to the question and the interaction between the participants, the discussions of the participants, observations made, and participant activity recorded by Haiku Learning.

3.8. Data analysis

The data collected in this research was qualitative data collected through surveys, and quantitative data collected through test results and data recorded by the Haiku learning platform.

3.8.1. Surveys.

Both surveys were designed based on the COI framework (Figures11 and 12). This supported the analysis process. Surveys were used to gain insight about what social media participants made use of and what they preferred. After learners completed the hard copy of the pre-survey, it was collected. The data was transferred to an Excel spreadsheet containing all forty participants and every response of the different questions. Qualtrics, a survey platform, was incorporated and used after the pre-survey was completed, therefore the post-survey was completed on Qualtrics whereas the pre-survey was a hard copy. After the use of Qualtrics commenced, the researcher created a profile for each participant for the pre-survey. The responses of each individual participant were copied without any alterations, modification or corrections to the profile of the corresponding participant on Qualtrics. Qualtrics analysed the data, and graphs were available based on the different responses to the questions. The graphs were mainly used to determine different phenomena amongst the participants.

The responses of the pre-survey were analysed to determine the number of participants with technological devices and internet access, as this was crucial for the research. The following responses were highly ranked: the interest in the virtual classroom as this indicated whether or not to design and develop the virtual classroom and the different social media accounts since it was considered for social learning.

After the post-survey was finalised, a survey was created on Quatrics and the questions from the post-survey were transferred to the online survey. An email containing a link to the survey was sent to each individual participant. The participants were required to follow the link to the survey and complete all the questions. As soon as the participants submitted the survey, the responses were recorded electronically. Exactly the same as for the pre-survey, the data was recorded and projected as graphs with all the responses.

The most important response of the participants was how often they made use of the virtual classroom and secondly, their experience during the intervention period. All responses were analysed, but some questions had greater value in their response.

3.8.2. Tests.

Pre- and post-tests had to be statistically analysed before any conclusion. The analysis process of the pre- and post-test were exactly the same. Both pre- and post-test were handed out (on separate occasions) and participants were required to complete the test in examination conditions. After completing the test, it was collected by the researcher and stored. The answers of the participants were copied to the grey shaded block, and then marked using a memorandum. A score out of thirty was awarded to each participant. All the answers of the participants were copied to an Excel spreadsheet. The reason for doing so was to ensure the marking was done correctly. The correct answer for each individual question was inserted in an “IF” equation. An “IF” equational allows the answers to the question to turn green if the answer is the same as the answer on the memorandum. In summary, the Excel spreadsheet ended in multiple green cells to indicate correct answers. The correct answers were counted for each participant and totaled. Comparing the score on the test and the total on the Excel spreadsheet ensured the correct score. At the bottom

of the spreadsheet, the number of answers for each choice (A, B, C, D) for every question was totaled, as well as the number of unanswered questions and the average for each question. The total and average for each question indicated the questions most participants did not comprehend, as well as the questions with less misconceptions amongst participants. After completing the results for the pre- and post-test separately, the results were compared. The difference in the number of correct answers as well as the difference in percentage between the pre- and post-test were calculated. Furthermore, the average, average deviation and median were calculated. Lastly the participants who engaged in the virtual classroom were cautiously analysed to determine the variation in score between the pre- and post-test, compared to the participants who did not use the virtual classroom.

3.8.3. Virtual classroom.

The Haiku learning platform recorded all activities of all participants during the intervention period. Data such as the number of participants who accessed the virtual classroom, participants who downloaded documents, who accessed links, started tests, who completed tests, test scores, who commented on the discussion, answers given for the questions and time spent on the virtual classroom were all recorded. The names of each participants with their individual activity was available. This was used in combination with the pre- and post-test results as well as the survey responses for data analysis.

Summary of all phases

Table 3: Phases done in this research

Phases	Description	Conceptual Framework
Pre-survey	Survey used to gather information about mobile social learning and possible mediums.	Figure 11
Pre-test	Test for participants prior to the intervention, based on the same topic as designed module.	
Intervention	Designing and developing of online classrooms.	Teacher presence Cognitive presence
	Implementing and encouraging the use of the online classroom.	Teacher presence
	Researcher – participant interaction. Peer interaction.	Social presence Cognitive presence
	Evaluating, improving and implementing the online classroom.	Teacher presence Cognitive presence
	Encouraging interaction and communication.	Social presence
Post-test	Test based on the content of the intervention (similar to pre-test).	
Post-survey	Survey to enquire about the intervention and participants' opinion.	Figure 12

Table 3 summarises the different phases completed in the research and how the intervention phase linked to the conceptual framework. The surveys were included in the research to gain information as discussed in Section 3.10.1 for the pre-survey and Section 3.10.2 for the post-survey. Both pre- and post-tests were the same and the result was used for comparison. A more elaborate discussion is found in section 3.10.3. The virtual classroom is the medium used for the intervention phase, as discussed in Section 3.10.4. To develop the virtual classroom, different steps needed to be done. Each step, as indicated in Table 3, linked to a presence of the conceptual framework.

3.9. Population and sample

According to Morgan and Sklar (2012), the population is all the people holding the specific criteria the researcher is interested in researching. It is not possible to research all people, therefore a sample group is selected. A sample is a representative group of the population.

All Grade 11 learners with physical science as school subject in South Africa is the population. It is not possible to research the entire population and accordingly a sample was selected. Therefore, a sample group was compiled from Grade 11 learners in Pretoria, in the same school, and with physical science as subject.

Convenient sampling was used to select the participants and constitute the sample group. Convenient sampling refers to the selection of a sample group based on the ease of access and the convenient availability. Because it is easy and convenient, it is usually an inexpensive method. Even though the sampling method is convenient, all the participants meet the same criteria. A larger group can be approached and those willing to participate constitute the sample group. The sample group can be described as a section of the population with specific criteria (Etikan, Musa & Alkassim, 2016; Maree & Pietersen, 2007). The reason for making use of convenient sampling is that the researcher was also one of the physical science teachers. Therefore the researcher was able to approach all Grade 11 physical science learners in the school to participate and those willing constituted the sample group.

All Grade 11 physical science learners were divided between two teachers, of which the researcher was one, with a combined number of eight Grade 11 classes and 166 learners in total. The teachers were consulted about the participation and informed about the process and expectations of the research. The Grade 11 physical science group was called together and informed about the research such as, the reason for the research, what the process for the research was, the requirements of participation, expectations of the participants, required consent from parents and learners, a completely voluntary participation, and ethical considerations. After the entire group of 166 learners were approached, fifty learners indicated interest in participating. The sample group comprised of the fifty learners after all consent forms were received.

Thus fifty learners started with the research and completed the pre-survey and the pre-test. After the pre-test some of the participants relocated or changed subjects, therefore only forty learners completed the research. All results, data, opinions and feedback collected was based on the forty learners completing every aspect. Even though forty learners completed the research, thirty-five learners did not participate in the online intervention, resulting in only five learners fully participating.

Number of learners participating per phase

Table 4: Population and sample group numbers

Phase	**Number of learners**
Learners approached	166
Indicated they want to participate	67
Started	50
Withdraw	10
Completed research	40
Fully participated	5

3.10. Ethical Considerations

The Research Ethics Committee of the University of Pretoria has compiled a document to clarify specific aspects of ethics. Facets of the document contain ethic principles – principles ethics should be based on to ensure effective research, basic ethics code of behaviour – guidelines to apply in any research to protect the researcher and participants, legal and procedural requirements – reference to the consent letter to be obtained from a variety of institutions and people - assessment of the ethics - emphasis is placed on the researcher and his role as well as involvement (Research Ethics Committee).

Research cannot be conducted without the appropriate documentation, ethical clearance and ethical considerations. These documentations include: approved ethical clearance as requested from the Department of Basic Education, since a school and its learners were used as participants. Approval from the head master of

the school was obtained, consent forms were filled out and signed by parents or guardians of learners as required, as the learners were not of age yet, and consent was obtained from participants (learners) to ensure they were informed about their rights (Dongre & Sankaran, 2016; Ferreira, 2012; Jelsma & Clow, 2005; Orb, Eisenhauer & Wynaden, 2001). Factors considered during the research were voluntary participation, consent, confidentiality and anonymity.

3.10.1. Voluntary participation.

Grade 11 learners in a school in Pretoria were selected as possible participants. After explaining and discussing the aim, purpose and procedure of the research, the learners had the opportunity to partake in the research. Each learner's participation was voluntary and they could withdraw at any stage from the research without any consequences. To ensure voluntary participation, the learners were informed about the voluntary participation and withdrawal from the research without any consequences. Both parents and learners were able to terminate the participation if wanted or needed. Consent forms, which parents and participants completed, stipulated the participation and withdrawal process (Research Ethics Committee).

3.10.2. Discrimination.

Discrimination is the exclusion of people based on race, gender, nationality, age, religion, or any other differences. Although learners did indicated they did not want to be a part of the research, they were not discriminated against. All learners had the opportunity to make use of all the aspects of the research, but data was only obtained from those who gave consent. This approach allowed all learners to have the benefit of the virtual classroom without any prejudice.

3.10.3. Consent.

Consent is required for the research as it is a signed document indicating the understanding of the research and the willingness to participate. The consent form of the headmaster was obtained first (see Appendix A). Because the learners were not of age, the consent of the parents were necessary. Each learner willing to participate was required to submit a completed consent form from the parents (see Appendix A) indicating they agreed to their child's participation, and a consent form of the learners

indicating they wanted to participate (see Appendix A). Only learners with completed parent consent forms and learner consent forms were selected as the sample group (Research Ethics Committee).

3.10.4. Confidentiality and privacy.

Confidentiality and privacy should be a high priority of any research. Participants share information during research which can be regarded as personal, humiliating, injurious or religious. Therefore the privacy of participants should be respected by not disclosing some information to public viewing, thus keeping the information confidential. Although this research did not require personal or private information, test results were considered confidential. A participant's name and age were also required, furthermore the information gathered from the surveys was a personal opinion about certain aspects (Research Ethics Committee).

3.10.5. Anonymity.

Anonymity refers to the removal of participants' names to protect their identity. Although participants made their identity known through the consent forms, surveys, tests and virtual classrooms, their names and identity were never mentioned during the research. Information and data gathered were used to examine tendencies and the effectiveness of the virtual classroom. The researcher was also the physical science teacher of some of the participants, therefore the researchers knew their identities prior to the research.

The safety of the participants was of utmost importance. Although the participants were not required to do anything that might have placed them in danger, it was considered. Each individual participant's identity was referred to pseudonymously when elaborating on the data and findings. At no stage were the participants revealed as to who they really were and how they scored on any of the tests. The participants' identity was kept confidential.

3.11. Conclusion

The conceptual framework selected for the research is the community of inquiry (Garrison et al., 1999). An interpretive research philosophy was selected because by understanding the problems learners were having, possible solutions could be implemented. Interpretivism focuses on understanding problems and concerns, therefore a qualitative research approach was implemented and the surveys were used as data collection instruments. In order to determine the effectiveness of a possible solution to learner's problems in physical science, an intervention research strategy was incorporated. Data was collected by a pre-test prior to the intervention and afterwards for comparison to determine the effectiveness. Although tests and surveys were used, the focus was on the surveys and the tests were only used for comparison. Not only were tests and surveys used, but also virtual classroom (intervention) recorded data. The order in which the data was collected was as follows: pre-survey, pre-test, first intervention, second intervention, post-test and post-survey.

The next chapter describes the results and findings of each of the two cycles of the research.

4. Chapter 4: Results and Discussion

4.1. Introduction

This chapter presents the results and findings of the two cycles of the research. Each cycle is individually discussed and lastly combined to determine the effectiveness of the virtual classroom. The research questions for the study are:

Primary research question

How can interactive learning through Open Education Resources (OER) support Grade 11 learners in Science education?

Secondary research questions

1. How do learners interact with each other and their study material through technology?
2. How can these interactions be incorporated in learning?
3. Which role can OER play as a vehicle for interactive learning?

4.2. First Intervention

4.2.1. Introduction.

The aim of the research was to determine the effectiveness of social mobile learning, therefore participants were required to partake in a virtual classroom where the opportunity of social learning was available. The platform used to create the virtual classroom was Haiku learning. Haiku learning recorded learner activity such as: time spent on the virtual classroom, downloaded files, pages open, discussion participation and marks for assessments. Different times during the year were used to implement the intervention. The ADDIE model was used to design and develop the intervention, and the first intervention was prior to the June exam. Modifications and alterations were made and a second intervention period was implemented during August.

The research process is illustrated by Figure 13 from the start until end.

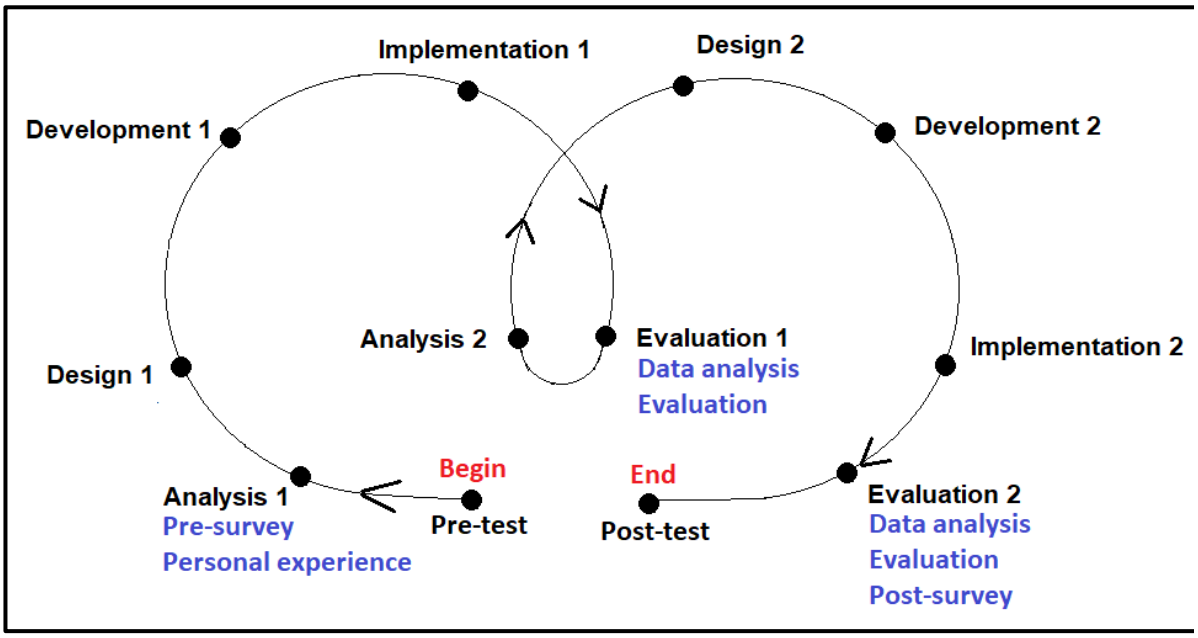


Figure 13: Research process

The research started with the pre-test, it was followed by the analysis for the first intervention. After 2 cycles of the intervention a post-test was completed. Although this was the sequence of events, the discussion that follows will differ. The pre- and post-test will be discussed at the end of the chapter, for comparative reasons.

4.2.2. First Intervention: Analysis.

The first step in the ADDIE model is analysis of the problem. Personal experience within the classroom points towards the lack of additional resources and support away from the classroom. Also, the selected topic, Newton's laws, was a topic most of the researcher's learners struggled with, as concluded from their term test results. Supporting that was the responses of the pre-survey indicating the interest of learners making use of a virtual classroom to aid them in teaching Newton's laws.

Pre-survey

The pre-survey, Appendix B, questions were analysed according to the conceptual framework areas. A summary of each question is provided firstly, after which each area in the COI is discussed.

Figure 14 illustrates the question allocations of the pre-survey

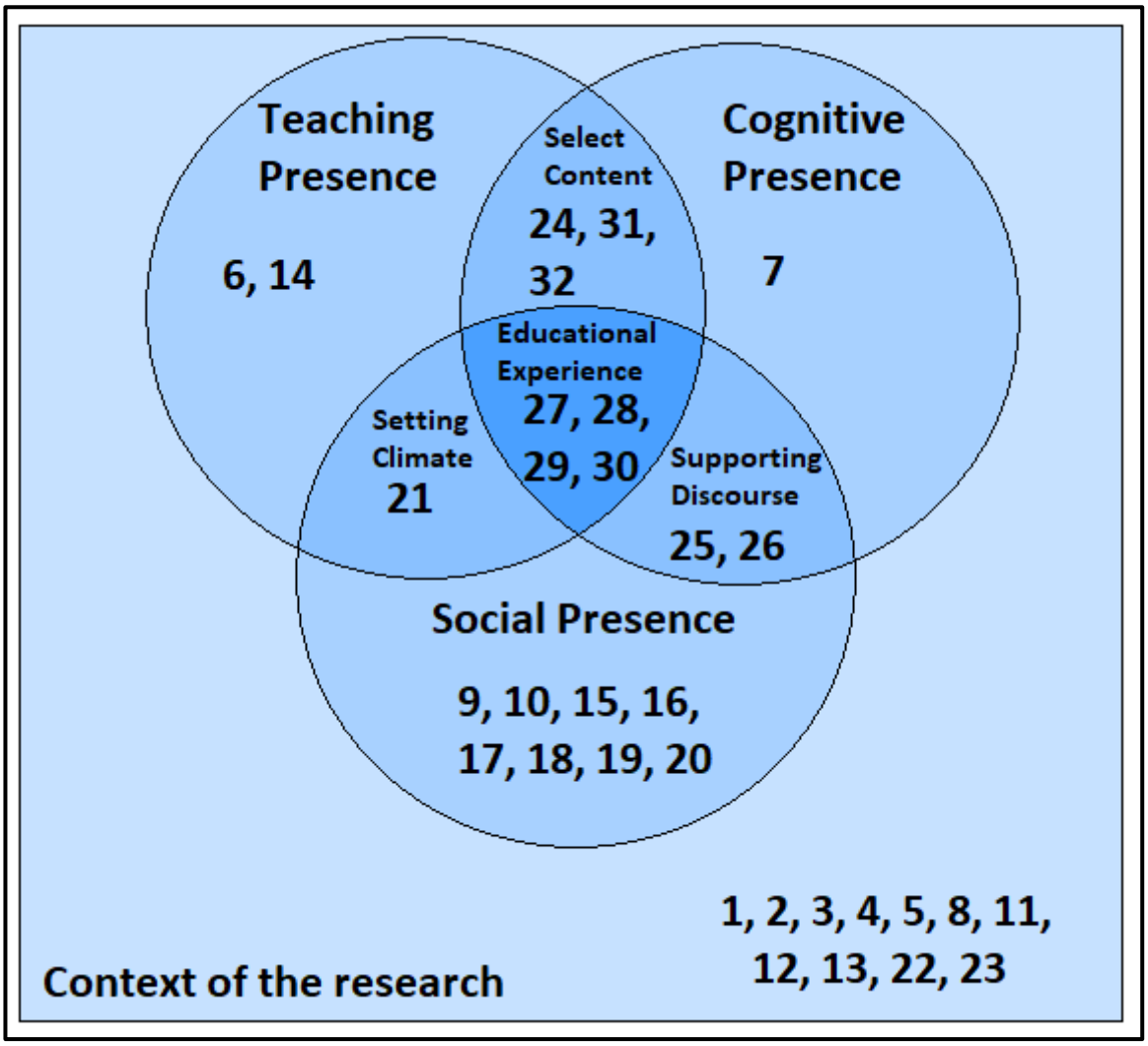


Figure 14: Pre-survey question analysis according to the conceptual framework.

Responses obtained from the pre-survey were captured on Qualtrics, as discussed in Section 3.11.1. In essence, Qualtrics have the ability to capture survey responses and analyse qualitative data.

Summary of pre-survey responses

1. The names of the participants were asked for comparison between the pre- and post-survey as well as the pre- and post-test. Their names were never mentioned.
2. The participant groups consisted of twenty-five females and fifteen15 males.

3. Nearly half of the participants were seventeen years of age (nineteen participants) while the remaining twenty-one participants were sixteen years of age.
4. Only two indicated their home language to be English and the remaining were all Afrikaans mother tongue.
5. The research was conducted at a high school in Pretoria.
6. A projector is used by all participants for education, even though some variations occur between the educational methods of teachers.
7. Of the sample group only three learners had trouble to access physical science materials.
8. The number of learners using pencils or pens were thirty-three learners, highlighters were used by twenty-six learners and paper or a notebook was used by thirty-five learners to study. Technological devices were not used that often. Computers were used by fourteen learners, tablets by three learners and smartphones by nine learners.
9. Even though learners did not make use of technological devices that often when studying, all participants possessed a smartphone and the majority possessed another technological device.
10. Technological devices were used by all participants for communication or for entertainment purposes such as YouTube.
11. Twenty-two learners indicated they were using technological devices when studying.
12. The majority (twenty-five) of learners participating wanted to make use of technological devices when studying and only two participants did not want to make use of it.
13. All participants wanted to use technological devices to search for information, worksheets, videos for explanations or any other form of help.
14. Smartphones were not the first choice as study devices by the participants.
15. Social media is openly accepted by nearly all participants. Thirty-nine of the forty participants had at least one social media account.
16. Instagram, Facebook and WhatsApp were the three most common social media accounts of the participants.
17. Nearly all participants (thirty-eight participants), excluding two, were fairly or very comfortable using social media.

18. Smartphones were by far the most used devices (forty participants) to access social media accounts, as all participants indicated using it. Computers (eleven participants) and tablets (nine participants) were used but not as regularly as smartphones.
19. Participants accessed social media very often.
20. Social media was used for communication with friends and family.
21. Even though some participants occasionally made use of social media for education purposes, thirteen of forty participants rarely or never made use of it.
22. Participants did not spend an enormous amount of time waiting, up to three hours.
23. All participants would have liked to make use of wasted time in a more productive manner.
24. The majority of participants, thirty-nine out of forty participants, would access educational material to increase productivity.
25. All participants indicated that they would partake in a virtual classroom if the option arose.
26. All participants would make use of the internet to access content.
27. Participants were eager to make use of social media as an education medium.
28. Most participants requested handouts and extra exercises as they believed it would increase their understanding and marks.
29. Participants expected the virtual classroom to increase their understanding of the content, resulting in an increase in their marks.
30. The connectivity and the data being used were the concerns about the use of a virtual classroom.
31. Participants were enthusiastic about the idea of a virtual classroom.
32. All participants expected an increase in their marks.

Context of the research (Questions 1, 2, 3, 4, 5, 8, 11, 12, 13, 22, 23) – Looking at the context of the pre-survey, all participants were in the same school, of similar age, and all participants owned at least a smartphone. Communication and entertainments were the two aspects for which participants used their smartphone the most. This created the opportunity to develop the virtual classroom for the intervention, because participants could access it via their smartphones and participants were keen on using mobile devices to access additional study material.

Teaching Presence (Questions 6, 14) – Teaching presence and cognitive presence indicated the curiosity and willingness of all participants to make use of an open educational resource, whereas the social presence indicated the use of mobile devices for everyday socialising. Because the participants were socialising using mobile devices, the social aspect had to be developed in the virtual classroom.

Cognitive Presence (Question 7) – Cognitive presence indicated the preference of study material participants used during studying. Pens, highlighters and papers were the most commonly used amongst participants, even though, computers were used 10.45% of the times, smartphones 6.72% and tablets 2.24%.

Social Presence (Questions 9, 10, 15, 16, 17, 18, 19, 20) – Participants do make use of a variety of social media, such as Facebook, Instagram, Twitter, WhatsApp and Snapchat. This allowed the intervention to incorporate a social aspect.

Selecting Content (Questions 24, 31, 32) – The topic was selected based on experience, because learners tend to struggle with the specific content. Participants were excited to make use of the virtual classroom based on a topic they found difficult.

Supporting Discourse (Questions 25, 26) – Due to the social aspects, participants could be assisted with any difficulties or problems they might have had through social media. Participants preferred to access the study material via internet.

Setting Climate (Question 21) – As indicated by the pre-survey, thirteen participants made use of social media when studying.

Educational Experience (Questions 27, 28, 29, 30) – Participants were eager to access academic content online and have the option of assistance through social media.

The pre-survey indicated the excitement and willingness of learners to have the facility and opportunity to access online study material, even though three participants had trouble accessing alternative study material. All participants indicated the possession of at least a smartphone and in most cases a smartphone and a tablet, computer or

both. Although participants had these technological devices they seldom used it when studying. Computers were used 10.45% of the times, smartphones 6.72% and tablets 2.24% of the time. When studying, participants made use of pencils or pens 24.63%, highlighters 19.40% and paper or a notebook 26.12% of the time. Even though participants had technological devices they preferred not to make use of it when studying, but when they were asked if they made use of technological devices when studying, twenty-two of the forty participants indicated that they did. It is clear that participants used technological devices when studying for one of three purposes.

1) To seek previous exam papers, for exercises or examples.
2) To view photos or notes taken from class.
3) To find explanations from videos or peers.

Social media was openly accepted by thirty-nine of the forty participants and most participants had more than one social media account. The most common social media accounts of the participants were Instagram, Facebook and WhatsApp, and all participants were comfortable using it. Participants accessed social media very often (multiple times per day) and the main purpose was for communication with friends and families and since all had smartphones, it was the device most often used to access social media. Even though social media was often accessed it was only used by thirteen participants for some form of education.

The responses of the pre-survey indicated participants' search for additional study material and assistance through an online source. Supporting this conclusion is personal observations in the classroom. Learners continue to ask for additional study material, old tests for preparation, additional exercises and problems, and extra classes to assist with problems. Analysing these responses lead to the conclusion of designing and developing a virtual classroom to support additional study material, additional problems and questions, as well as teacher assistance.

4.2.3. First Intervention: Design / Structure.

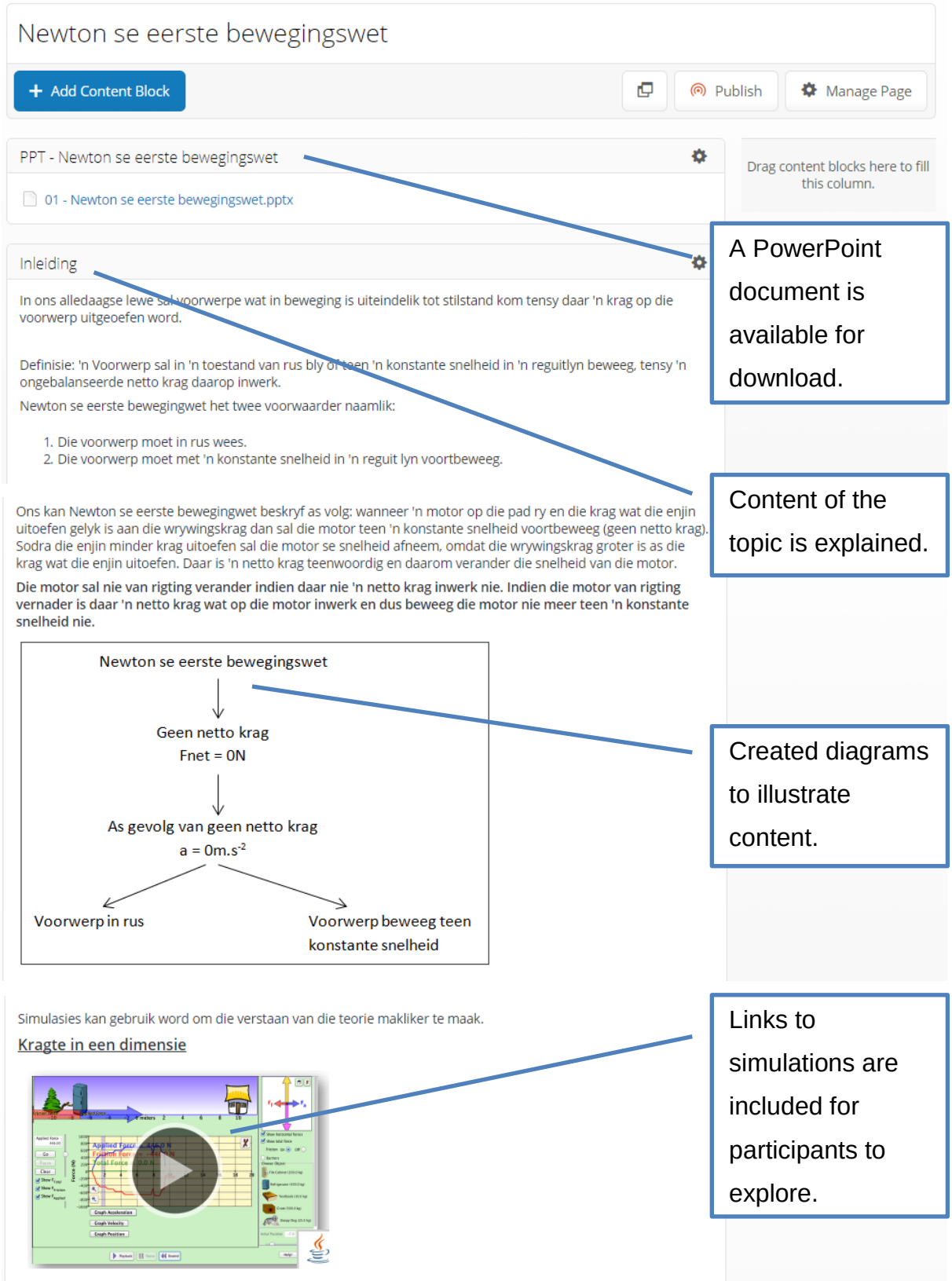
After analysing the problem, the topic of Newton's laws was selected as the content and the intervention could be designed, as the participants showed interest in such a system. Therefore, the design process commenced.

Each module designed for the virtual classroom had similar structures and layouts. The reason being, participants could familiarise themselves with the structure and reducing the time required to search for a specific section. All three modules had the following structure: a PowerPoint document for downloading, introduction and content about the topic, additional problems or questions if applicable, simulations that could be used to explain content, content and videos related to the content, and lastly a discussion for any questions or problems.

4.2.4. First Intervention: Develop / Examples.

The intervention was developed according to what was designed. Each module was developed as planned and designed. The following images display the developed intervention for each of the three modules.

First Intervention: Module 1



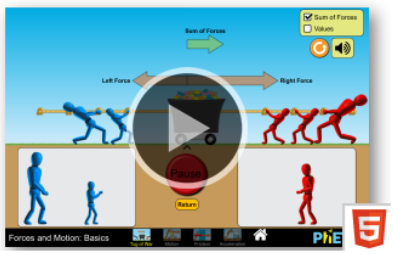
A PowerPoint document is available for download.

Content of the topic is explained.

Created diagrams to illustrate content.

Links to simulations are included for participants to explore.

Basiese kragte



Kragte

Traagheid

Soos ons gesien het uit Newton se eerste bewegingswet sal 'n voorwerp net van rigting of snelheid verander sodra 'n ongebalanseerde krag op die voorwerp inwerk. Die voorwerp sal versnel in die rigting van die ongebalanseerde krag (netto krag).

Alle voorwerpe gaan die verandering in rigting of snelheid teenwerk. Hierdie teenwerking word **traagheid** genoem.

Definisie: Die mate waarin 'n voorwerp weerstand bied teen 'n verandering in sy posisie in rus of konstante beweging in 'n reguit lyn, word die voorwerp se traagheid genoem.

Voorbeeld van traagheid:

1. Allerdaagse lewe
2. Kar beweeg met pendulum en ballon

Traagheid word bepaal deur 1 faktor en dit is die **massa** van die voorwerp. Hoe groter die massa van die voorwerp hoe moeiliker is dit om die voorwerp se bewegingstoestand te verander.

Traagheid in 'n vertikale rigting

Newton se eerste bewegingswet

Geleentheid word gebied om vrae te vra or enige onsekerheid of onduidelikheid. Leerder kan mekaar bystaan met moontlike probleme, as ook besprekings oor die teorie.

Discuss: Newton se eerste bewegingswet

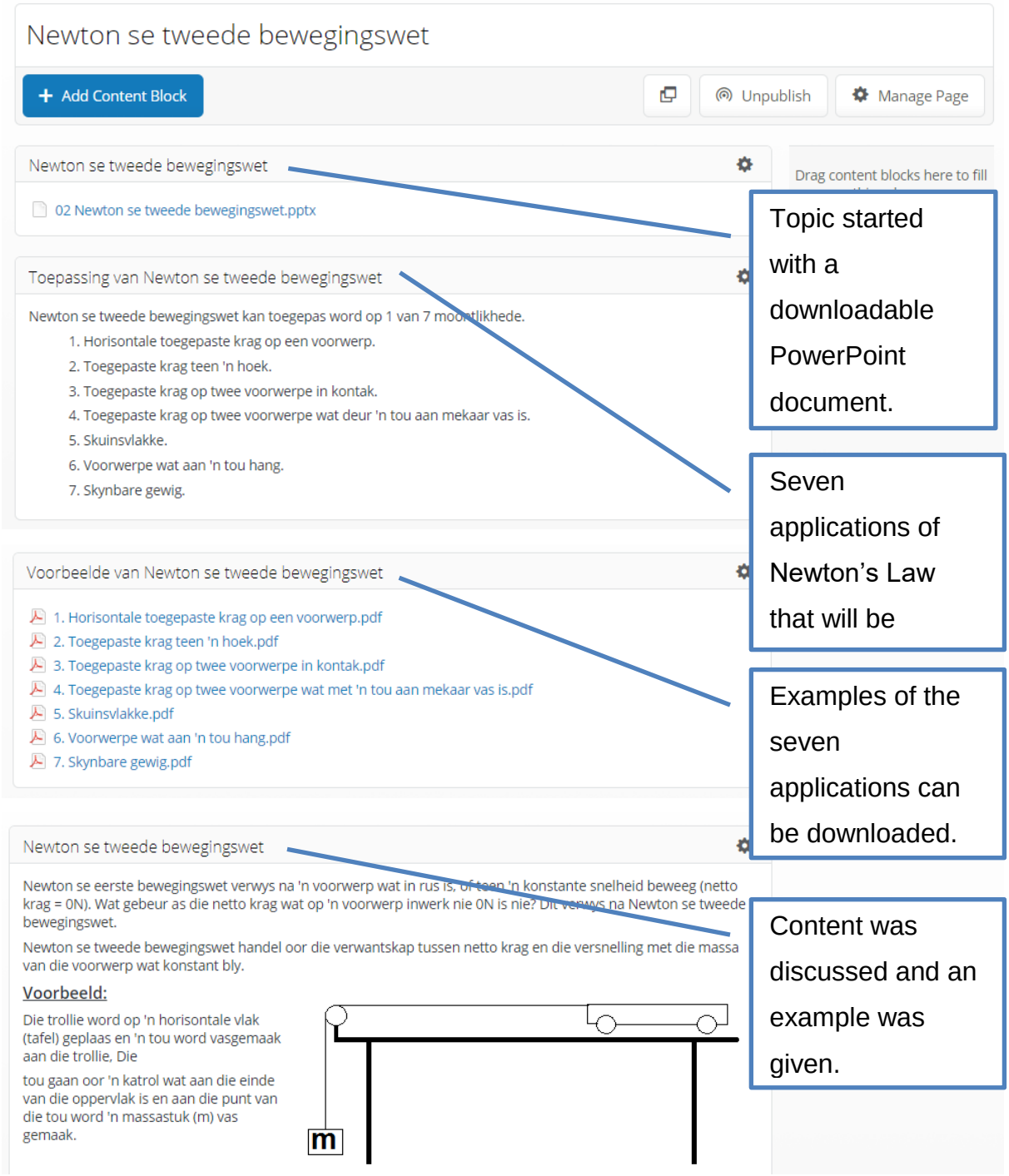
Page Comments 0

Another topic of content is explained.

Links to YouTube videos about the discussed topic.

Discussion is included for any questions or problems.

First Intervention: Module 2



Verband tussen netto krag en versnelling

Die massa van die trollie word konstant gehou.

Sodra die massa (m) gelos word versnel die trollie oor die oppervlak totdat dit die einde van die oppervlak bereik.

Wanneer die ondersoek herhaal word en die massastuk (m) word verdubbel, wat sal gebeur met die versnelling van die trollie? Die trollie se versnelling sal dubbel wees van dit wat dit in die eerste ondersoek was.

Afleiding wat gemaak kan word

Die versnelling (a) van die trollie is direk eweredig aan die netto krag (Fnet), mits die massa van die trollie konstant bly.

a α Fnet (massa van trollie bly konstant).

Verband tussen massa en versnelling

In hierdie ondersoek word die massa van die trollie verander om te bepaal wat is die effek wat dit het op die versnelling van die trollie terwyl die netto krag konstant gehou word.

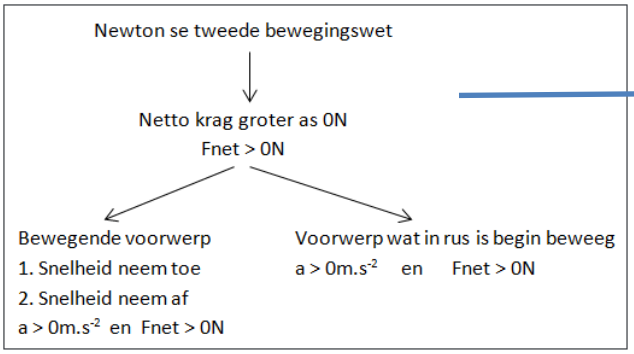
Die oomblik wat die massastuk gelos word vernel die trollie tot teen die einde van die oppervlak. As die ondersoek herhaal word en die die netto krag op die trollie bly konstant maar die massa van die trollie neem toe, wat sal dan gebeur met die versnelling van die trollie?

Die trollie sal stadiger versnel maar nogsteeds die einde van die oppervlak bereik. Omdat die massa van die trollie vermeerder het, het die versnelling van die trollie verminder.

Afleiding wat gemaak kan word

Die versnelling (a) van die trollie is omgekeerd eweredig aan die massa van die trollie, mits die netto krag konstant gehou word.

a α 1/massa (netto krag bly konstant).



Newton se tweede bewegingswet

Newton se tweede bewegingswet van toepassing op sport

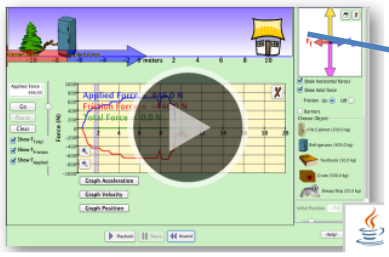
Newton se tweede bewegingswet demonstrasie

Diagrams were created to illustrate the content.

Links to YouTube videos explaining the content.

Simulasies kan gebruik word om die verstaan van die teorie makliker te maak.

Kragte in een dimensie



Basiese kragte

Kragte

Simulations were included to help explain the content.

Newton se tweede bewegingswet

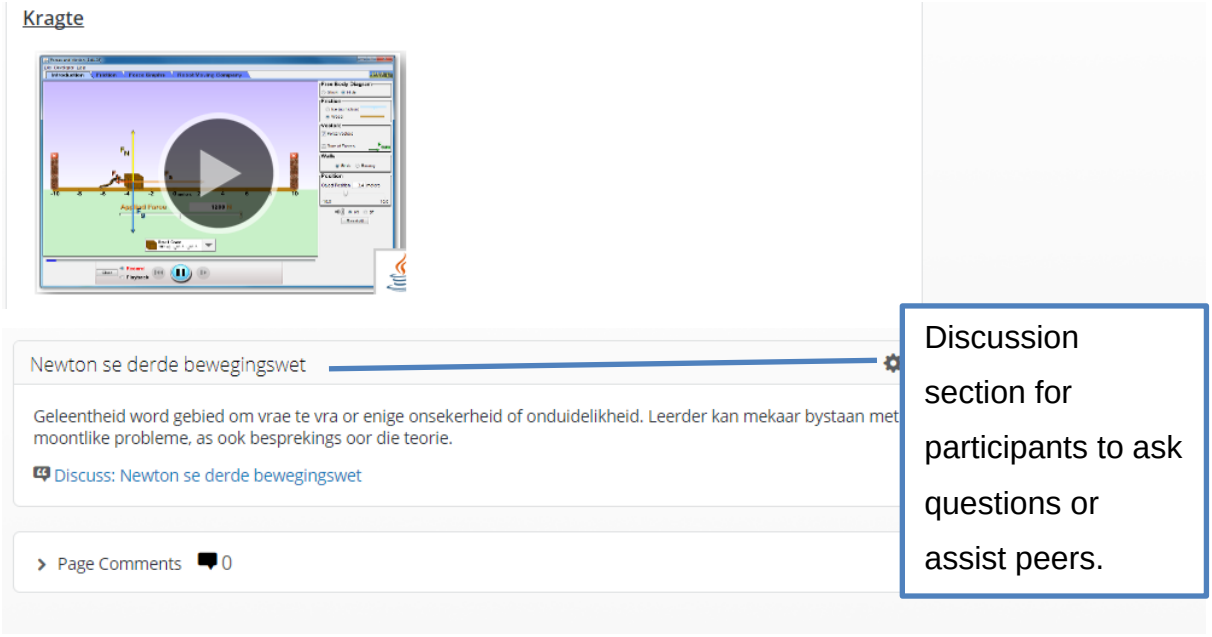
Geleentheid word gebied om vrae te vra or enige onsekerheid of onduidelikheid. Leerder kan mekaar bystaan met moontlike probleme, as ook besprekings oor die teorie.

Discuss: Newton se tweede bewegingswet

Page Comments 0

Discussion for participants to ask questions or raise difficulties they encounter.

First Intervention: Module 3



4.2.5. First Intervention: Implementation.

Once the development of the virtual classroom was completed, it was implemented between 1 May 2017 and 20 June 2017. All functions, tabs, downloadable documents, videos, simulations and discussions were tested before learners gained access. All Grade 11 physical science learners were given the opportunity to make use of the virtual classroom, but the data collected was restricted to the participants. Learners were constantly informed and encouraged, in their classroom, to made use of the virtual classroom. The researcher was active on the virtual classroom to ensure discussions were restricted to academics and academically correct in terms of the content.

The data recorded by the virtual classroom revealed the results that were used to improve the virtual classroom. A total of thirty-one minutes were spent by participants on the virtual classroom and the six most active participants spent more than one minute on the classroom. The rest of the participants spent less than one minute. Because the research focus on the interactive learning the most important result is the amount of social interaction. Only three participants engaged in any discussion with a total of five comments. Participants had access to download files for educational purposes, of which four participants made use, with a total of eighteen files downloaded. Videos were included in the virtual classroom, yet one participant used one link for a YouTube video. Pages were mostly accessed by six participants, with

more than one minute spent on pages and nine minutes and thirty seconds the most time spent on pages by an individual.

4.2.6. First Intervention: Evaluation.

Evaluating the virtual classroom was a crucial part in the research, as it revealed possible changes and improvements to be made, in order to design and develop an improved model. Two different evaluations were used when evaluating the effectiveness of the virtual classroom. The two evaluations were the analysis of the data recorded by the virtual classroom and the researcher's evaluation. Evaluation of the virtual classroom was based on each individual aspect, as illustrated in the following table.

Table 5: Guideline to incorporate COI framework

Framework presence	Crucial aspect to achieve
Social presence	Effective communication (effective expression), group cohesion, and open communication.
Cognitive presence	Critical thinking requires a person to explore content, construct ideas, solve problems and reflect.
Teaching presence	Teaching presence refers to the presence of a teacher to conduct and focus learning on a pre-determined topic in an online environment.
Supporting discourse	Encounter different learners' perspectives and necessitate critical thinking.
Selecting content	Design, facilitate and provide instructions based on the content selected to promote critical thinking/
Setting climate	Responsibility of the teacher to guarantee learning takes place through interaction and not letting learners get distracted.
Practical inquiry model (process of cognitive presence)	Triggering events, explorations, integration and resolution.

Social presence – Figure 15 summarises the results of the first intervention obtained from Haiku learning. The figure portray the number of five different categories, the time (in minutes) spent on the virtual classroom, the number of pages viewed, number of participants participating in the discussion, the number of links followed to simulations and videos, and the number of documents downloaded.

Number of participants = 40

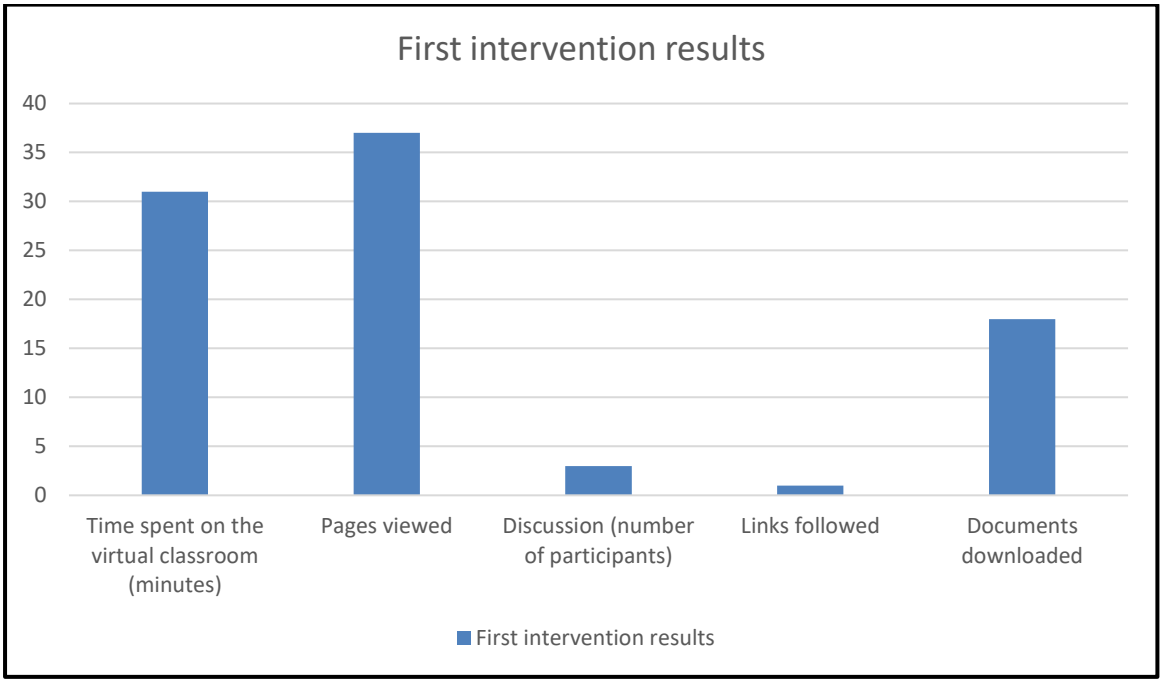


Figure 15: Results of first intervention

All the results illustrated in Figure 15 is for the entire sample group of forty participants. As can be seen, the number of participants engaging in discussions and the number of links followed were not many. The social aspect and participant interaction lacked during the first intervention.

Cognitive presence – The order of the virtual classroom was developed to trigger curiosity and guide participants towards critical thinking. Tests were included for participants to tests their understanding.

Teaching presence – As seen during the implementation phase, thirty-one minutes were spent on the virtual classroom, of which thirty-four participants spent less than

one minute on the virtual classroom. This raised the question, why did participants spent so little time on the virtual classroom? Only three participants engaged in a discussion with a total of five messages sent. All three modules combined had eighteen files downloaded amongst forty participants.

Supporting discourse – Various types of educational mediums were included for participants to use. Videos, simulations, content, problems, diagrams and tests were all included.

Selecting content – The content selected was prescribed content from the Department of Basic Education. Learners were required to master the content.

Setting climate – All the content on the virtual classroom was related to the topic in order to help participants focus on the content. A discussion was included for participants to ask for assistance or guidance with any difficulty they encountered.

Participants could be encouraged to explore each aspect of the virtual classroom by including instructions.

Practical inquiry model (Triggering events, explorations, integration and resolution) – The specific topic was selected because of poor learner performance. Each course focused on one aspect, the triggering event. Participants were encouraged to explore and engage, apply various methods and possible solutions to the problems encountered in order to resolve the problem.

The results from the virtual classroom showed little activity from the participants' side, as seen by the time spent online, files downloaded, and messages sent in the discussion. Because participants did not engage in the virtual classroom as expected, alterations and improvements were made to increase social mobile learning. The researcher's evaluations revealed the following:

1. Include instruction at each new section to guide participants what to do and how to make use of the section.
2. Add a test to the virtual classroom participants had to complete, and hopefully increase the usage of the virtual classroom.

3. To start the discussion and interaction, a problem was stated and the participants were required to answer the problem and discuss possible solutions, or methods to obtain the correct answer.
4. A separate discussion was developed for any queries or problems participants might have had.

These changes and improvements were made to increase the usage of the virtual classroom, to encourage participants to make use of it more often, to engage in discussions, to download problems and practices and to use the tests as indication of their understanding of the content.

4.3. Second Intervention

4.3.1. Second Intervention: Analysis.

The research problem could not be addressed with the data gathered from the first intervention. Although some learners participated, the ideal was to get more participants involved. When the cognitive-, teaching-, and social presence are considered, the content selected, problems stated and tests set for the intervention met the cognitive presence, the teachers selected the content and were available for assistance as required by teaching presence, while the social presence was not met due to the lack of interaction. The participants did not engage in the interaction and social aspect of the intervention, therefore the intervention was executed a second time. The concern remains the same as for the first intervention, but the focus shifts towards increasing the participation to determine the effectiveness of the virtual classroom.

4.3.2. Second Intervention: Design / Structure.

After the evaluation of the first intervention, the alterations and improvements were designed. The majority of the virtual classroom's structure remained the same. It started with: a PowerPoint document for downloading, introduction and content about the topic, additional problems or questions if applicable, simulations that could be used to explain content, content and videos related to the content, a test participants had to complete, a problem or question stated which participants were required to answer, and lastly a discussion of any questions or problems. The test and the problem were

the only new additions to the virtual classroom. Changes were made to the initial interventions rather than designing and developing a new virtual classroom.

4.3.3. Second Intervention: Develop / Examples.

Similar to the first intervention's development, the structures of the three modules remains similar to the first intervention and similar to each other. The following images illustrate the second intervention and the red circled areas indicate changes from the first intervention.

Second Intervention: Module 1

Newton se eerste bewegingswet

+ Add Content Block | Unpublish | Manage Page

PowerPoint - Newton se eerste bewegingswet

Die PowerPoint dokument bevat die teorie van die hoofstuk en kan afgelaai word. Gebruik dit en werk d
teorie.

01 - Newton se eerste bewegingswet.pptx

PowerPoint document available for download, but the red circle included instructions.

Inleiding en Teorie

In ons alledaagse lewe sal voorwerpe wat in beweging is uiteindelik tot stilstand kom tensy daar 'n krag op die voorwerp uitgeoefen word.

Definisie: 'n Voorwerp sal in 'n toestand van rus bly of teen 'n konstante snelheid in 'n reguitlyn beweeg, tensy 'n ongebalanseerde netto krag daarop inwerk.

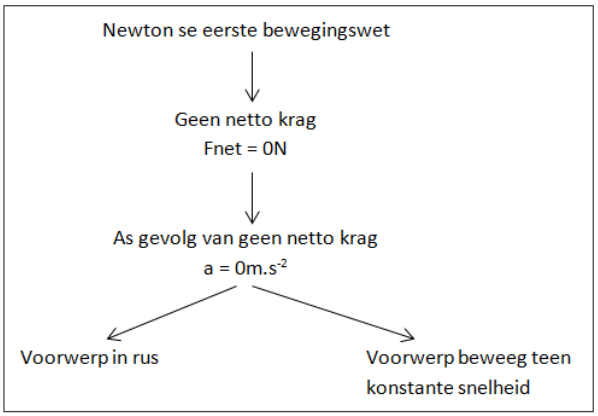
Newton se eerste bewegingwet het twee voorwaarder naamlik:

1. Die voorwerp moet in rus wees.
2. Die voorwerp moet met 'n konstante snelheid in 'n reguit lyn voortbeweeg.

Content was explained and a diagram was included to illustrate content.

Ons kan Newton se eerste bewegingwet beskryf as volg: wanneer 'n motor op die pad ry en die krag wat
wrywingskrag dan sal die motor teen 'n konstante snelheid voortbeweeg (geen netto krag). Sodra die enj
snelheid afneem, omdat die wrywingskrag groter is as die krag wat die enjin uitoefen. Daar is 'n netto kra
snelheid van die motor.

Die motor sal nie van rigting verander indien daar nie 'n netto krag inwerk nie. Indien die motor van rigting vernader is daar 'n netto krag wat op die motor inwerk en dus beweeg die motor nie meer teen 'n konstante snelheid nie.

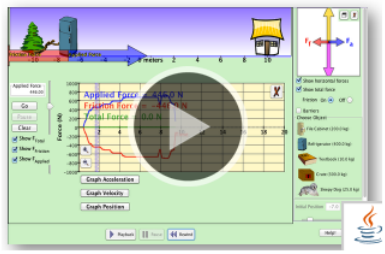


Simulasies

Maak gebruik van die simulasies om Newton se eerste bewegingswet te illustreer.

Kliek op die prentjie van die simulasie om die webblad oop te maak.

Kragte in een dimensie



Although the same simulations were included, the red circle indicated the instructions about the simulations for the participants.

Basiese kragte

Kragte

Traagheid

Soos ons gesien het uit Newton se eerste bewegingswet sal 'n voorwerp net van rigting of snelheid verander sodra 'n ongebalanseerde krag op die voorwerp inwerk. Die voorwerp sal versnel in die rigting van die ongebalanseerde krag (netto krag).

Alle voorwerpe gaan die verandering in rigting of snelheid teenwerk. Hierdie teenwerking word **traagheid** genoem.

Definisie: Die mate waarin 'n voorwerp weerstand bied teen 'n verandering in sy posisie in rus of konstante beweging in 'n reguit lyn, word die voorwerp se traagheid genoem.

Voorbeeld van traagheid:

Hiedie voorbeelde word verduidelik deur gebruik te maak van demonstrasies.

1. Allerdaagse lewe
2. Kar beweeg met pendulum en ballon

Traagheid word bepaal deur 1 faktor en dit is die **massa** van die voorwerp. Hoe groter die massa van die voorwerp hoe moeiliker is dit om die voorwerp se bewegingstoestand te verander.

Traagheid in 'n vertikale rigting

Content was explained.

Links to YouTube videos were included.

Newton se eerste bewegingswet

Voltooi die toets wat handel oor Newton se eerste bewegingswet.

- Om die toets te begin, kliek op die skakel.
- Daar is **geen tyd** limiet aan die toets gekoppel nie.
- Die toets tel vir punte en dus is daar net **een poging**.

Click the link below to preview this practice.

Practice: Newton se eerste bewegingswet

Closed as of Aug 24, 11:59 pm.

Tests were an addition to the second intervention.

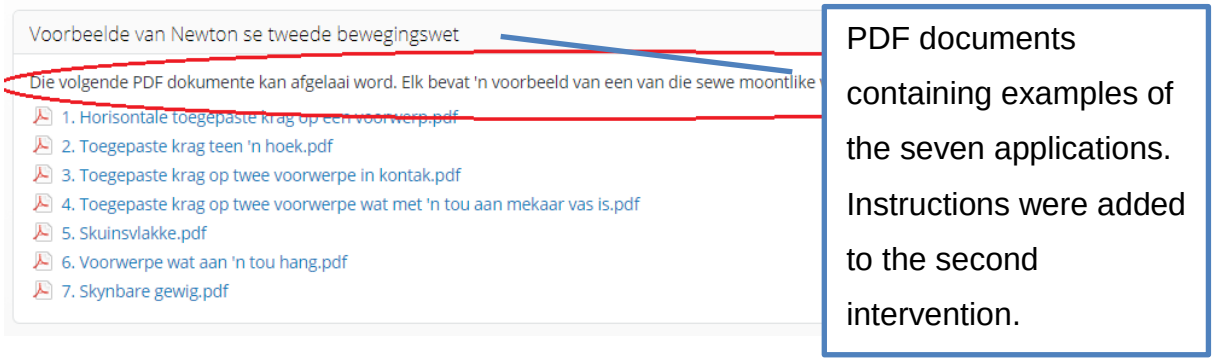
A question was given to the participants to answer and to discuss the answer amongst peers.
New to the second intervention.

A discussion was included for participants to raise questions or difficulties they encountered.

Second Intervention: Module 2

A downloadable PowerPoint document with instructions for participants.

Seven applications of Newton's second law.



PDF documents containing examples of the seven applications. Instructions were added to the second intervention.

Newton se tweede bewegingswet

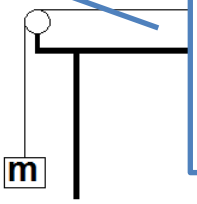
Newton se eerste bewegingswet verwys na 'n voorwerp wat in rus is, of teen 'n konstante snelheid beweeg (netto krag = 0N). Wat gebeur as die netto krag wat op 'n voorwerp inwerk nie 0N is nie? Dit verwys na Newton se tweede bewegingswet.

Newton se tweede bewegingswet handel oor die verwantskap tussen netto krag en die versnelling met die massa van die voorwerp wat konstant bly.

Voorbeeld:

Die trollie word op 'n horisontale vlak (tafel) geplaas en 'n tou word vasgemaak aan die trollie, Die

tou gaan oor 'n katrol wat aan die einde van die oppervlak is en aan die punt van die tou word 'n massastuk (m) vas gemaak.



Content were explained and examples were given.

Verband tussen netto krag en versnelling

Die massa van die trollie word konstant gehou.

Sodra die massa (m) gelos word versnel die trollie oor die oppervlak totdat dit die einde van die oppervlak bereik.

Wanneer die ondersoek herhaal word en die massastuk (m) word verdubbel, wat sal gebeur met die versnelling van die trollie? Die trollie se versnelling sal dubbel wees van dit wat dit in die eerste ondersoek was.

Afleiding wat gemaak kan word

Die versnelling (a) van die trollie is direk eweredig aan die netto krag (Fnet), mits die massa van die trollie konstant bly.

a α Fnet (massa van trollie bly konstant).

Verband tussen massa en versnelling

In hierdie ondersoek word die massa van die trollie verander om te bepaal wat is die effek wat dit het op die versnelling van die trollie terwyl die netto krag konstant gehou word.

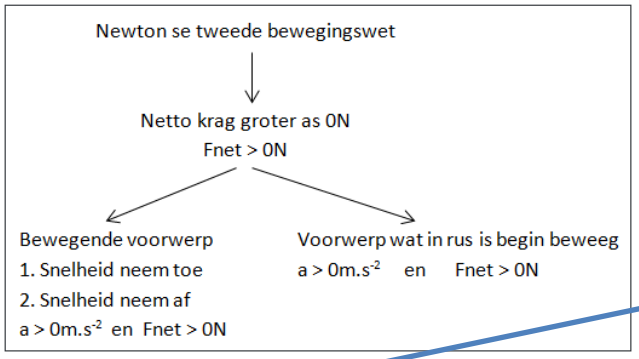
Die oomblik wat die massastuk gelos word vernel die trollie tot teen die einde van die oppervlak. As die ondersoek herhaal word en die die netto krag op die trollie bly konstant maar die massa van die trollie neem toe, wat sal dan gebeur met die versnelling van die trollie?

Die trollie sal stadiger versnel maar nogsteeds die einde van die oppervlak bereik. Omdat die massa van die trollie vermeerder het, het die versnelling van die trollie verminder.

Afleiding wat gemaak kan word

Die versnelling (a) van die trollie is omgekeerd eweredig aan die massa van die trollie, mits die netto krag konstant gehou word.

a α 1/massa (netto krag bly konstant).



Videos

Hierdie videos verduidelik Newton se tweede bewegingswet en hoe dit van toepassing is op verskillende

Newton se tweede bewegingswet

Newton se tweede bewegingswet van toepassing op sport

Newton se tweede bewegingswet demonstrasie

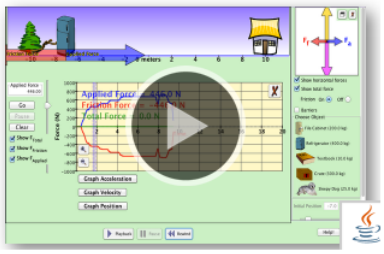
Links to YouTube videos with instructions for participants to follow.

Simulasies

Maak gebruik van die simulasies om Newton se eerste bewegingswet te illustreer.

Kliek op die prentjie van die simulasie om die webblad oop te maak.

Beweging in een dimensie



Basiese kragte

Kragte

Simulations were included. The red circled text provided instructions in making use of the simulations.

Newton se tweede bewegingswet

Voltooi die toets wat handel oor Newton se tweede bewegingswet.

- Om die toets te begin, kliek op die skakel.
- Daar is **geen tyd** limiet aan die toets gekoppel nie.
- Die toets **tel vir punte** en dus is daar net **een poging**.

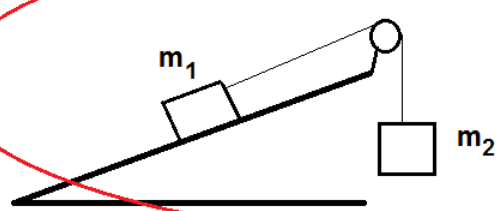
Click the link below to preview this practice.

Practice: Newton se tweede bewegingswet

Closed as of Aug 24, 11:59 pm.

Tests were incorporated into the second intervention.

Newton se tweede bewegingswet



Blok m_1 het 'n massa van 6kg en

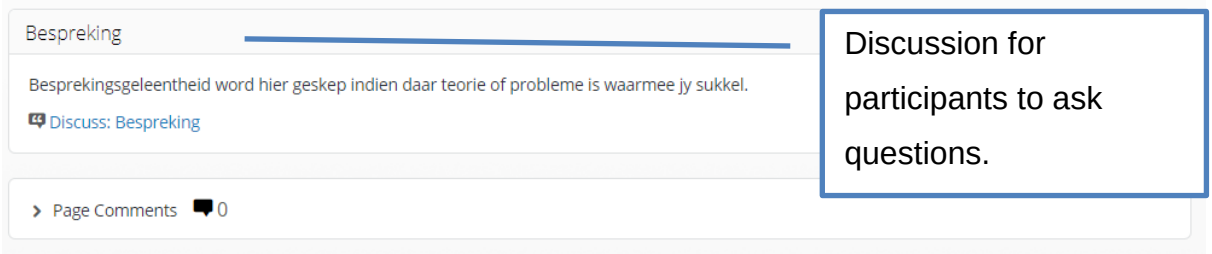
'n hoek van 30^0 met die horisonta

wrywingskrag van 4N.

Bereken die versnelling van die st

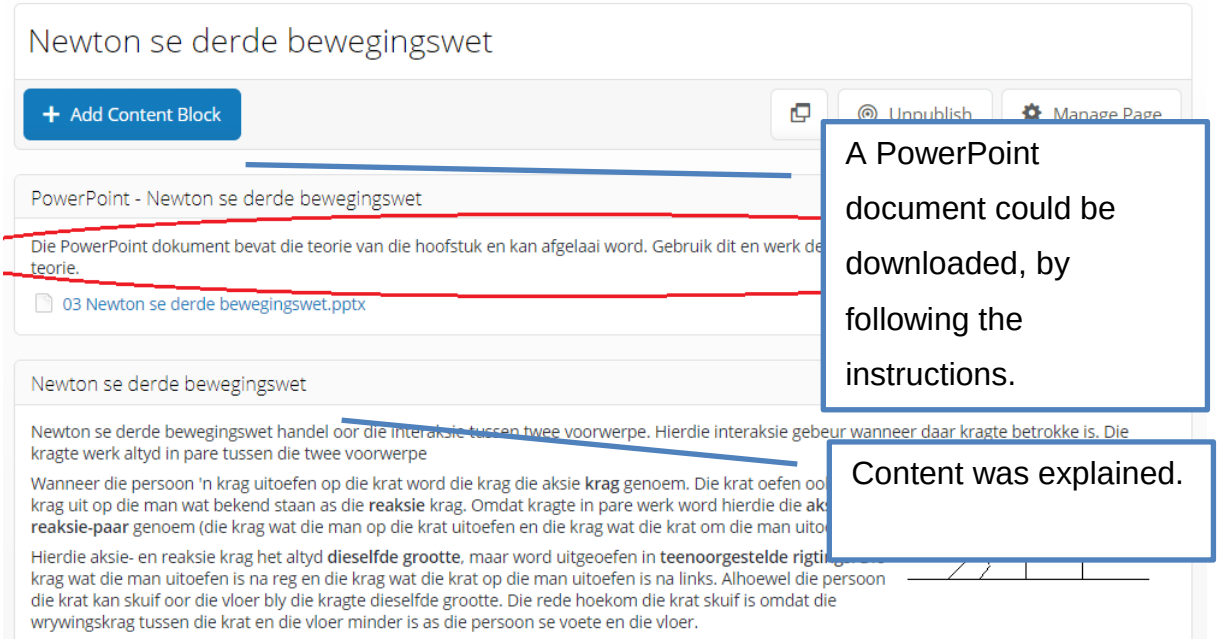
Discuss: Newton se tweede be

A problem was given and participants were required to discuss the process of solving the problem.



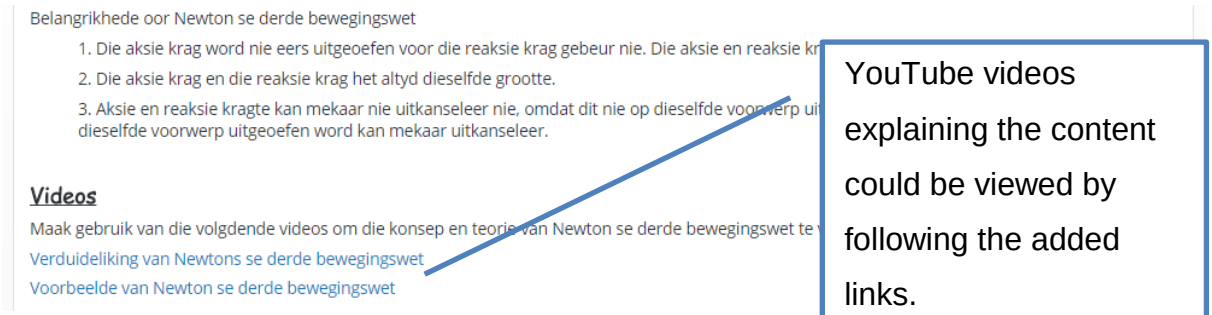
Discussion for participants to ask questions.

Second Intervention: Module 3

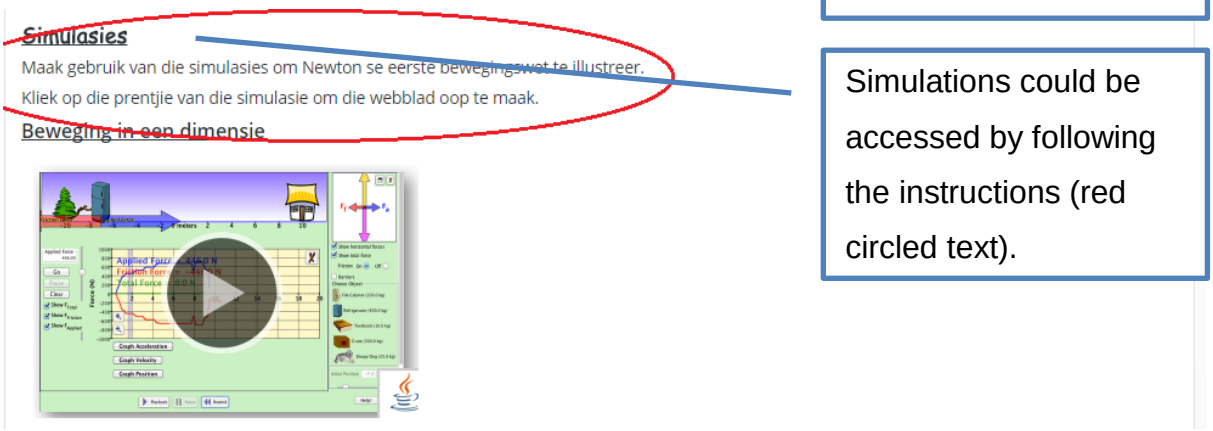


A PowerPoint document could be downloaded, by following the instructions.

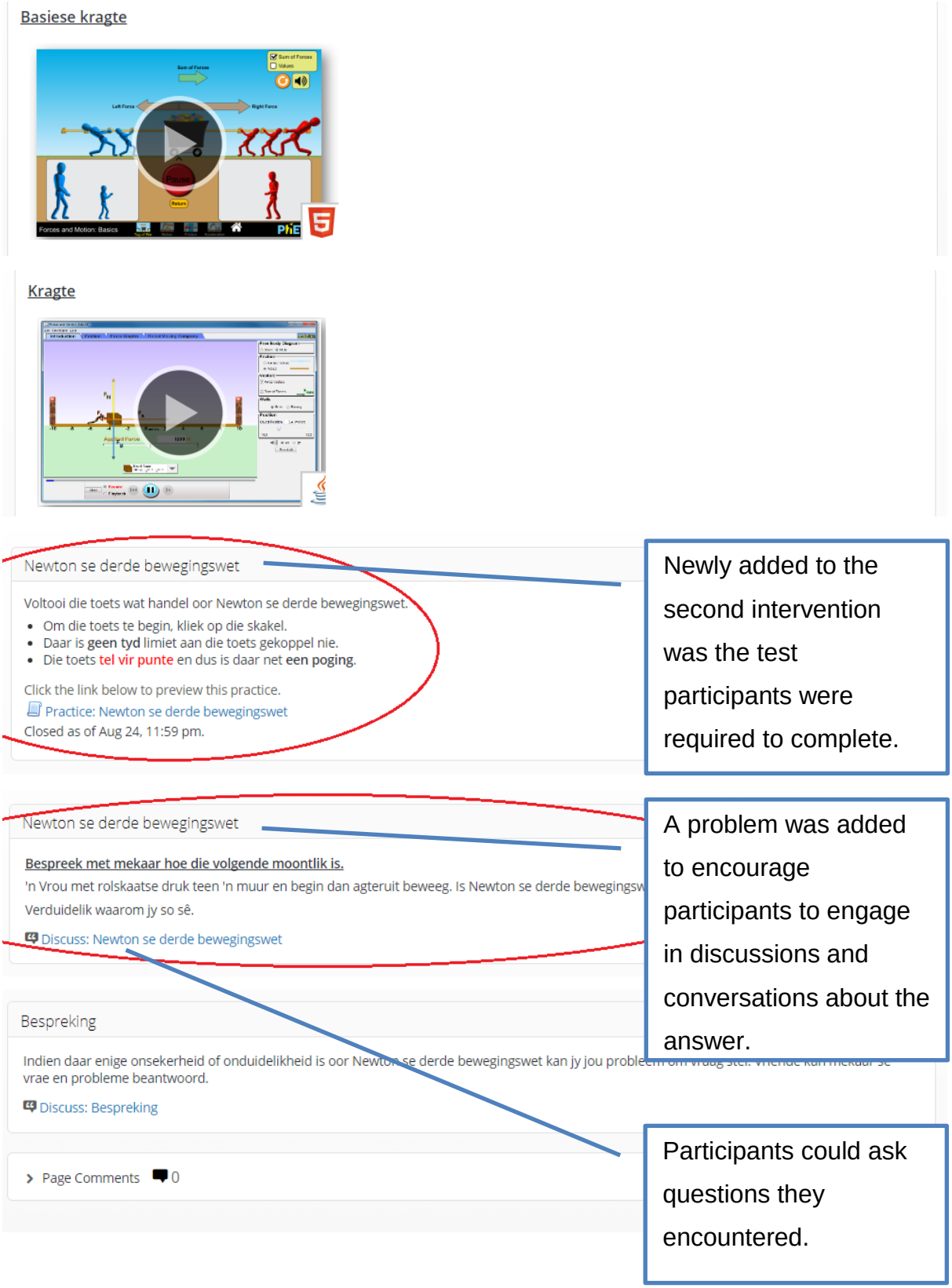
Content was explained.



YouTube videos explaining the content could be viewed by following the added links.



Simulations could be accessed by following the instructions (red circled text).



4.3.4. Second Intervention: Implementation.

The second intervention commenced on 20 July 2017 and ended 11 August 2017. During this period participants were encouraged to make use of the virtual classroom,

to download the file for personal use, view the videos, complete the prescribed tests and answer the question stated and converse with peers.

4.3.5. Second Intervention: Evaluation.

The evaluation of the second intervention will be unpacked according to the Guideline to incorporate a COI framework

Table 6: Guideline to incorporate COI framework

Framework presence	Crucial aspects to achieve
Social presence	Effective communication (effective expression), group cohesion, and open communication.
Cognitive presence	Critical thinking requires a person to explore content, construct ideas, solve problems and reflect.
Teaching presence	Teaching presence refers to the presence of a teacher to conduct and focus learning on a pre-determined topic in an online environment.
Supporting discourse	Encounter different learners' perspectives and necessitate critical thinking.
Selecting content	Design, facilitate and provide instructions based on the content selected to promote critical thinking.
Setting climate	Responsibility of the teacher to guarantee learning takes place through interaction and not letting learners get distracted
Practical inquiry model (process of cognitive presence)	Triggering events, explorations, integration and resolution.

Social presence – Participants engaged more in the social interaction. The encouragement and instructions had an effect.

Cognitive presence – The content remained unchanged, but some changes were made. Instructions that were included, problems and tests were the changes.

Teaching presence – The researcher was available for participants' assistance, but was not required. The layout of the virtual classroom remained the same.

Supporting discourse – various aspects were included, but not all learners made use of all aspects. Depending on their preference the appropriate aspect was selected.

Selecting content – The content remained unchanged from the first intervention. Additions were made but did not alter the content.

Setting climate – Participants were encouraged to make use of the interaction and proved to have an effect. More participants made use of the virtual classroom, although more time and attentions should be spent on increasing the number of participants engaging in the social interaction.

Practical Inquiry Model (Triggering events, explorations, integration and resolution) – One of the major aspects included in the second intervention to enhance the Practical Inquiry Model, was the stated problem. A problem was given (triggering event) and the participants were encouraged to explore possible solutions, apply solutions to the problem, and solve the problem. Participants could engage in interaction and assist one another or request assistance.

Comparing first intervention data to second intervention data

a. Data from Haiku learning

The data recorded by the Haiku platform was analysed and the following was found: Participants spent five hours and fifty-five minutes on the virtual classroom and two hundred pages were viewed. The most time spent by a single participant was one hour and thirty-two minutes. Assessments were developed for grading purposes and to provide participants with an indication of their understanding of the content. Despite the grading aspect, only eight assessments were completed by six different participants. A total of twenty-six participants followed the link to the assessments but never attempted or completed the assessment. This implies thirty-four participants had not completed any assessment and each participant was required to complete three assessments. Thus, only eight out of one hundred and twenty assessments, in total, were completed. Surprisingly five learners participated in the discussion, but only six

messages were sent. Just five minutes were spent on the discussion section of the virtual classroom. The number of files downloaded, including PowerPoints and PDF files, increased to sixty-four. Even though the number of links for YouTube videos increased, it remained as five links opened.

The virtual classroom contained three different modules and for each module an individual multiple choice assessment was developed and implemented. Two participants completed the first module's assessment, there were nine completions for the second module and two for the third assessment. It was expected of each individual participant to complete all three assessments, which would have resulted in one hundred and twenty assessments completed, yet the total number of completed assessments were eight.

Figure 16 is a similar illustration to the first intervention's results, as discussed in Section 4.2.6. The same five aspects were graphed in order to compare to the first intervention.

Number of participants = 40

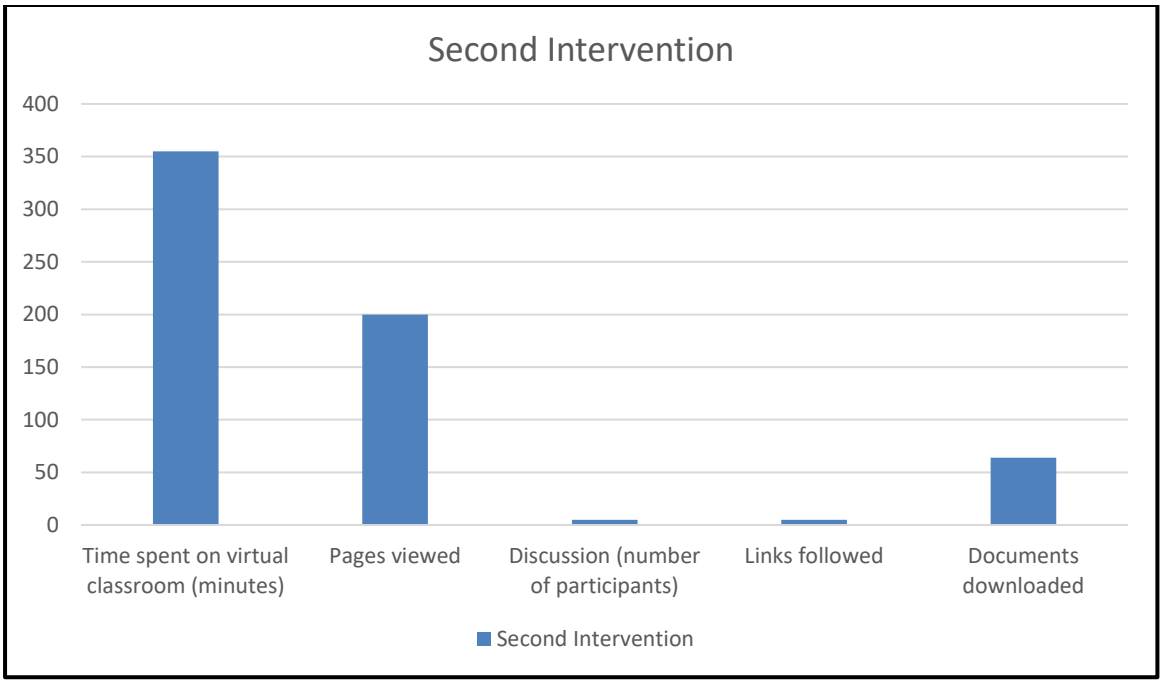


Figure 16: Second intervention results

Figure 16 illustrates the same aspects as the first intervention. When viewing the results the number of participants participating in the discussion and the number of links followed were far less than the rest, similar to the first intervention. When comparing the results of the first and second intervention, the results portrayed a slight difference.

Figure 17 compared the data of the first and second intervention.

Number of participants = 40

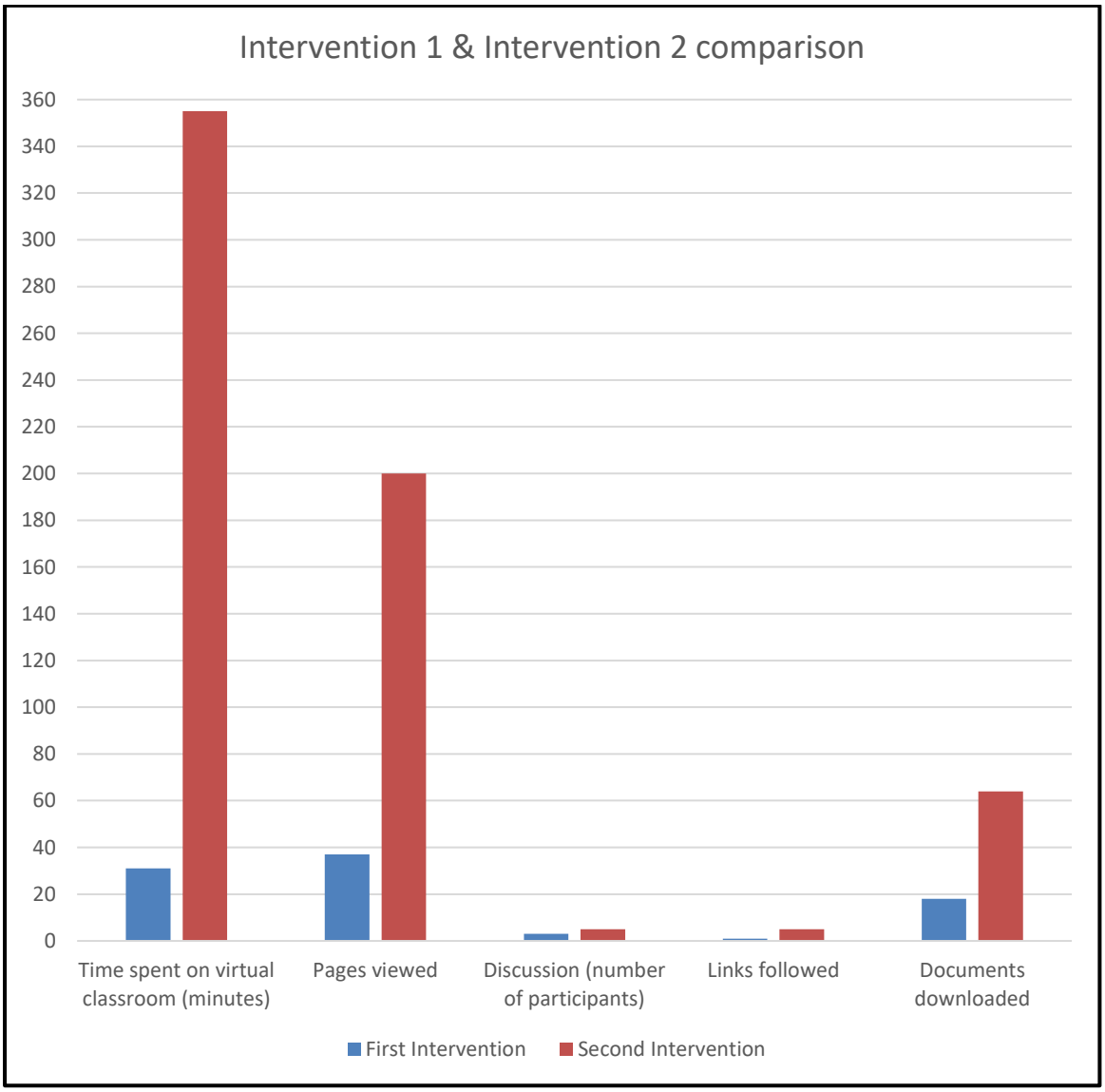


Figure 17: Intervention 1 and intervention 2 comparison

As illustrated in Figure 17, the second intervention had a lot more participants and activity on the virtual classroom than the first intervention. Although the second intervention indicated an increase, not all participants were active users.

Although the difference between the two interventions with the discussion and the links followed were not clearly visible on Figure 17 and Table 4 contain the exact values.

Comparison of the first and second intervention results.

Table 7: First and second intervention data

Type of data for participants	First intervention	Second intervention	Result
All	69	170	Increase 101
Assessment 1	N/A	1	
Assessment 2	N/A	6	
Assessment 3	N/A	1	
Discussion	5	6	Increase 1
Files downloaded	18	64	Increase 46
Links	1	5	Increase 4
Pages viewed	37	200	Increase 163

From the table the use of discussion increased by one and the number of links followed increased by four.

Comparing the results of the first and second intervention, it is clear that the second intervention was more often used and more aspects of the virtual classroom were used. All aspects compared showed an increase from the first to the second intervention. Concluding, the modification and changes made increased the usage of the virtual classroom. The number of interactions increased, the number of participants using the virtual classroom increased, the number of links accessed and files downloaded also increased.

b. Post-survey

The post-survey, Appendix C, questions, similar to the pre-survey questions, were categorised according to the conceptual framework. Figure 18 is an illustration of the conceptual framework and the allocation of the post-survey's question numbers. A summary of results is provided first, after which each aspect in the COI is discussed separately.

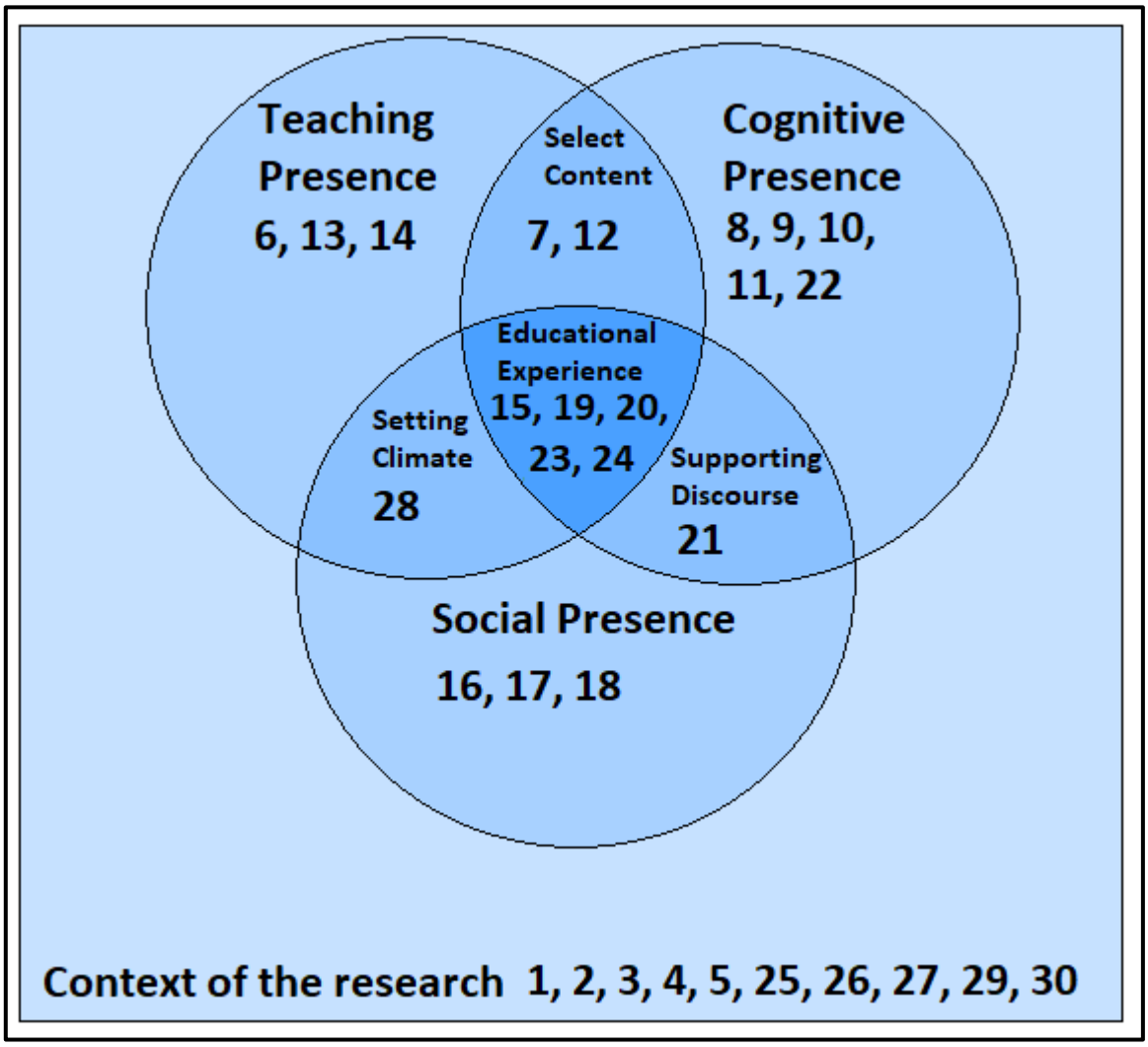


Figure 18: Post-survey question analysis according to the conceptual framework

Summary of post-survey responses

1. Participants consisted of fifteen males and twenty-five females.
2. Participants who were sixteen years of age totaled fourteen and twenty-six participants were seventeen years of age.
3. Two participants had an English mother tongue and thirty-eight were Afrikaans speaking.

4. The High School Menlo Park was the school where the research was conducted, therefore all participants were from the same school.
5. The majority of participants indicated projectors and whiteboards were used as the main teaching tool.
6. Smartphones were used by twenty-nine participants to access technological content, and eighteen participants used computers. Tablets were only used by five participants.
7. A number of five participants never accessed the virtual classroom, nine accessed it once, eleven participants used it once a month, ten made use of it once a week, three used it more than twice a week, one made use of it once a day and one participant accessed it more than once a day.
8. The participants who completed all the assessment on the virtual classroom were four, twenty-two completed some and fourteen completed no assessment at all.
9. Evenings and late evenings were the time most of the participants accessed the virtual classroom.
10. When asked about the helpfulness of the virtual classroom, thirty-four participants agreed that it was helpful, four did not agree and two did not respond.
11. Participants found it helpful that they could access the content at any convenient time. It included extra exercise and examples and the videos helped the understanding. Most of the participants who did not agree did not access the virtual classroom.
12. The virtual classroom was preferred to an extra class at a fixed time by eighteen participants, while seven participants did not prefer it and fifteen participants were unsure.
13. Those who preferred the virtual classroom to extra class did so because of convenience, and for those participants who did not was because they preferred the teacher-learner interaction.
14. The majority of participants make use of pencils or pens, highlighters, and paper or a notebook when studying. Some made use of whiteboards or technological devices.
15. The majority, thirty-seven participants, did not participate in the discussion, two indicated they participated and one did not respond.

16. Participants did not provide a reason for not participating.
17. The majority, thirty-three participants, found the virtual classroom helpful, five did not and two did not respond.
18. Examples, pictures and discussions were what most participants indicated that they preferred in the virtual classroom.
19. Positive aspects of the virtual classroom were the ease at which it could be accessed, availability of additional information and examples and convenience. Negative aspects included the data used, difficulty using the virtual classroom and the connectivity.
20. When asked, twenty-eight participants felt their marks would improve after using the virtual classroom, eleven felt it made no difference and one participant did not respond.
21. Most of the participants felt they had a better understanding of the content after making use of the virtual classroom (twenty-nine participants), six were unsure and five felt it made no difference.
22. Standard teaching methods scored better than the virtual classroom indicating a preference toward standard teaching methods.
23. Participants found classrooms to be more educational and easier to understand. The virtual classroom was new and participants needed to adjust.
24. The virtual classroom was an option for future use for thirty-three participants.
25. The reasons participants would make use of the virtual classroom were the convenience and extra exercises.
26. The amount of data used was a concern for thirteen participants, fifteen were not concerned and eleven participants were not concerned at all.
27. The virtual classroom was helpful and improved understanding to some extent for thirty participants, whereas six participants fully agreed and two did not agree.
28. A few minor concerns, such as data used, time available and interaction, were raised, but the majority of the participants had no complaints or experienced of drawback of the virtual classroom.
29. Participants raised arguments to improve the virtual classroom such as more examples, more problems, to be able to download the videos and be able to communicate easier with the teacher.

Context of the research (Questions 1, 2, 3, 4, 5, 25, 26, 27, 29, 30) – The sample group remained the same as from the pre-survey. The only difference was the age of the participants, because between the pre-survey and the post-survey seven participants turned seventeen years of age. Convenience and additional exercises were the main reasons for making use of the virtual classroom, while the amount of data used was the main concern.

Teaching Presence (Questions 6, 13, 14) – Stationary such as pens, pencils, highlighters and notebooks were commonly used, and in addition to the stationary smartphones and tablets were used to study.

Cognitive Presence (Questions 8, 9, 10, 11, 22) – According to the participants, four participants completed all the assessments, while twenty-two participants completed at least one assessment and fourteen participants did not complete any assessment. The virtual classroom was mostly accessed during evenings and thirty-four participants stated the helpfulness of the virtual classroom. Those participants who did not agree, did not access the virtual classroom. Although participants found it helpful, they preferred teacher interaction when content was explained.

Social Presence (Questions 16, 17, 18) – The discussion was not used by many participants due to the lack of time they had. Participants did not have questions or concerns, or they did not want to participate. Examples, pictures and discussions were the three aspects of the virtual classroom the participants preferred and found most helpful. These two answers were contradicting, because participants were not very active due to various reasons but the discussion was one of the features the participants found most helpful.

Selecting Content (Questions 7, 12) – The content selected for the virtual classroom was a physical science topic many learners struggled with during a term test, as supported by the pre-test results. Even though many learners struggle with the topic, according to the responses of the participants five participants accessed the virtual classroom once, nine accessed it once, eleven participants used it once, ten used it once a week, three used it more than twice a week, one used it once a day and one

participant accessed it more than once a day. After the research, eighteen participants preferred the virtual classroom to an extra class at a fixed date and time.

Supporting Discourse (Question 21) – According to the participants, twenty-nine felt the virtual classroom increased their understanding and comprehension of the topic, while six were unsure and five felt it made no difference. Although the majority of the participants felt the virtual classroom increased their understanding, not that many participants made use of the virtual classroom on a regular basis and the post-test results contradicted their statement.

Setting Climate (Question 28) – The intersection between teaching presence and social presence is described as setting climate. The teacher designed, developed and incorporated the social aspect into the virtual classroom. One of the main concerns about engaging this intersection was the amount of data used. Other factors influencing the decision was the amount of time available and the interaction amongst peers.

Educational Experience (Questions 15, 19, 20, 23, 24) – The virtual classroom was an integration of teaching content through an alternative teaching method and making use of a social aspect for communication. Even though the virtual classroom was developed in such a manner, thirty-seven participants did not participate in the social aspect. Only three participants engaged in the discussion, yet twenty-eight participants felt their marks would improve. The virtual classroom was a new incentive, therefore participants found it more educational during teaching in class. The virtual classroom was a possible future study method for thirty-three participants.

4.4. Pre-test and post-test

4.4.1. Introduction.

All participants were required to complete a pre- and post-test. The pre-test was completed prior to any other data collection, whereas the post-test was completed at the very end of the research. The results of both pre- and post-test were transferred to an Excel spreadsheet. This allowed analysis of each individual question, averages, worst answered question, variation in question scores, increases and decreases in scores.

As mentioned in Section 4.2.2, the pre-test and post-test were completed as indicated in Figure 13, but analysed and compared after the discussion of the intervention. Both the pre- and post-test were analysed and discussed separate and afterwards compared.

4.4.2. Pre-test.

The pre-tests were marked using a memorandum and all answers were recorded on an Excel spreadsheet for further analysis. Both pre- and post-tests were the same test containing thirty multiple-choice questions, therefore the same marking sheet was used. The average for the pre-test was 18.5 out of 30, or 61.67%. The lowest score of an individual participant was six out of 30 (20%), while the highest score was 26 out of 30 (86.67%). Question averages ranged from 15% up to 92.5%. Some participants did not answer all the questions, but the unanswered questions only amounted to seven of the thirty test questions from forty participants.

Five different statistics of the pre-test out of a score of thirty. Number of participants = 40.

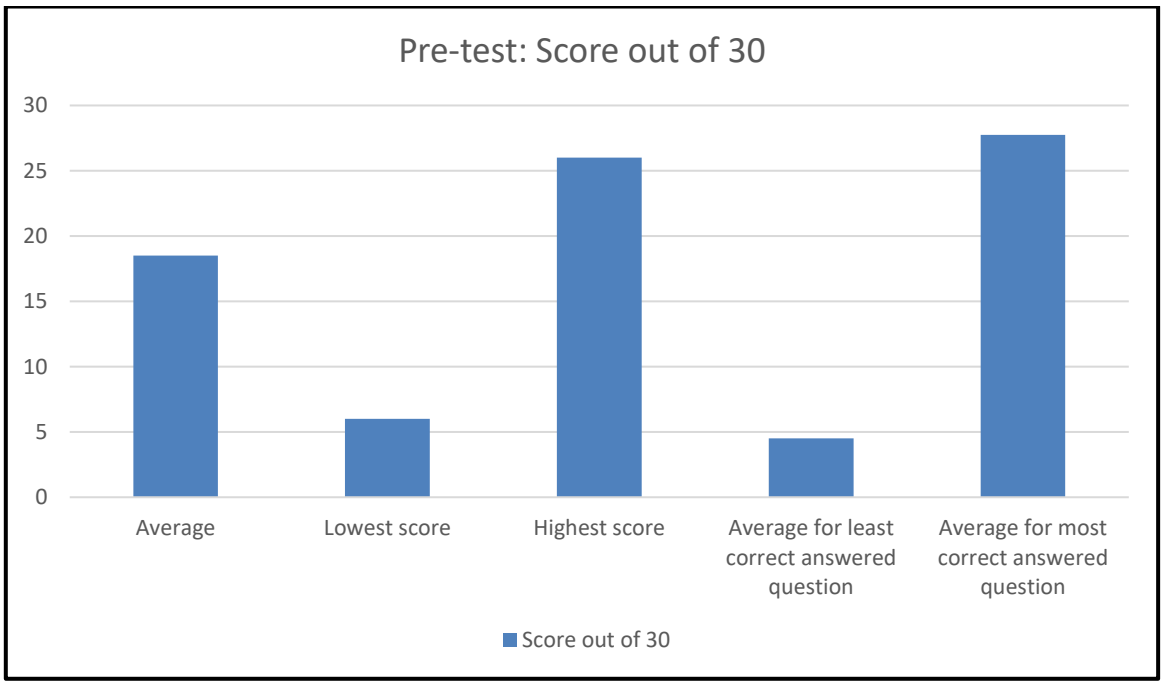


Figure 19: Pre-test score out of 30

As indicated in Figure 19, the test contained well answered questions, as well as poorly answered questions. Even though the highest score was 26 out of 30 and the lowest score was 6, the average was 18.5.

Question 5 was the worst answered question with the average of 15% and the question was the following:

> An object is dropped by an airplane in the Earth's atmosphere and it falls to the ground. Ignore air friction and consider the following statements.
> As it falls . . .
> 1. the gravitational force the object experiences increases.
> 2. its acceleration increases.
> 3. its velocity increases.
> 4. its mass increases.

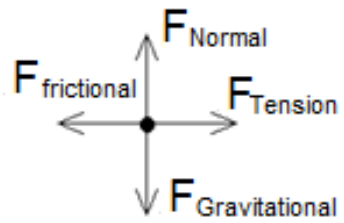
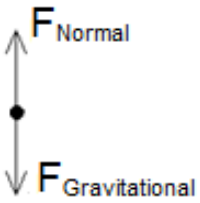
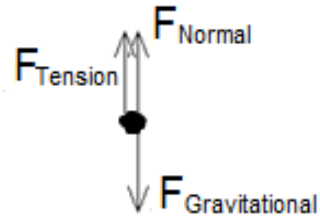
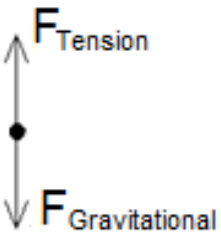
Which of the statement(s) is/are true:

A) All are true	C) Only 2 and 3 are true.
B) 1, 2, and 3 are true.	D) Only 3 is true.

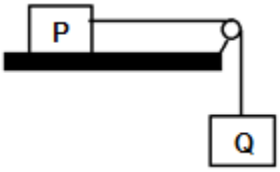
The majority of participants chose C to be incorrect.

On the other hand, the best answered questions, question 3 and question 21, scored 92.5% average and the questions were the following:

Which of the following illustrates the free body diagram of box A?

A) 	C) 	Office use
B) 	D) 	

The correct answer, and the answer most participants chose, is D.



The following question was based on the given diagram.

Which one of the two blocks will experience a normal force?

A) Q, because of the applied force upwards in the rope.	C) P, because of the surface underneath the block.	Office use
B) Q, because of the tension in the rope.	D) P, because the tension in the rope is to the right.	

Option C was the correct answer for the question, and was indicated by most participants.

4.4.3. Post-test.

The post-test was exactly the same as the pre-test. Neither the pre-test nor the post-test were ever discussed with participants to determine whether participants had better conceptual understanding of topics after the intervention. Participants scored on average 17.725 out of 30 for the post-test (59.08%), which was slightly lower than the results of the pre-test. The participant with the lowest score for the post-test scored 9 out of 30 (30%) and the highest score was 26 out of 30 (86.67%). Although the highest score for the pre- and post-tests were the same, the lowest score for the pre-test was less than the post-test. Question 9 was the worst answered question with an average of 12.5%.

Five different statistics of the post-test out of a score of 30. Number of participants = 40

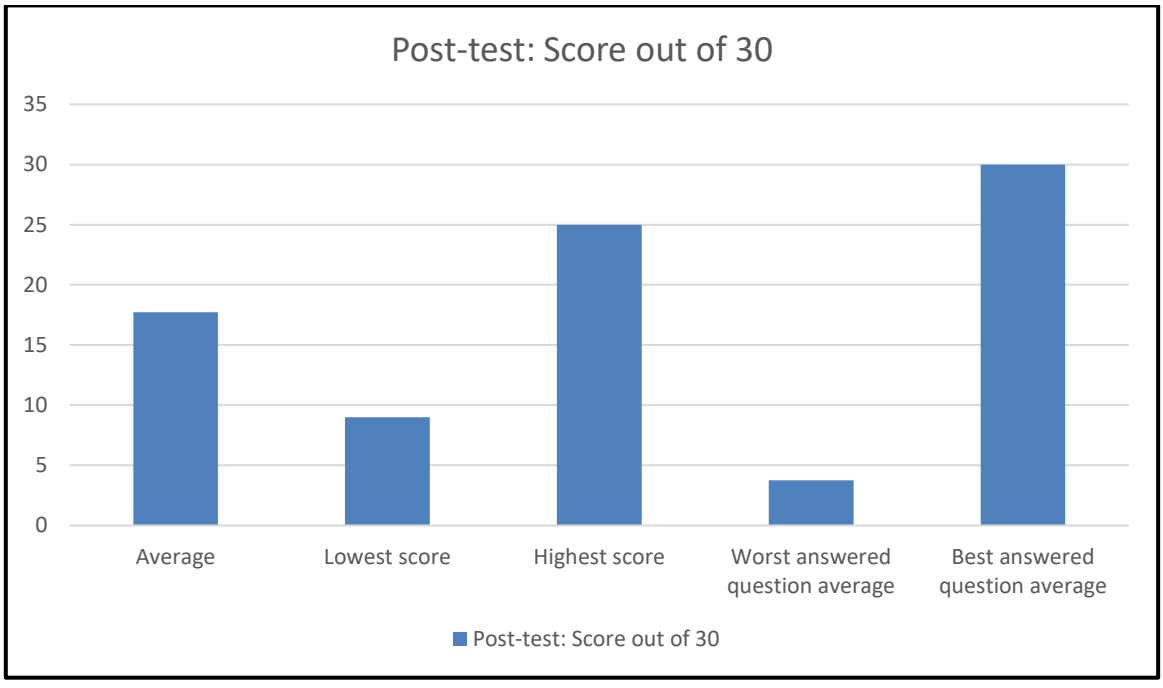


Figure 20: Post-test score out of 30

Similar to Figure 19, Figure 20 illustrates the range between poorly answered questions and poor performances and well answered questions and peak performances.

Question 9

If a horizontal force is exerted on an object on a flat surface and the object is not moving, which one of the following statements is true?

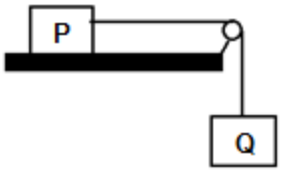
A) Applied force = frictional force	C) Frictional force is less than applied force	Office use
B) Applied force is less than frictional force	D) Both the applied force and the frictional force are equal to 0N	

The correct answer for the question is option A, yet most participants chose option B.

The best answered question was question 21 with a 100% average.

The following question is based on the given diagram.

Which one of the two blocks will experience a normal force?



A) Q, because of the applied force upwards in the rope.	C) P, because of the surface underneath the block.	Office use
B) Q, because of the tension in the rope.	D) P, because the tension in the rope is to the right.	

The correct answer for the question is option C.

4.4.4. Comparing pre-test and post-test results.

When considering the effectiveness of the virtual classroom the results of the pre- and post-tests were more crucial. The average of the pre-test was 18.5 out of 30 (61.67%) compared to 17.73 out of 30 (59.08%) for the post-test. In itself the difference in averages were insignificant. Interestingly the lowest score for the post-test was three points higher than the lowest score of the pre-test. Since not all participants accessed

or engaged the virtual classroom, the results of the pre- and post-tests of the participants were compared. Even though sixteen participants made use of the virtual classroom in some form, the overall results of the post-test did not indicate an improvement.

The results of the participants who accessed the virtual classroom showed an increase for some and a decrease in score for the others. That being said, the responses of the post-survey indicated that two participants did not feel they had a better understanding of the topic because of the virtual classroom, of whom one made use of the virtual classroom.

The results of the pre- and post-tests did not indicate any significant impact made by the virtual classroom. For the pre-test the average deviation was 3.6 and for the post-test 3.55. On average, the participants fluctuated less from the average in the post-test than their performance in the pre-test, yet the difference was 0.05. When converting the scores to percentage the difference was 0.17%. In perspective, the difference in average deviation was barely noticeable.

Comparison between the results of the pre-test and the post-test.
Number of participants = 40

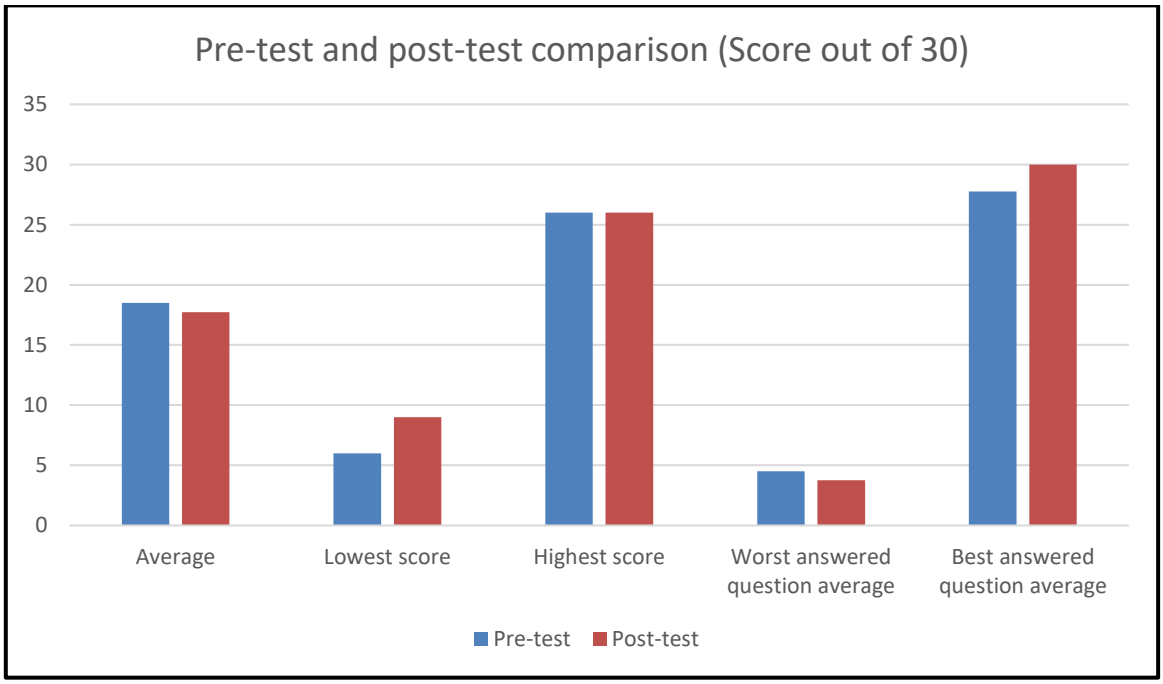


Figure 21: Pre-test and post-test comparison

Top five participants' results:

As seen in Figure 21, the results of the pre- and post-test were similar, but the focus of the research was to determine the effectiveness of the virtual classroom as an alternative source of education and information. Therefore, the top five participants who spent the most time using the virtual classroom were considered and their test results were compared. The reason for selecting the top five participants was that 63% of the total time spent on the virtual classroom was due to the top five participants.

Comparison of the test results (mark out of 30) for the top five participants.

Table 8: Top five participant's test result compared

	Pre-test result	Post-test result
Participant 1	20	25
Participant 2	22	22
Participant 3	22	17
Participant 4	21	18
Participant 5	18	20

Three of the five participants presented an increase from the pre-test to the post-test results. Participant one spent 92 minutes on the virtual classroom and had a five marks increase. Participant two spent 39 minutes and scored the same. Participant three and four scored lower, but participant five had a two marks increase with 28 minutes spent on the virtual classroom.

When considering the overall results of the pre-test and post-test, the results differ slightly. The average of the pre- and post-test differs by 0,77%, the lowest score differs by three points, while the highest score was the same for the pre-test and post-test. The average for the question with the most incorrect answers differed by 0.75 points between the pre-, and post-test, whereas the question with the most correct answers differed by 2.25 points. Figure 21 illustrates the similarity in the overall comparison between the pre-test and the post-test.

Although the overall results of the pre-test and post-test were similar, a difference occurred when considering each individual participant. The participants who made use

of the virtual classroom on a regular basis, indicated a greater increase, compared to the participants who did not make use of the virtual classroom. Because not all the participants made use of the virtual classroom, the average scores did not indicate any increase.

4.5. Assumptions

The main focus for the research was to determine the effectiveness of mobile social learning. Three assumptions were made prior to the research: Availability of mobile devices, motivation of learners, and the topic for intervention.

4.5.1. Availability of mobile devices.

Because the main focus required participants to own mobile devices, the biggest assumption was the possession of smartphones and/or tablets by all the participants. Although all the participants possessed at least a smartphone with which they were able to access the virtual classroom, it was an assumption at the beginning.

4.5.2. Motivation of the learners.

Assuming learners will be motivated to make use of the virtual classroom proved to be a limitation, because in the absence of learner participation the effectiveness of mobile social learning cannot be determined.

4.5.3. Topic for intervention.

Grade 11 Physical Science contains many topics and an assumption was made that Newton's Laws were one of the topics learners found most difficult. Evidence from the Department of Education did support this assumption, but were for different districts and provinces and not school specific.

4.6. Conclusion

According to the pre-survey and post-survey responses, learners were keen and eager to make use of the virtual classroom. Technology allows for incorporation into classrooms and producing an alternative teaching method, and allowing learners to access academic content ubiquitously.

The virtual classroom used in this research was not accessed and engaged with by all participants, as they indicated in the pre-survey and post-survey. A personal assumption of the researcher is that it was due to the newness and uncertainty of learners. The second intervention was more used than the first intervention. The researcher assumes that once learners became familiar with the technology they might make use of it more often. For future research to increase the level of usage, the virtual classroom should not be an additional source of content learners are referred to, but rather an incorporation into the classroom. Having assessments, PowerPoint documents, additional exercises, previous test papers and discussions available could encourage learner usage.

5. Chapter 5: Conclusion

5.1. Introduction

This chapter commences with a discussion of the research questions and comments on the sample group, the use of the virtual classroom, physical science as a subject, the intervention period and factors influencing the data. This is followed by a discussion on the conceptual framework as well as the set of proposed guidelines. Lastly the limitation, reflection on the research process as well as recommendations and improvements for future research are presented.

5.2. Revisiting the research questions

The focus of this research was to determine the effectiveness of using an Open Educational Resource as a teaching medium, while incorporating a social aspect for learners to communicate. This led to the research questions.

Secondary research questions

1. How do learners interact with each other and their study material through technology?
2. How can these interactions be incorporated in learning?
3. Which role can OER play as a vehicle for interactive learning?

Primary research question

- How can interactive learning through Open Education Resources (OER) support Grade 11 learners in science education?

Secondary research questions

1. The pre-survey indicated most learners made use of social media for communication with friends and family. Social media is being used for educational purposes as well and mainly to send and request information or notes. The communication and interaction amongst learners are far less than expected.
2. As indicated on the pre-survey, learners do communicate with friends and family via various social media and interaction platforms. The interaction was

incorporated into the virtual classroom by making use of the features of the platform. Participants had the opportunity to communicate with peers or teachers about any concerns, problems, questions or difficulties they encountered. Even though participants were given the opportunity and were encouraged to make use of the interaction, few participants did. For future research, the incorporation of the interactions needs to be changed.

3. Open Educational Resources can be used as an effective educational tool. With the increase in usage in technological devices, applications and functions of these devices, OER does pose as an effective educational tool. This provides learners access to content at any given time and place, as some of the participants in the research did, as well as allowing learners from different schools to access content.

Primary research question

Interactive learning through an Open Educational Resource can support Grade 11 learners in science education. Although the research indicates participants who made use of the virtual classroom on a regular basis and improve their understanding and inevitably, their marks, there are conditions for this to be effective. The participants who found the virtual classroom to be useful and effective were the participants who accessed the virtual classroom on a regular base and made use of all the aspects, such as the videos, simulations, tests and downloadable documents. The participants who felt the virtual classroom to be ineffective were the participants who rarely, if at all, accessed the virtual classroom.

Education is South Africa is a major concern due to the lack of teachers (de Villiers, 2017; Gumede, 2017; Hofmeyr & Draper, 2015), the lack of resources (Considine & Zappalà, 2002; Mji & Makgato, 2006; Mushtaq & Khan, 2012; Taylor, 2008), the quality of education (Armstrong, 2015; Ndlovu & Lawrence, 2012) and learner performance. According to TIMSS results, South Africa placed near the bottom of each category during the worldwide research for mathematics and science education (HSRC, 2016; Martin et al., 2012).

Technology is being used to improve education through various methods and approaches. Video games (Annetta et al., 2014; González et al., 2016), interactive

videodisc systems (Carter et al., 2016), and smartphone integration (Chu et al., 2010; Hwang et al., 2011) are all methods used by teachers to increase teaching effectiveness. Teachers select and implement these educational methods and monitor learner progress throughout the process.

Technology's usage increased dramatically over the last couple of years, resulting in an increase in social communication. Teachers realised the tendency and incorporated it into different classrooms. (Balakrishnan & Gan, 2016; Boticki et al., 2015; Milošević et al., 2015). Because technology, more specific the social component, is new, there are aspects to consider when incorporating or planning incorporating social media and interaction into classrooms (Anderson, 2012; Balakrishnan & Gan, 2016; Milošević et al., 2015).

The incorporation of technology or social media into classrooms is done for one main reason, to improve education. Different approaches, teaching methods or platforms can be used, but the focus of all are to increase learner understanding and comprehension, thus increasing learners' cognitive levels. This requires learners to solve problems, analyse situations, think critically, consider and evaluate various solutions (Brahimi & Sarirete, 2015; Chin & Chen, 2013; de Sousa Monteiro et al., 2016; Ke & Hsu, 2015; Reychav & Wu, 2015; Sung et al., 2015).

The responses of the participants in the pre-survey indicated the use of mobile devices for communication and entertainment. When asked, participants were excited and enthusiastic about the virtual classroom and were keen for the incorporation. This seemed to have an overall positive effect on the participants, as reported in various studies. Research by Alfahad (2012), Archer, et al. (2014) and Guzey and Roehrig (2009) revealed a positive effect when incorporating technology into classrooms as an educational instrument.

After the pre-survey, the participants were required to complete a pre-test, later to be used for comparison. The pre-test was based on a preselected topic, due to the difficulties observed during class.

The responses of the post-survey indicated the participation, better understanding and the effectiveness of the virtual classroom. Participants valued the virtual classroom as it provided additional study material, short tests and, explanations all of which they could access from home.

Contradicting the responses were the participant activity recorded on the virtual classroom via Haiku learning and the test results. Only a few of the participants made use of the virtual classroom, and not continuously, during the intervention period; while other participants claimed to make use of it.

The results of the pre- and post-tests of all participants were similar, even the averages only differed slightly. Analysing the results of the tests of the participants who did not engage in the virtual classroom, the results of the pre- and post-test were similar. When focusing on the participants engaging in the virtual classroom, the results did improve. The participants who made use of the virtual classroom on a regular base, accessing all aspects, and completing the tests did perform better during the post-test.

Not all the participants using the virtual classroom scored higher in the post-test. Some participants' score decreased from the pre-test to post-test even though they used the virtual classroom occasionally. Not all research focusing on the use of technology in classrooms reveal a positive effect. Schleicher (2015) reported the struggle of schools using technology for education. When incorporating technology into classrooms, the effectiveness is unknown, but various aspects should be considered. The effect of technology should not only be measured by the results of learner performances, but the effect of learning abilities, social aspects, less teacher attention and no sense of sitting in class and communicating with peers (O'Brien, 2018).

The main focus of the research was to determine the effect of social mobile learning of Grade 11 Physical Science learners. Since most of the participants did not use the discussion, which was referred to as the social aspect, it is difficult to determine whether or not it had an effect. Although it was difficult to determine the effectiveness, one issue is clear: The majority of the participants who did not use the virtual classroom and the discussion, saw no change in their results. Because some participants did not engage in the virtual classroom the following can be concluded: If

the participants did not find the need or value to make use of the virtual classroom, they will not make use of the discussions. Even though the responses of the pre-survey indicated participants would have liked to make use of the virtual classroom, as soon as they had the responsibility to access the virtual classroom and participate in the discussion, they did not execute.

When considering the test results, the outcome is no different than the results of Haiku learning. The results of the pre- and post-test were compared and a slight difference was present. Although there was a difference, the difference was small. Considering the median and the standard deviation, the results were the same.

Lastly, when the results were compared between participants who participated in the virtual classroom on a regular base and the participants who did not, there was a difference. Participants who made use of the virtual classroom revealed an increase for the pre-test to the post-test.

Haiku learning can be used as an Open Education Resource for Grade 11 Physical Science learners during which learners can access various aspects of the virtual classroom. A discussion can be created on the virtual classroom, allowing learners to communicate and interact with peers and the teacher. Although currently learners are using various social media to interact and access study material from their smartphones, the virtual classroom was developed as a source of both interaction with peers and accessing study material. As recommended in Section 5.4, if the OER is not referred to as an additional or optional resource, but incorporated into day-to-day classroom teaching, OER can be used for interactive learning.

In conclusion, social mobile learning for Grade 11 physical science learners can be an effective teaching method under the right conditions, one of which is the regular use of the virtual classroom.

5.2.1. Sample group.

The sample group was not selected to be diverse, nor was it selected based on quantity, but the sample group was selected by convenient sampling for Grade 11 learners with physical science as subject. Therefore, the results and findings were specific to the circumstances of this research. The possibility does exist for this research to be repeated but with a small alteration such as: different age group, change in subject, different province or area or slight change to the intervention. Such a change might result in different findings to what this study produced. These alterations can be made to widen the research and cover what has not been covered during the research because of limited time available and the lack of resources.

Selecting more schools does have the potential to provide insight of the effect of open and ubiquitous learning in a different manner. A more diverse sample group can be obtained and a variety of schools can represent the population.

5.2.2. Use of the virtual classroom.

The virtual classroom was used as an alternative method instead of a scheduled extra class. By incorporating the virtual classroom as a teaching aim it might contribute more. As can be seen in a scheduled extra class, learners enquire about the time and place of the extra classes but do not attend, similar to the results of the virtual classroom. By incorporating the virtual classroom in your day-to-day education, it might contribute more and be more effective.

5.2.3. Physical Science as subject.

The focus of the research is on physical science as subject, but by expanding to different subjects the results are broadened. The effect of the virtual classroom on other subjects is not known, therefore to broaden the effect the virtual classroom can be incorporated in different subjects.

5.2.4. The intervention period.

The virtual classroom was new to the learners and the period of the intervention might be extended to provide learners with enough time to be comfortable with the use of the virtual classroom, as well as the time when the intervention period is active. During this research, the first intervention was prior to the June exam, whereas the second intervention period commenced after the exam. Different times during the year can affect the outcome of the research.

5.2.5. Factors influencing data.

The results of any research are seldom without any influencing factor. An influencing factor is a factor affecting the results of the research, but is not planned as part of the research. Thus, the results of this research could not be without all influencing factors and this should be considered in the research.

Participants in the research was Grade 11 learners. It is possible for learners to not perform as well at the beginning of the year but during the course of the year realise the essence of their Grade 11 results. Usually tertiary institutions require applicants' Grade 11 marks for conditional approval of the applicants. Therefore, it is important for Grade 11 to take responsibility and work towards their goals, leading to better results towards the end of the year but this effect is not caused by the intervention. The increase in marks is influenced by self-motivation and responsibility taken.

The results of the tests can be influenced by participants not knowing the answer, but by guessing. It is possible for participants to guess the correct answer in one of the two tests and not do it in the other test. Guessing of the answers is seen as an influencing factor.

Busy daily schedules of the participants could result in fewer participants accessing the virtual classroom. A busy day to day schedule could force participants to complete the most important task at hand first before attempting the next task, leading to a decrease of activity on the virtual classroom.

The time of the year can influence the participation and results greatly. Different times during the year were used for the intervention period. An intervention period took place, then the intervention was modified and altered and implemented a second time, because the ADDIE model was used to develop the intervention. The first intervention was prior to the June exams, while the second intervention took place after the exams. Exam time can be a motivation for participants to work harder and seek alternative teaching methods, exercises and help.

5.3. Conceptual framework conclusion

The conceptual framework used for this research was the Community of Inquiry (Garrison et al., 1999). This framework contained three intersecting aspects: teaching presence, cognitive presence and social presence. The focus of the research was to obtain the educational experience, the area of intersection of all three aspects.

Teaching Presence

Teachers are required for teaching presence, as teachers conduct and focus teaching, guide learning, instruct learners, and select and compile study material in various forms. Social presence and cognitive presence cannot be as efficient without teaching presence to facilitate learning. (Garrison, 2007; Garrison et al., 1999).

The researcher developed the online virtual classroom, designed the tests for learners to determine their level of understanding and the questions to encourage learners to participate in the discussions. Even though the researcher was available and approachable, no participant engaged. The topic selected by the researcher was due to the lack of understanding of the topic among learners.

Cognitive Presence

Cognitive presence can be found in the content or the material that is taught through the selected teaching method. During the cognitive presence phase, learners are required to develop and train their ability as critical thinkers. Critical thinking is crucial to explore new content, design and develop possible solutions to problems and evaluate the success or efficiency of the implemented solutions.

In order to achieve the cognitive presence, participants were required to develop the skill of critical thinking. The practical inquiry model assists and guides the critical thinking process. Participants who engaged with the virtual classroom were able to develop the skill of critical thinking. These participants were able to understand the problem they encountered, analyse possible solutions and apply a solution to the problem.

Social Presence

Social presence is the ability of subjects to project their social and emotional aspects through a medium of communication. Skills, motivation, context created communication, activities, organisational commitment and the amount of time using media are aspects through which social presence is defined. The value of social presence is to enhance cognitive presence and critical thinking through communication.

The research included an interaction aspect referring to the social presence. In order for the social presence to be achieved, interaction and communication are needed. Participants did not interact and communicate much, as for the discussion, the participants did not engage in the discussion. The social presence intended was not achieved and it is recommended in future research to increase social interaction.

The conceptual framework is a guideline for teaching instructions incorporating social, teaching and cognitive presence. The focus is for all presences to be incorporated to encounter the educational experience. During this research, it was difficult to incorporate all three presences simultaneously. The first intervention indicated the absence of the social presence, leading to analysis of the intervention and improving it to include the social presence. Due to the improvements, participants encountered the educational experience during the second intervention.

The conceptual framework was designed for online education, which simplified the process of developing and incorporating social opportunities for participants. Community of Inquiry framework can easily be adapted to suit the needs of the planned research. Because this research made use of communication as an online educational medium, the community of inquiry framework was selected amongst the

considered frameworks. It was adapted into the virtual classroom as designed and developed on an educational platform. After evaluating the framework and the research, limitations were identified and recommended improvements were advised.

5.4. Guidelines implementation

5.4.1. Guidelines to incorporate Community of Inquiry framework.

The following table, as discussed in Section 2.3.2 contains the essence of the theoretical framework, as all the elements should be incorporated and achieved for a successful incorporation of the Community of Inquiry framework.

Table 9: Guideline to incorporate COI framework

Framework presence	Crucial aspect to achieve
Social presence	Effective communication (effective expression), group cohesion, and open communication.
Cognitive presence	Critical thinking requires a person to explore content, construct ideas, solve problems and reflect.
Teaching presence	Teaching presence refers to the presence of a teacher to conduct and focus learning on a pre-determined topic in an online environment.
Supporting discourse	Encounter different learners' perspectives and necessitate critical thinking.
Selecting content	Design, facilitate and provide instructions based on the content selected to promote critical thinking.
Setting climate	Responsibility of the teacher to guarantee learning takes place through interaction and not letting learners get distracted.
Practical inquiry model (process of cognitive presence)	Triggering events, explorations, integration and resolution.

Social presence – The participants did not engage much in the social interaction. Only three of the participants engaged in social communication. Although the number of

participants increased from the first to the second intervention, incorporating social presence for future research must be a priority.

Cognitive presence – The content selected for the virtual classroom is prescribed by the Department of Basic Education. Critical thinking was required by the participants to construct ideas of possible solutions and apply the solutions to obtain answers. Participants were required to do so during the pre-, and post-test, online test and problems stated for participants to solve.

Teaching presence – The virtual classroom was constructed and developed by the teacher. All content had been developed and implemented including tests, questions, content, videos, simulation and problems. As for the communication, the teacher was available for interaction and communication, but was not engaged. For future research, the researcher could encourage participants through social interaction. By doing so the researcher will open the interaction and participants might feel at ease to interact.

Supporting discourse – Various aspects were included in the virtual classroom for participants with various study needs and preferences. The researcher believes that the inclusion of more aspects for various study methods is not necessary. Too many options could confuse participants.

Selecting content – The content selected for the virtual classroom covers a chapter learners find difficult. As this is a prescribed chapter by the Department of Basic Education, it was used for the research. All the content and design of the virtual classroom were done to increase the ease of study for participants.

Setting climate – The researcher created a learning environment with the virtual classroom for the participants. By increasing the social interaction amongst the participants, problems might occur by setting the climate and focusing participants on content.

Practical inquiry model – The practical inquiry model was incorporated in the virtual classroom through the stated problems. The problems were the triggering events,

participants were required to explore possible solutions, integrate the methods and solutions and resolve the problems.

5.4.2. Trustworthiness and the Hermeneutic principles.

Trustworthiness:

Trustworthiness is an important aspect to consider during qualitative research. The following are aspects to assist in ensuring the trustworthiness of the research.

Confirmability is the extent to which the data collected and findings made can be confirmed by other researchers. The findings of a research cannot be made on fragments of the data collected.

Credibility can be described as the confidence in the findings because of the interpretations made based on the data gathered from the participants. The interpretations should be correct and accurate according to the data obtained; this ensures the credibility of the findings.

Dependability refers to the accuracy of data collection. The focus of all data collection methods should be to answer the main research question. Data gathered from different sources should support each other.

Transferability is the ability of the research to be transferred to different locations or different subjects. The focus is to gather data from different participants to answer the same research question. Although different participants could be used, they need to meet the requirements as used in the first study in order to be valid.

Triangulation requires the use of various methods to obtain data for comparison to support the results and findings with various data. This helps to reduce the level of bias from the researcher. (Anney, 2014; Moon, Brewer, Januchowski-Hartley, Adams, & Blackman 2016; Shenton, 2004).

Hermeneutics:

Hermeneutic principles are seven crucial principles to further evaluate the trustworthiness of interpretive research and was designed and developed by Klein and Myers (1999). Each principle values and focuses on different aspects of the interpretive research, as discussed in Section 3.3. These seven principles were used to evaluate the research.

Fundamental principles of the Hermeneutic circle

The virtual classroom contained various teaching materials to support learning. All of the materials focused on the same content and the goal was to improve participant understanding of the content.

Contextualisation

The content selected to base the research upon was specifically selected because of the poor learner performance for the past two years. Learners cannot avoid the topic, as it is a prescribed topic by the Department of Basic Education for Grade 11 physical science learners.

Interaction between the researchers and the subjects

The researcher was available upon participant's request for assistance or guidance, which raises the possibility of being biased. Therefore, the research included quantitative data for the tests and the data recorded by the virtual classroom. The quantitative data was compared with the qualitative data to minimise the bias factor. Although the researcher could be biased and the quantitative data was included as precaution, the researcher was not approached by the participants on the virtual classroom and very little researcher – participant interaction occurred.

Abstractions and generalisation

The content in which the data was collected was described and various data collection methods were used, in order to compare data or to support various conclusions.

Dialogical reasoning

The literature did provide contradicting content as the majority of the literature revealed positive feedback and results on the incorporation of technology in classrooms, while some literature did not share similar positive results. This research indicated the effect of participants who fully engaged in the virtual classroom, but for future research, a crucial improvement should be to increase the number of participants who fully participate.

Multiple interpretations

The data of this research revealed and increased the understanding amongst the participants who fully participated. Different interpretations of the data are possible by different people, such as how to increase the number of participants engaging.

Suspicion

The researcher was the teacher of some of the learners which could lead to possible bias. Therefore various data collection methods were included to compare the data. In the classroom the researcher engaged with more learners than the ones participating in the research. Even though the participants could engage with the researcher through the virtual classroom, none did. The lack of interaction reduced the risk of bias.

5.5. Limitations

This research, similar to other research, revealed shortages and areas for future research or improvements. While the pre-survey responses indicated the interest of participants to incorporate the virtual classroom into their study routine, the activity of the virtual classroom did not reveal similar results. Participants were keen to make use of the virtual classroom, but once they had the opportunity not all participants made use of it.

Social interaction was incorporated into the research but due to the lack of participant activity on the virtual classroom, the social interaction was not used to full effect. The social aspect was incorporated to allow participants to communicate, assist and guide any of their troubling peers, or to raise questions they might encounter. Although the

idea was for the participants to communicate and assist each other, the researcher was available to ensure the advice and guidance given were scientifically correct. Should none of the peers have an answer to a question the researcher could intervene and provide an explanatory answer.

After evaluating the research and the shortages personally, the reason for the above-mentioned shortages was found to lie in the incorporation of the virtual classroom. The virtual classroom was designed and implemented as an additional source of information for learners. Participants were constantly reminded to make use of the virtual classroom,

5.6. Recommended research

Future research can be done in order to improve the effectiveness of an online OER intervention, based on the community of inquiry framework. Two changes are recommended. Firstly, instead of using the virtual classroom as an additional class, it can be incorporated into classrooms as a teaching aid. Class tests can be set on the virtual classroom for learners to complete and the results could be used for school grading purposes as well. Class notes, PowerPoint slideshows, tests of previous years, additional examples, worksheets and explanations can be incorporated into the virtual classroom and learners can be allowed to access and download what they require.

The second alteration is to include the social learning aspect, but not make it the main focus. The social learning can be used for learners to ask questions, but to determine the effectiveness learners need to use the interaction. Incorporating technology into classrooms is at its starting phase, therefore changes and improvements needs to be made regularly and more importantly, learners require the time to accept and use the various techniques.

5.7. Reflection on the research process

Reflecting on the research, the process allowed for various new aspects encountered and new skills developed. During the research the ADDIE model needed to be incorporated for the development of the intervention, as well as the evaluation of the intervention in order to change and improve it for the second implementation. Before the ADDIE could be incorporated, research was done to understand the use and goal of the ADDIE model.

The research, specifically the literature review, requires tremendous amounts of detail. This process forces any researcher to become well informed and educated about the field of study. Analysing literature to determine the applicability to the research requires the researcher to critically analyse, evaluate and incorporate the literature into the research.

Prior to the data collection, it was expected that the learners would access the virtual classroom regularly, make use of all the features and engage in the communication and discussions. The reason for this expectation was the learners' response prior to the research and learners said they did not attend extra classes due to other activities on the same day and time. Therefore, they would have preferred the virtual classroom as they could access it from home. The results contradicted the initial expectations, therefore changes and improvements were made to the intervention. After the changes, participants engaged more in the virtual classroom, but still not nearly what was expected. This contradiction forced the researcher to evaluated and determine possible reasons for this phenomenon.

Looking at the increase from the first to the second intervention, it seemed like a big increase, but when looking at the number of assessments completed in the second intervention, it remained few. All forty participants were required to complete assessments one, two and three. One of the forty participants completed assessment one, six of the forty participants completed assessment two, and one of the forty participants completed assessment three.

To summarise the reflection, this research allowed development of critical analysis of literature, to determine the relevance to the current research, categorise literature into similar topics and discuss the literature in terms of the theoretical framework. Even though the results of the research were not what was expected, it required o adaptation and the making of changes to improve the intervention phase. The improvements did reveal more interaction of the participants, but still not what was expected. Evaluating the research to determine possible reasons for this phenomenon, critically analysing the data, and reaching a conclusion were all skills that needed to be developed.

5.8. Conclusion

Concluding, the results of the research indicated the effectiveness of the virtual classroom, if being used regularly. As for the participants who seldom, or never made use of it, they did not find the virtual classroom to be an effective tool. Learners do interact through social media, but seldom for an explanation of assistance for those in need, therefore the method of interaction and the incorporation of the interaction medium is crucial. Open Education Resources do pose an effective instrument for education. One of the main drawbacks of making use of an OER is the technological devices learners are required to have in order to access content.

Recommended improvements for future research are to incorporate the OER into classrooms as a medium for learners to access content and for them to pose questions or difficulties they might encounter. By incorporating the OER into the classroom, learners are more encouraged to make use of it rather than seeing it as a platform for additional content. The second improvement is the incorporation of the social aspect. Learners do not feel comfortable asking questions in groups, by making the interaction and communication personal learners will not feel as exposed. By making this alteration, learners might feel more comfortable to make use of the interaction more often.

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Appendix A: Consent forms

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Faculty of Education
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Letter of permission – Headmaster/ Governing Body

February 2017

Dear Headmaster / Governing Body

Mobile technologies in teaching and learning Physical Science through Open Education Resources.
I am a Masters student at the University of Pretoria, supervised by Dr. Ronel Callaghan, and I am curious about the use and effects of using mobile social learning through Open Education Resources as an educational medium. I request the participation of all grade 11 learners with Physical Science as subject, as well as grade 11 Physical Science teachers in a research project. All activities in this research will be after school hours.

The research investigates the use of mobile social learning to provide education for Grade 11 learners in Physical Science as subject. Learners can access educational material online, on an allocated Open Educational Resource with pre-developed modules based on different Physical Science topics. The educational material can be accessed by a mobile phone or a tablet, the only requirement is internet access from the mobile device/s. At the end of each module learners can discuss the content, raise questions or problems, or any uncertainties they might have. Each module is created based on the content learners need to know as prescribed by the CAPS document.

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Each learner participating is required to complete a pre-survey and a pre-test, after which learners are given the opportunity to access the online educational resource. Once the intervention period expires learners are requested to complete a post-survey and post-test. All surveys and tests are to be completed outside class periods as not to consume educational time. Teacher/s participating in the research need to hand out surveys and tests and inform learners about the online educational medium. The research will commence on 6 February 2017, starting with the pre-survey, and the end of the research period is 30 April 2017.

The table that follows indicates the proposed dates, duration and activity to be completed.

Start date	End date	Activity	Where	When
6 Feb 2017	10 Feb 2017	Pre-survey	Classroom/s	After school hours
13 Feb 2017	17 Feb 2017	Pre-test	Classroom/s	After school hours
20 Feb 2017	31 Mar 2017	Intervention	Preferred place of participant	Preferred time of participant
1 Apr 2017	10 Mar 2017	Post-test	Classroom/s	After school hours
11 Apr 2017	20 Apr 2017	Post-survey	Classroom/s	After school hours
21 Apr 2017	30 Apr 2017	Interview/ focus group	Classroom/s	After school hours

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Process of the research

The entire grade 11 Physical Science learners will be approached to participate in the research. It is the right of the learners to choose whether or not to participate. Once all the participants have been established a time (after 2 o'clock pm), date (2 Feb – 10 Feb) and place will be arranged for the completion of the pre-survey. Likewise with the pre-test the participants will be informed about the time (after 2 o'clock pm) and date (13 Feb – 17 Feb) and ideally the same location will be used. During the period from 20 February 2017 to 31 March 2017 participants can access the database used for the intervention, where participants can select different modules. No location or time will be arranged as participants can access the modules at any given time or place, assuming they have internet access from their mobile devices. Once the intervention period elapsed, arranging a time (after 2 o'clock pm), date (1 Apr – 10 Apr) and place for the post-test will commence. Shortly after (11 Apr – 20 Apr) the completing the post-test all participants are required to complete a post-survey. During the last week of research, interviews/focus groups will be held for not more than 10 participants.

The results of the research can provide information about the use of mobile devices amongst Grade 11 learners. Pre- and post-test results might indicate if the mobile social learning does have any effect on the understanding of certain topics amongst learners. As for the surveys, it provides information about the mobile social learning such as, the ease of use, possible changes to be made, do they prefer to make use of it and can learners easily access the content.

All learners and parents do have to choice to take part in the research or not.

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Should you agree to allow your school to participate, please read the following and sign the letter of permission:

- I consent that data can be collected from activities and reflections on the activities, as well as from the survey, tests and interventions/focus groups.
- I authorize the researchers to use class/online activities and reflections on the activities, as well as the results from the survey tests and interventions/focus groups.

I acknowledge that:

- I have been informed that participation is voluntary and the school and any participants are free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied.
- I have been informed that the confidentiality of the information collected will be safeguarded.
- My school will be referred to by pseudonym or code name in any publications arising from the research – ensuring anonymity.

"*All data collected with public funding may be made available in an open repository for public and scientific use*."

Regards

Researcher: M. Joubert
Email: jmariusjoubert@gmail.com

Supervisor: Dr. R Callaghan
Email: ronel.callaghan@up.ac.za

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PERMISSION FOR RESEARCH

I, _____, hereby give my consent

that the teacher/s and learners in my school _____ may participate in the study. I am assured of anonymity, and know that we can withdraw if we do not wish to participate any more.

Headmaster signature: _____ Date: _____

Researcher/s signature/s:_____
Date:_____

Supervisor's signature: _____ Date: _____

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Letter of consent - Parents

February 2017

Dear Parent/s

Mobile social learning to teach Physical Science

I am a Masters student enrolled at the University of Pretoria, supervised by Dr. Ronel Callaghan, and researching the use of mobile social learning of Physical Science for grade 11 learners. I request the participation of your child/children in this research. All activities in this research will be after school hours.

Every learner participating in the research is requested to complete a pre-survey as this information is used to implement an online resource used for teaching possibilities. An intervention will be developed based on the response of the pre-survey. The intervention will allow learners to access learning material at his/her convenient time, by making use of their mobile phones or tablets, assuming they have internet access. Different modules will be created to provide learners with the option for different topics, and as learners complete the topic a discussion will be held at the end. The discussion allows peers to assist each other with problems and difficulties they might encounter, as the research follows the discussion to ensure assistance is scientifically correct. Once the intervention is completed learners are requested to complete a post-survey to provide information about the intervention itself, as this will be used to better the intervention. Pre-test will be written before the intervention and a post-test afterwards. Both tests are set on certain Physical Science topics and the results will be compared to determine any significant change.

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I would like to possibly interview some learners or include them in a focus group to discuss their ideas and views.
Participation of learners is crucial as the experience of the learners help to develop an alternative teaching method for future use.

Possible risks

Learners might feel forced to participate in the research, because if they do not they will be excluded from all activities. However, should a learner choose not to participate, he/she can still make use of the intervention even though data will not be collected from him/her.

Benefits

Learners do have the opportunity to make use of an alternative teaching method allowing learners to access it at any time or place.
Learners can raise concerns or questions they might have about a topic and peers have the chance to assist or answer the concerns or questions.
An increase in understanding of the content and performance, such as achieving higher grades, are a possibility.

Should you agree that your child participate, please read the following.

- I consent that data can be collected from surveys and tests, as well as from the survey/focus groups and observations.
- I authorize the researcher to use class activities and reflections on the activities, as well as the results from the survey/focus groups.

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I acknowledge that:

- I have been informed that participation is voluntary and the school and any participants are free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied.
- I have been informed that the confidentiality of the information collected will be safeguarded.
- My school will be referred to by pseudonym or code name in any publications arising from the research – ensuring anonymity.

"*All data collected with public funding may be made available in an open repository for public and scientific use*."

If you agree to the research, please complete the form below and return it to the researcher

Regards

Researcher: M. Joubert
Email: jmariusjoubert@gmail.com

Supervisor: Dr. R Callaghan
Email: ronel.callaghan@up.ac.za

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PARTICIPATION IN THE RESEARCH

I, _____, hereby wish to indicate

that **my child**_____**do** want to be part of the research and that **data** collected from him/her may be used for the research.

Parent signature: _____ Date: _____

Participant signature: _____ Date: _____

Researcher/s signature/s:_____ Date: _____

Supervisor's signature: _____ Date: _____

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Letter of consent - Teacher

February 2017

Dear Educator

Mobile social learning to teach Physical Science

I am a Masters student at the University of Pretoria, supervised by Dr. Ronel Callaghan, and am curious about the use and effect of using mobile social learning through Open Education Resources as an educational medium. I request that teachers and learners in the school participate in the research. All activities in this research will be after school hours.

The research investigates the use of mobile social learning to provide education for Grade 11 learners in Physical Science as subject. Learners can access educational material online, on an allocated Open Educational Resource with pre-developed modules based on different Physical Science topics, via a mobile phone or tablet at any time and place (internet access required). At the end of each module learners can discuss the content, questions, problems or uncertainties they might have. Each module is created based on the content learners need to know as prescribed by the CAPS document.

Each learner participating is required to complete a pre-survey and a pre-test, after which learners are given the opportunity to access the online educational resource. Once the intervention period expires learners are requested to complete a post-survey and post-test. All surveys and tests are to be completed outside class periods

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as not to consume educational time. Teachers participating in the research need to hand out surveys and tests and inform learners about the online educational medium.

The results of the research can provide information about the use of mobile devices amongst Grade 11 learners. Pre- and post-test results might indicate if the mobile social learning does have any effect on the understanding of certain topics amongst learners. As for the surveys, it provides information about the mobile social learning such as, the ease of use, possible changes to be made, do they prefer to make use of it and can they easily access the content knowledge.

The role of the teacher requires him/her to hand out the pre-survey, which will be given to the teacher, to the learners. A pre-test is required from all participants, therefore the teacher should hand a pre-test to all participants and ensure test rules and regulations are enforced. As the intervention is created and developed by the researcher, the teacher needs to refer the participants to the online learning medium where learners can access learning material. After a period of time the intervention will be stopped and the participants are requested to complete a post-survey and a post-test. The teacher should provide each participant with the needed documents and ensure the same environment is created as during the pre-test and pre-survey.

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The table that follows indicate the date, duration and activity to be completed.

Start date	End date	Activity	Where	When
6 Feb 2017	10 Feb 2017	Pre-survey	Classroom/s	After school hours
13 Feb 2017	17 Feb 2017	Pre-test	Classroom/s	After school hours
20 Feb 2017	31 Mar 2017	Intervention	Preferred place of participant	Preferred time of participant
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11 Apr 2017	20 Apr 2017	Post-survey	Classroom/s	After school hours
21 Apr 2017	30 Apr 2017	Interview/ focus group	Classroom/s	After school hours

Should you agree to participate, please read the following and sign the letter of consent:

- I consent that data can be collected from activities and reflections on the activities, as well as from the survey/focus groups and observations.
- I authorize the researchers to use class/online activities and reflections on the activities, as well as the results from the survey/focus groups.

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I acknowledge that:

- I have been informed that participation is voluntary and the school and any participants are free to withdraw from the project at any time without explanation or prejudice and to withdraw any unprocessed data previously supplied.
- I have been informed that the confidentiality of the information collected will be safeguarded.
- My school will be referred to by pseudonym or code name in any publications arising from the research – ensuring anonymity.

"*All data collected with public funding may be made available in an open repository for public and scientific use*."

Looking forward to working with you

Regards

Researcher: M. Joubert
Email: jmariusjoubert@gmail.com

Supervisor: Dr. R Callaghan
Email: ronel.callaghan@up.ac.za

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PERMISSION FOR RESEARCH

I, _____, hereby give my consent for participation in the study. I am assured of anonymity, and know that I can withdraw if I do not wish to participate any more.

Participant signature: _____ Date: _____

Researcher/s signature/s:_____ Date: _____

Supervisor's signature: _____ Date: _____

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Letter of consent - Learner

February 2017

Dear Participant

Mobile social learning to teach Physical Science

I am a Masters student enrolled at the University of Pretoria, supervised by Dr. Ronel Callaghan, and researching the use of mobile social learning of Physical Science for grade 11 learners. I request your participation in the research. All activities in this research will be after school hours.

Should you choose to participate in the research you will be requested to complete a pre-survey as this information is used to implement an online resource used for teaching. An intervention will be created based on the feedback of the pre-survey. The intervention will allow you to access learning material at your convenience by making use of your smart phone or tablet (internet access is required). Different modules will be created to provide you with the option for different topics, and as you complete the topic a discussion will be held at the end. The discussion allows peers to assist each other with problems and difficulties they or you might encounter, as the researcher follows the discussion to ensure assistance is scientifically correct. Once the intervention is completed you are requested to complete a post-survey to provide information about the intervention itself, as this will be used to improve the intervention for future use. Pre-test will be written before the intervention and a post-test afterwards. Both tests are set on certain Physical Science topics and the results will be compared to determine any significant change. I would like to interview some

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of the participants or include them in a focus group to discuss their ideas and views. Participation of learners is crucial as the experience of the learners help to develop an alternative teaching method for future use.

Possible risks

Learners might feel forced to participate in the research, because if they do not they will be excluded from all activities. However, should a learner choose not to participate, he/she can still make use of the intervention even though data will not be collected from him/her.

Benefits

Learners do have the opportunity to make use of an alternative teaching method allowing learners to access it at any time or place.
Learners can raise concerns or questions they might have about a topic and peers have the chance to assist or answer the concerns or questions.
An increase in understanding of the content and performance, such as achieving higher grades, are a possibility.

Should you agree to participate, please read the following.

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- I authorize the researcher to use class activities and reflections on the activities, as well as the results from the survey/focus groups.

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"*All data collected with public funding may be made available in an open repository for public and scientific use*."

If you agree to the research, please complete the form below and return it to the researcher

Regards

Researcher: M. Joubert
Email: jmariusjoubert@gmail.com

Supervisor: Dr. R Callaghan
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PARTICIPATION IN THE RESEARCH

I, _____, hereby wish to participate in the research and that **data** collected from me may be used for the research.

Participant signature: _____ Date: _____

Researcher/s signature/s:_____ Date: _____

Supervisor's signature: _____ Date: _____

Appendix B: Pre-survey

Pre-survey

Using mobile social learning through Open Education Resources for Physical Science grade 11 learners.

The research investigates the use of mobile social learning to provide education for Grade 11 learners in Physical Science as subject. Learners can access educational material online, on an allocated Open Educational Resource with pre-developed courses based on different Physical Science topics. The educational material can be accessed by a mobile phone or a tablet, the only requirement is internet access from the mobile device/s. At the end of each module learners can discuss the content, raise questions or problems, or any uncertainties they might have. Each module is created based on the content learners need to know as prescribed by the CAPS document.

The purpose of the pre-survey is to obtain information about which social media learners are using, if it is used for educational purposes, do they access educational content on the internet and if not would they make use of it if information is available at any time or place. After analysing the pre-survey the information gather will be used to set up a mobile social learning facility for learners.

Pre-survey for Grade 11 Physical Science learners in Gauteng area.

Answer all questions by indicating with an “X” in the darker block, or when applicable by writing your answer in the space provided.
Please complete all questions.

1. Name and surname

2. Gender

Female	
Male	

3. Age

14 years	
15 years	
16 years	
17 years	
18 years	
Other - specify	

4. Home language

Afrikaans	
English	
Sotho	
Xhosa	
Zulu	
Other – specify	

5. Name of school

6. Technology used during teaching?

Projector	
Black board	
Transparencies	
Other – specify	

7. How easily do you have access to Physical Science content?

Very easy	
Fairly easy	
Fairly difficult	
Very difficult	

8. What resources do you use when studying?

Pencil, pen	
Highlighters	
Paper, note book	
Computer	
Tablets	
Smartphones	
Whiteboard and markers	
Other – specify	

9. Which of the following devices do you possess?

Smart phone	
Tablet	
Notebook or laptop	
Desktop computer	
Other – specify	

10. Specify your answer in question 9: How do you use technology in your day-to-day environment?

11. Do you make use of technology (electronic devices, internet, etc.) when studying?

Yes	
No	

12. Would you prefer to make use of technology when studying, if you are not already using technology?

Yes	
No	
Unsure	

13. How do you think you could use/ are you using technology when studying?

14. Rank the following devices in order of most likely (1) to the least likely (3) you would use for studying?

Mobile phone
Tablets
Computer

15. Do you have a social media profile (Facebook, Twitter, etc.)?

Yes	
No	

16. If question 15 is answered yes, specify which social media.

17. How comfortable are you using the social media named in question 16?

Very comfortable	
Fairly comfortable	
Fairly uncomfortable	
Very uncomfortable	

18. How do you access social media?

Smart phone	
Tablet	
Computer	
Other - specify	

19. How often do you make use of social media?

More often than twice a day	
1-2 times a day	
Once in two days	
Once a week	
Once a month	
Less than once a month	

20. What do you use social media for, most of the time?

21. Do you use social media for educational purposes?

Yes, often	
Sometimes	
Rarely	
Not at all	

22. How much time do you currently spend waiting for something/someone per day?

5+ hours	
3-5 hours	
1-3 hours	
0-1 hour	

23. If the opportunity was available, would you spend wasted time more productive?

Yes	
No	

24. While waiting, would you access educational content for studying to use your time more productively?

Yes	
Occasionally	
Rarely	
No	

25. If virtual class discussions were available, would you take part?

Yes	
No	

26. Would you make use of the internet to access educational material?

Yes	
No	

27. Would you use social media for educational purposes?

Yes	
No	

28. In your opinion, what resources (computer, projector, handouts, whiteboard, etc.) should be used by teachers, and in what way, to enhance your learning experience?

29. *Virtual social education is the use of technology to access subject specific content at any time or place, which is used for educational purposes. Discussions are included in these virtual classrooms where learners can communicate and discuss problems or content.*

    What would you expect from virtual social education?

30. What problems do you foresee with virtual social education, specify and explain (connectivity, data usage, interaction).

31. How do you feel about the idea of educational material for Physical Science available at any time, which can be accessed for learning purposes?

32. What effect do you expect to see in your marks, learning experience and method of learning?

Appendix C: Post-survey

Using mobile social learning through Open Education Resources for Physical Science grade 11 learners.

The research investigates the use of mobile social learning to provide education for Grade 11 learners in Physical Science as subject. Learners can access educational material online, on an allocated Open Educational Resource with pre-developed modules based on different Physical Science topics. The educational material can be accessed by a mobile phone or a tablet, the only requirement is internet access from the mobile device/s. At the end of each module learners can discuss the content, raise questions or problems, or any uncertainties they might have. Each module is created based on the content learners need to know as prescribed by the CAPS document.

The purpose of the post-survey is to obtain information about which mobile social learning. Participants have the opportunity to give their opinion about the intervention such as the positive aspects, negative aspects or recommendations for possible improvements.

Post-survey for Grade 11 Physical Science learners in Gauteng area.

Answer all questions by drawing an “X” in the darker block, or when applicable by writing your answer in the space provided.
Please complete all questions.

1. Name and surname

2. Gender

Female	
Male	

3. Age

14 years	
15 years	
16 years	
17 years	
18 years	
Other - specify	

4. Home language

Afrikaans	
English	
Sotho	
Xhosa	
Zulu	
Other – specify	

5. Name of school

6. Teaching method of your educational instruction

Projector	
Black board	
Transparencies	
Other – specify	

7. How did you access the technological content?

Smart phone	
Tablet	
Computer	
Other – specify	

8. How often did you access the technological content?

Once a month	
Twice a week	
Once a week	
Once a day	
More than once a day	

9. When did you access the technological content (virtual social learning)?

Once off	
Regular basis	
Before an assessment	
Other – specify	

10. If you accessed technological content (virtual social learning), at what time during the day?

Early morning (4:00-7:00)	
Morning (07:00-12:00)	
Afternoon (12:00-17:00)	
Evening (17-20:00)	
Late evening (20:00-24:00)	

11. Did you find it helpful?

Yes	
No	

12. Explain why you found it helpful, or why you did not found it helpful.

13. Do you prefer this method to extra classes on a fixed date and time?

Yes	
No	
Uncertain	

14. Explain why you prefer this method to a fixed extra class, or why you do not prefer it to a fixed extra class.

15. What resources do you use when studying?

Pencil, pen	
Highlighters	
Paper, note book	
Computer	
Tablets	
Smartphones	
Whiteboard and markers	
Other – specify	

16. Have you participated in the virtual classroom discussions?

Yes	
No	

17. Did you find it to be user friendly?

Yes	
No	

18. Explain the positive aspects, negative aspects or challenges that you encountered.

19. Have your marks improved since using virtual classroom discussions?

Yes	
No	

20. Do you feel you have a better understanding of the Physical Science content?

Yes	
No	

21. On a scale of 1 to 10, 1 being least effective and 10 being extremely effective, how effective would you say this method of teaching is?

1	2	3	4	5	6	7	8	9	10

22. What is the reason for you answer in question 21?

23. Would you make use of it in the future?

Yes	
No	

24. Give a reason for you answer in question 23.

25. Were you concerned about the amount of data being used?

Yes	
No	

26. The virtual classrooms improved my understanding of the topic.

I fully agree	
I agree	
I disagree	
I strongly disagree	

27. What drawback or complaints do you have?

28. Do you have any suggestions for improving this teaching method?

Appendix D: Pre- and post-tests

Test

The following test consists of 30 multiple choice questions. Answer all questions by choosing the correct option for each individual question. Mark the correct answer with an “X”.

The shaded (grey blocks) are for office use only.

General questions:

Name and surname:

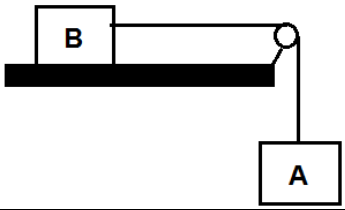
Gender

Age

1. Susan places a box on an inclined plane, but the box does not slide down the slope. Which of the following is **NOT** a way to get the box into motion?

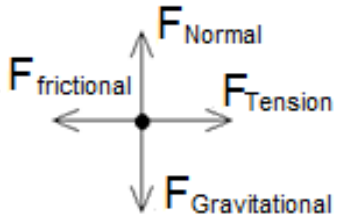
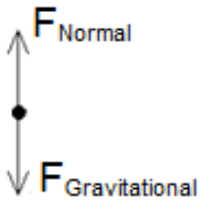
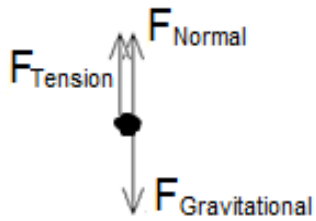
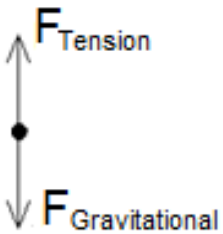
A) Reduce the friction between the box and the surface.	C) Apply a small force just to get the box moving.	Office use
B) Increase the mass of the object.	D) Increase the angle of the plane with the horizontal.	

2. Steve throws a ball upwards. As soon as the ball leaves his hand, what is/are the force(s) acting on the ball? Ignore any friction and air resistance.

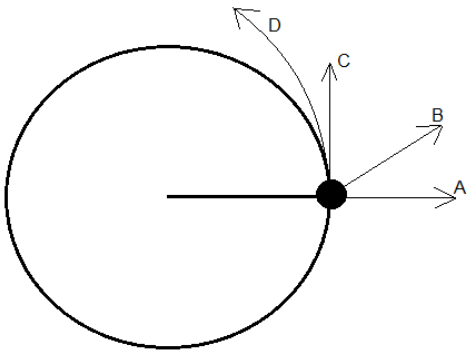


A) Upward applied force only.	C) Upward applied force and downward gravitational force.	Office use
B) Downward gravitational force only.	D) No force as the ball is in midair.	

3. Which of the following illustrates the free body diagram of box A?

A) 	C) 	Office use
B) 	D) 	

4. A ball is attached to a rope and swung above the head in a horizontal circle. The picture illustrates the overview. When the ball reaches the mark on the right the rope breaks. Choose the direction the ball will travel in as seen from above.



A) A	C) C	Office use
B) B	D) D	

5. An object is dropped by an airplane in the Earth's atmosphere and it falls to the ground. Ignore air friction and consider the following statements. As it falls . . .
    5. the gravitational force the object experiences increases.
    6. its acceleration increases.
    7. its velocity increases.
    8. its mass increases.

    Which of the statement(s) is/are true:

A) All are true	C) Only 2 and 3 are true.	Office use
B) 1, 2, and 3 are true.	D) Only 3 is true.	

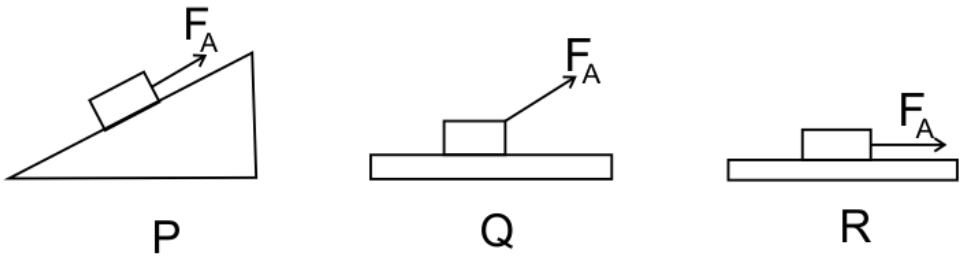
6. Is a force needed to keep a car moving at a constant velocity if friction is present?

A) Yes, a force equal to the frictional force is needed.	C) No, at constant velocity the forces are in equilibrium	Office use
B) Yes, a force greater than friction is needed	D) No, resultant force is 0N	

7. A man exerts a force of 100N on a bookshelf, but the bookshelf remains at rest. What is the force the bookshelf exerts on the man?

A) More than 100N, because the bookshelf is stronger than the man.	C) Equal to 100N, because the force by the man and the force by the bookshelf are in equilibrium.	Office use
B) Less than 100N, because the bookshelf is not a living thing and cannot exert a force.	D) Equal to 100N, but in the opposite direction, because this is a law of the physical world.	

8. Consider the following boxes resting on a surface as shown in the diagrams.



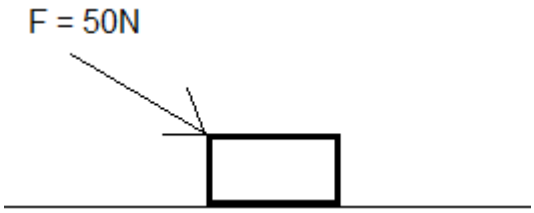
In which of the situations above is/are it true that $F_{Normarl} = F_{gravity}$?

A) In all the cases.	C) Only in R.	Office use
B) Only in Q and R.	D) In none of the cases	

9. If a horizontal force is exerted on an object on a flat surface and the object is not moving, which one of the following statements is true?

A) Applied force = frictional force	C) Frictional force is less than applied force	Office use
B) Applied force is less than frictional force	D) Both the applied force and the frictional force are equal to 0N	

10. A box is pushed across a horizontal floor by an applied force as indicated in the diagram. The magnitude of the normal force is . . .

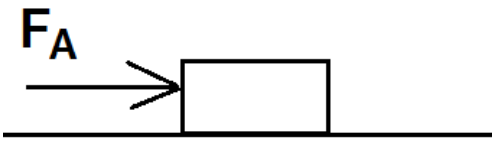


A) equal to the gravitational force plus y-component of the applied force.	C) equal to the gravitational force.	Office use
B) equal to the gravitational force minus y-component of the applied force.	D) equal to the y-component of the applied force.	

11. Which one of the following statements is true about a man applying a force to a wall?

A) The force the man exerts on the wall is equal to the force the wall exerts on the man.	C) The force the wall exerts on the man is greater than the force the man exerts on the wall.	Office use
B) The force the man exerts on the wall is the same magnitude but opposite direction than the force the wall exerts on the man.	D) The man exerts a greater force on the wall than the wall exerts on the man.	

12. Consider the following situation where an object moves across a surface while a force F_A is applied to the object.



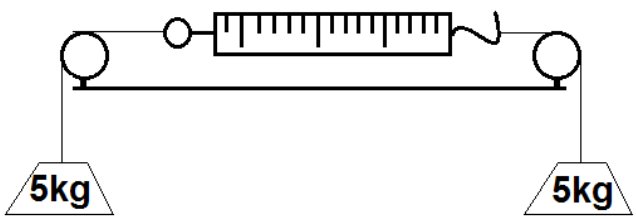
Which of the following is **NOT** true about the kinetic frictional force between the object and the surface on which it is moving?

A) Kinetic frictional force will increase when normal force increases.	C) Kinetic frictional force will increase when the mass of the object increases.	Office use
B) Kinetic frictional force will increase when the object is placed on a coarser area.	D) Kinetic frictional force will increase when the applied force increases.	

13. A net force of 100N to the right is applied to a crate. If the mass of the crate is kept constant and the force is doubled, what effect will it have on the acceleration?

A) Acceleration will be half.	C) Acceleration will increase by factor 4.	Office use
B) Acceleration will double.	D) Acceleration will remain constant.	

14. Two weights of 5kg each is connected to the two ends of a spring balance with a rope. The spring scale is on a table and the weights are hanging freely, as indicated in the diagram. The weights and the spring balance are in equilibrium.



Which of the following will be the reading on the spring balance?

A) 49 N, because for every action there is an equal but opposite reaction.	C) 24,5 N, because the weight on the one side reduces the effect of the other weight.	Office use
B) 98 N, because the weights are applying a force at both ends of the spring balance.	D) 0N, because the forces are in opposite directions.	

15. A horizontal net force of 5N is applied to a 5kg box on a horizontal surface. The box accelerates form rest and reaches a velocity of 5m.s^{-1} at a specific instant (at 5s) during its motion. What will be true for the box from 5s onwards?

A) The box will keep accelerating as a net force is applied.	C) The box will slow down and come to a stop.	Office use
B) The box will move with a constant velocity.	D) The box will move with a constant velocity and then reduce velocity.	

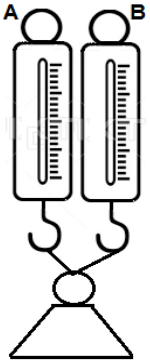
16. An object is dropped from a height of 2m. What forces are acting on the object when the object reaches the midpoint? Ignore all effects of air resistance.

A) Normal force upwards and gravitational force downwards.	C) Gravitational force downwards and applied force downwards.	Office use
B) Normal force downwards and gravitational force upwards.	D) Gravitational force downwards.	

17. Two spring balances are connected to each other and a weight is attached to the bottom spring balance. Ignore the mass of the spring balances. Which of the following is true about the spring balances?

A) The lower balance will have a greater reading than the higher balance.	C) Both balances will have the same reading.	Office use
B) The higher balance will have a greater reading than the lower balance.	D) The higher balance will be the only balance with a reading.	

18. Two spring balances are connected to a mass and the balance A has a reading of 50N. Which of the following is true about spring balance B and the weight of the object?



A) B = 50N, weight of the object = 100N	C) B = 100N, weight of the object = 100N	Office use
B) B = 50N, weight of the object = 50N	D) B = 100N, weight of the object = 50N	

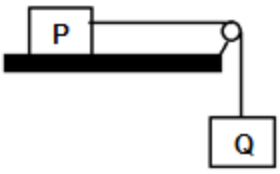
19. A woman on roller skates pushes horizontally against a table. The table does not move but the woman moves backwards. Why does the woman move backwards?

A) The force the table exerts on the woman is more than the force the woman exerts on the table.	C) The woman only pushes herself backwards.	Office use
B) The force the women exert on the table and the force the table exerts on the women are equal and therefore the woman does not accelerate but moves backwards.	D) The frictional force between the roller skates and the floor is overcome by the reaction force on the table.	

20. On Earth, any object will accelerate in the direction of an applied force across a rough surface, if . . .

A) the applied force causes a (non zero) net force.	C) there is no force in the opposite direction as the applied force.	Office use
B) the force is applied horizontal to the surface.	D) the friction in the opposite direction is the same magnitude as the applied force.	

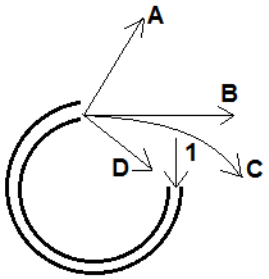
21. The following question is based on the given diagram.



Which one of the two blocks will experience a normal force?

A) Q, because of the applied force upwards in the rope.	C) P, because of the surface underneath the block.	Office use
B) Q, because of the tension in the rope.	D) P, because the tension in the rope is to the right.	

22. A ball is dropped vertically downward in a pipe at position 1 as shown in the diagram.



Which path will the ball follow after it has left the pipe?

A) A	C) C	Office use
B) B	D) D	

23. Ben is pushing a box of 50kg at a constant velocity across the floor. If the mass of the box is halved, what effect does it have on the force required to maintain the same velocity?

A) The force required also halves	C) The force required remains the same.	Office use
B) The force required doubles.	D) The force decreases because acceleration increases.	

24. Kate is working on the 10th floor of a building. What happens to Kate's weight if she uses the elevator to go up?

A) Decreases.	C) Remains constant.	Office use
B) Increases.	D) First decreases then increases.	

25. A box is placed on an inclined plane and remains at rest. Choose the reason why the box does not move.

A) The static friction force upwards along the surface is greater than the downward force of gravity.	C) The static and kinetic friction upwards along the surface is enough to keep the box at rest.	Office use
B) The static friction force upwards along the surface is the same as the downward force due to gravity.	D) The kinetic friction force downwards along the surface is not enough to overcome the static friction force.	

26. When a space rocket is launched from the firing pad the velocity of the spaceship increases. This is due to. . .

A) the force applied due to the shooting out of gasses.	C) the initial launch that keeps the spaceship moving at a constant velocity.	Office use
B) the gasses exerting a force on the firing pad and the firing pad exerts a force on the space rocket.	D) the force that keeps the spaceship moving at a constant velocity.	

27. If you are in space and you throw a ball. How much force should be applied after the ball was thrown to keep the ball moving?

A) Enough force to overcome the weight.	C) No force because there is no friction.	Office use
B) Enough force to keep it from falling.	D) Enough force to overcome friction and resistance.	

28. For an object finding itself on a frictionless surface, which action requires the least amount of applied force?

A) Getting a stationary object into motion.	C) Keeping a moving object in motion.	Office use
B) Increasing the velocity of a moving object.	D) Changing the direction of a moving object.	

29. During a car crash passengers tend to suffer from neck injuries if they wear seatbelts. This is because of . . .

A) acceleration.	C) tension due to the collision.	Office use
B) inertia.	D) the impact to the passengers' head.	

30. A car will remain at rest as long as an applied force . . .

A) is greater than kinetic friction.	C) is smaller than kinetic friction.	Office use
B) is greater than static friction.	D) is smaller than maximum static friction.	